CIRCULAR:-

A reference is invited to the syllabi relating to the Master of Engineering (Mechanical) Heat Power Engineering degree course vide this office Circular No.UG/08 of 2013-14, dated 23rd April, 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. 4.31 and that in accordance therewith, the revised syllabus as per Choice Based Credit System for Master of Engineering (Mechanical) Heat Power 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/ 4.31/14/07/2016.

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

No. UG/14]-A of 2016 MUMBAI-400 032 November, 2016

Copy forwarded with compliments for information to:-

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

(Dr.M.A.Khan)
REGISTRAR
UNIVERSITY OF MUMBAI

Revised Syllabus for the M. E. Program

Program: M. E. (Mechanical)

HEAT POWER 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 stakeholders.

Dr. S. M. Khot

Chairman, Board of Studies in Mechanical Engineering, University of Mumbai
Program Structure for  
ME Mechanical Engineering (Heat Power 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>
</tr>
</thead>
<tbody>
<tr>
<td>HPEC101</td>
<td>Advanced Heat Transfer</td>
<td>04 -- 04</td>
<td>04</td>
</tr>
<tr>
<td>HPEC102</td>
<td>Advanced Thermodynamics</td>
<td>04 -- 04</td>
<td>04</td>
</tr>
<tr>
<td>HPEC103</td>
<td>Gas Turbine and Steam Turbine</td>
<td>04 -- 04</td>
<td>04</td>
</tr>
<tr>
<td>HPEDLO101X</td>
<td>Department Level Optional Course I</td>
<td>04 -- 04</td>
<td>04</td>
</tr>
<tr>
<td>ILO101X</td>
<td>Institute Level Optional Course I</td>
<td>03 -- 03</td>
<td>03</td>
</tr>
<tr>
<td>HPEL101</td>
<td>Laboratory I - Simulation of Thermal Systems</td>
<td>-- 02 --</td>
<td>01</td>
</tr>
<tr>
<td>HPEL102</td>
<td>Laboratory II - Refrigeration and Air conditioning Technologies</td>
<td>-- 02 --</td>
<td>01</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>19 04 19 02</td>
<td>21</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Examination Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPEC101</td>
<td>Advanced Heat Transfer&quot;</td>
<td>Internal Assessment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Theory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test1  Test2  Avg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End Sem Exam  Exam Duration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Term Work  Pract/Oral  Total</td>
</tr>
<tr>
<td>HPEC101</td>
<td>Advanced Heat Transfer</td>
<td>20 20 20 80 03</td>
</tr>
<tr>
<td>HPEC102</td>
<td>Advanced Thermodynamics</td>
<td>20 20 20 80 03</td>
</tr>
<tr>
<td>HPEC103</td>
<td>Gas Turbine and Steam Turbine</td>
<td>20 20 20 80 03</td>
</tr>
<tr>
<td>HPEDLO101X</td>
<td>Department Level Optional Course I</td>
<td>20 20 20 80 03</td>
</tr>
<tr>
<td>ILO101X</td>
<td>Institute Level Optional Course I</td>
<td>20 20 20 80 03</td>
</tr>
<tr>
<td>HPEL101</td>
<td>Laboratory I - Simulation of Thermal Systems</td>
<td>-- -- -- 25 25 50</td>
</tr>
<tr>
<td>HPEL102</td>
<td>Laboratory II - Refrigeration and Air conditioning Technologies</td>
<td>-- -- --</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>100 100 100 400 50 50 600</td>
</tr>
<tr>
<td>Course Code</td>
<td>Department Level Optional Course I</td>
<td>Course Code</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------------------------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>HPEDLO1011</td>
<td>Utilization of Solar Energy</td>
<td>ILO1011</td>
</tr>
<tr>
<td>HPEDLO1012</td>
<td>Cogeneration and Waste Heat Recovery Systems</td>
<td>ILO1012</td>
</tr>
<tr>
<td>HPEDLO1013</td>
<td>Alternative Fuels</td>
<td>ILO1013</td>
</tr>
<tr>
<td>HPEDLO1014</td>
<td>Design of Refrigeration and Air conditioning Systems</td>
<td>ILO1014</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ILO1015</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ILO1016</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ILO1017</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ILO1018</td>
</tr>
</tbody>
</table>

# Common with Thermal Engineering and Heat Power Engineering

& Common for Thermal Engineering and Energy Systems and Management
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Teaching Scheme (Contact Hours)</th>
<th>Credits Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Theory</td>
<td>Pract</td>
</tr>
<tr>
<td>HPEC201</td>
<td>Modelling and Analysis in Thermal Engineering #</td>
<td>04</td>
<td>--</td>
</tr>
<tr>
<td>HPEC202</td>
<td>Advanced Fluid Mechanics</td>
<td>04</td>
<td>--</td>
</tr>
<tr>
<td>HPEC203</td>
<td>Heat Exchanger Design and Performance #</td>
<td>04</td>
<td>--</td>
</tr>
<tr>
<td>HPEDLO 202X</td>
<td>Department Level Optional Course II</td>
<td>04</td>
<td>--</td>
</tr>
<tr>
<td>ILO202X</td>
<td>Institute Level Optional Course II</td>
<td>03</td>
<td>--</td>
</tr>
<tr>
<td>HPEL201</td>
<td>Laboratory III - Computational Fluid Dynamics</td>
<td>02</td>
<td>--</td>
</tr>
<tr>
<td>HPEL202</td>
<td>Laboratory IV - Energy Audit</td>
<td>02</td>
<td>--</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>19</td>
<td>04</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Examination Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Internal Assessment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test1</td>
</tr>
<tr>
<td>HPEC201</td>
<td>Modelling and Analysis in Thermal Engineering #</td>
<td>20</td>
</tr>
<tr>
<td>HPEC202</td>
<td>Advanced Fluid Mechanics</td>
<td>20</td>
</tr>
<tr>
<td>HPEC203</td>
<td>Heat Exchanger Design and Performance #</td>
<td>20</td>
</tr>
<tr>
<td>HPEDLO 202X</td>
<td>Department Level Optional Course II</td>
<td>20</td>
</tr>
<tr>
<td>ILO202X</td>
<td>Institute Level Optional Course II</td>
<td>20</td>
</tr>
<tr>
<td>HPEL201</td>
<td>Laboratory III - Computational Fluid Dynamics</td>
<td>--</td>
</tr>
<tr>
<td>HPEL202</td>
<td>Laboratory IV - Energy Audit</td>
<td>--</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

# Common with Thermal Engineering and Heat Power Engineering
& Common with Thermal Engineering and Energy Systems and Management
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Department Level Optional Course II</th>
<th>Course Code</th>
<th>Institute Level Optional Course II</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPEDLO2021</td>
<td>Cryogenics #</td>
<td>ILO2021</td>
<td>Project Management</td>
</tr>
<tr>
<td>HPEDLO2022</td>
<td>Computational Fluid Dynamics &amp; Heat Transfer</td>
<td>ILO2022</td>
<td>Finance Management</td>
</tr>
<tr>
<td>HPEDLO2023</td>
<td>Advanced Turbo Machinery #</td>
<td>ILO2023</td>
<td>Entrepreneurship Development and Management</td>
</tr>
<tr>
<td>HPEDLO2024</td>
<td>Non-Conventional Power Plants #</td>
<td>ILO2024</td>
<td>Human Resource Management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ILO2025</td>
<td>Professional Ethics and CSR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ILO2026</td>
<td>Research Methodology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ILO2027</td>
<td>IPR and Patenting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ILO2028</td>
<td>Digital Business Management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ILO2029</td>
<td>Environmental Management</td>
</tr>
</tbody>
</table>
### Semester III

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Teaching Scheme (Contact Hours)</th>
<th>Credits Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Theory</td>
<td>Pract</td>
</tr>
<tr>
<td>HPE301</td>
<td>Seminar</td>
<td>--</td>
<td>03</td>
</tr>
<tr>
<td>HPE301</td>
<td>Dissertation I</td>
<td>--</td>
<td>24</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>--</td>
<td>30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Examination Scheme</th>
<th>Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Internal Assessment</td>
<td>End SemExam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test1</td>
<td>Test 2</td>
</tr>
<tr>
<td>HPE301</td>
<td>Seminar*</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>HPE301</td>
<td>Dissertation I</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

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

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

### Semester IV

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Teaching Scheme (Contact Hours)</th>
<th>Credits Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Theory</td>
<td>Pract</td>
</tr>
<tr>
<td>HPE401</td>
<td>Dissertation II</td>
<td>--</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>--</td>
<td>30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Examination Scheme</th>
<th>Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Internal Assessment</td>
<td>End SemExam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test1</td>
<td>Test 2</td>
</tr>
<tr>
<td>HPE401</td>
<td>Dissertation II*</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

* Seminar of Semester III and Dissertation II of Semester IV should be assessed jointly by the pair of Internal and External Examiners
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 descritisation, 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>
</tr>
</tbody>
</table>
Assessment:

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

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

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

References:

1. Yunus A Cengel and Afhin J Ghajar, Heat and Mass Transfer
3. S.P. Sukhatme, Heat transfer, University Press
Objectives
1. Describe the concepts entropy and exergy and their use in analyses of thermal energy systems
2. Master the property equations and the methods for analyzing multi-component systems.
3. Acquire basic knowledge of chemical thermodynamics.

Outcomes: Learner will be able to…
1. Use exergy concept in the analysis of thermal systems.
2. Knowledge of phase equilibria in multi-component systems.
3. Ability to estimate thermodynamic properties of substances in gas or liquid state of ideal and real mixture
4. Have knowledge of contemporary issues related to chemical engineering thermodynamics

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Introduction:</strong> Availability, Irreversibility and Second-Law Efficiency for a closed System and steady-state, control Volume. Availability Analysis of Simple Cycles. Thermodynamic Potentials, Maxwell relations, Generalized relation for changes in Entropy, Internal Energy and Enthalpy.</td>
<td>06</td>
</tr>
<tr>
<td>02</td>
<td><strong>Equation of State:</strong> State postulate for Simple System and equation of state, Ideal gas equation, Deviation from ideal gas, Equation of state for real gases, generalized Compressibility chart, Law of corresponding states. Different Equations of State, Fugacity, Compressibility, Principle of corresponding States. Use of generalized charts for enthalpy and entropy departure, fugacity coefficient, Lee-Kesler generalized three parameter tables.</td>
<td>08</td>
</tr>
<tr>
<td>03</td>
<td><strong>Laws of thermodynamics:</strong> 2nd-law Analysis for Engineering Systems, Entropy flow &amp; entropy generation, Increase of entropy principle, entropy change of pure sub, T-ds relations, entropy generation, thermo electricity, Onsager equation. Exergy analysis of thermal systems, decrease of Exergy principle and Exergy destruction.</td>
<td>10</td>
</tr>
<tr>
<td>04</td>
<td><strong>Properties of Pure Substances:</strong> Phase change process of pure substances, PVT surface, P-v &amp; P- T diagrams, Use of steam tables and charts in common use <strong>Thermodynamic Property Relations:</strong> Partial Differentials, Maxwell relations, Clapeyron equation, general relations for du, dh, ds, and Cv and Cp, Joule Thomson Coefficient, , , s of real gases.</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td><strong>Chemical Thermodynamics:</strong> Chemical reaction, Fuels and combustion, Enthalpy of formation and enthalpy of combustion, First law analysis of reacting systems, adiabatic flame temperature, Chemical and Phase equilibrium - Criterion for chemical equilibrium, equilibrium constant for ideal gas mixtures, some remarks about Kp of Ideal-gas mixtures, fugacity and activity, Simultaneous relations, Variation of Kp with Temperature, Phase equilibrium, Gibb’s phase rule, Third law of thermodynamics, Nerst heat theorem and heat death of universe</td>
<td>10</td>
</tr>
<tr>
<td>06</td>
<td><strong>Gas Mixtures</strong> – Mass &amp; mole fractions, Dalton’s law of partial pressure, Amagat’s law, Kay’s rule. <strong>Statistical Thermodynamics</strong> - Fundamentals, equilibrium distribution, Significance of</td>
<td>10</td>
</tr>
</tbody>
</table>
Lagrangian multipliers, Partition function for Canonical Ensemble, partition function for an ideal monatomic gas, equi-partition of energy, Bose Einstein statistics, Fermi-Dirac statistics.

Assessment:

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

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

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

References:
4. Rao, Y.V.C., Postulational and Statistical thermodynamics, Allied Pub. Inc
5. Jones and Hawkings: engineering Thermodynamics, john Wiley & Sons, Inc. USA
8. Wark, Advanced Thermodynamics, McGraw Hill
15. Cengel, Thermodynamics, TMH
16. Van Wylen& Sontag: Thermodynamics, John Wiley & Sons, Inc., USA
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 steam as well as gas turbine
2. Solve numerical on steam and gas turbine sizing

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
</tr>
</thead>
<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>
</tr>
<tr>
<td>02</td>
<td>Steam turbine auxiliary systems: turbine protective devices, tripping devices, unloading gears, lubricating systems, glands and sealing systems</td>
</tr>
<tr>
<td>03</td>
<td>Construction, Operation and Maintenance of Steam Turbines</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>
</tr>
<tr>
<td>05</td>
<td>Combustion chambers, requirements, types, factor affecting performance of CC, performance of turbines</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>
</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 Plat.

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

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

5. R Yadav, Steam and Gas Turbines and Power Plant Engineering, Central Publishing House, Allahabad, 2004
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>
</tr>
</thead>
<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>
<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 Plat.

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 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

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Cogeneration:</strong> Introduction - Principles of Thermodynamics - Combined Cycles - Topping - Bottoming - Organic Rankine Cycles - Advantages of Cogeneration Technology</td>
<td>08</td>
</tr>
<tr>
<td>02</td>
<td><strong>Application &amp; techno economics of cogeneration:</strong> 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><strong>Waste heat recovery:</strong> Introduction - Principles of Thermodynamics and Second Law - sources of Waste Heat recovery - Diesel engines and Power Plant etc. Vapour absorption system working on waste.</td>
<td>08</td>
</tr>
<tr>
<td>04</td>
<td><strong>Waste heat recovery systems:</strong> 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>10</td>
</tr>
<tr>
<td>05</td>
<td><strong>Applications &amp; techno economics of waste heat recovery systems:</strong> Applications in industries, selection of waste heat recovery technologies - financial considerations - operations and investment costs of waste heat recovery</td>
<td>08</td>
</tr>
<tr>
<td>06</td>
<td><strong>Introduction to tri-generation and quad-generation</strong></td>
<td>04</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 Plat.
**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 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.

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Fossil Fuels to Alternative Fuels</td>
<td>10</td>
</tr>
<tr>
<td></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></td>
</tr>
<tr>
<td>02</td>
<td>Advanced Liquid Biofuels</td>
<td>12</td>
</tr>
<tr>
<td></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></td>
</tr>
<tr>
<td>03</td>
<td>Advanced Gaseous fuels</td>
<td>08</td>
</tr>
<tr>
<td></td>
<td>Bio-CNG from sugarcane, Synthetic gas SynGas, generation of SynGas through plasma gasification of plastic waste, Applications.</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>Hydrogen Technology</td>
<td>08</td>
</tr>
<tr>
<td></td>
<td>Hydrogen as Alternative fuel, Hydrogen storage, hydrogen liquefaction, ortho and para hydrogen, Non-fossil Natural gas and methane, Applications.</td>
<td></td>
</tr>
<tr>
<td>05</td>
<td>Fuel Cells</td>
<td>08</td>
</tr>
<tr>
<td>06</td>
<td>Alternative Fuels and Environmental Impact</td>
<td>06</td>
</tr>
<tr>
<td></td>
<td>Climate change, Benefits of alternative fuel to environment, Environmental impact assessment.</td>
<td></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 Plat.
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:

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.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPEDLO 1014</td>
<td>Design of Refrigeration and Air conditioning Systems</td>
<td>04</td>
</tr>
</tbody>
</table>

### 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 content</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Vapour Compression refrigeration</strong> - Multi-evaporator system; Multi expansion system; Cascade systems; Study of P-h; T-s; h-s and T-h charts for various refrigerants, Heat Pumps-circuits, industrial application &amp; future role</td>
<td>06</td>
</tr>
<tr>
<td>02</td>
<td><strong>Vapour absorption refrigeration</strong> - Standard cycle and actual cycle, thermodynamic analysis, Li-Br-water, NH3-water systems, Three fluid absorption systems, half effect, single effect, double effect, and triple effect system. Non-conventional refrigeration system (Principle and thermodynamic analysis only) - Thermoelectric refrigeration, Pulse Tube refrigeration, steam jet refrigeration, vortex tube refrigeration</td>
<td>10</td>
</tr>
<tr>
<td>03</td>
<td><strong>System Components &amp; Accessories, Controls</strong> - Refrigeration Compressors - Different types &amp; capacity control, Evaporators - different types &amp; application, Condensers - Types, Economical water rate &amp; velocity, Cooling Tower - Range &amp; approach, Expansion Devices, Accessories &amp; Controls - Oil separator, drier, Receiver, HP-LP cut out, Thermostats, relief valves, safety valves</td>
<td>08</td>
</tr>
<tr>
<td>04</td>
<td><strong>Air Conditioning Technology: Load Estimation and Air Distribution</strong> - study of various sources of the internal and external heat gains, solar heat gain, Load from - occupants, equipment, infiltration air, miscellaneous heat gain, heat load calculations, RSHF, GSHF, ESHF etc. Inside and outside design conditions, Duct-pressure drop calculations, design ducts by different duct design methods, duct layout patterns. Air distribution systems - types, ventilation systems - Types, Types of grills, diffusers, wall registers, etc.</td>
<td>10</td>
</tr>
<tr>
<td>05</td>
<td><strong>Air Conditioning equipment &amp; Control system</strong> - humidifiers, dehumidifiers, air filters, air washers, Fans and Blowers - types, performance characteristics, series and parallel arrangement, selection procedure, Basic elements of control system, thermostat, humidistat, control system used for winter &amp; summer air conditioning</td>
<td>08</td>
</tr>
<tr>
<td>06</td>
<td><strong>Direct and Indirect Evaporative Cooling and Air conditioning systems</strong> - Basic psychometric of evaporative cooling, Thermodynamics of evaporative cooling, types of evaporative coolers, design calculations, indirect evaporative cooling for tropical countries. Air conditioning systems - Classification, constructional details - window, package, split, central units. Typical air conditioning systems such as automobile, air plane, ships, railway coach air-conditioning, industrial refrigeration applications, medical application etc. warm air system, hot water systems, heat pump, clean rooms (descriptive treatments only). <strong>Standards and Codes:</strong> ASHRAE/ARI, BIS standards study and interpretation, ECBC, NBC codes</td>
<td>10</td>
</tr>
</tbody>
</table>
Assessment:

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

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

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

References:

1. R.J. Dossat, Principles of refrigeration, Pearson Education Asia
2. C.P. Arora, Refrigeration and Air-Conditioning
3. Stoecker and Jones, Refrigeration and Air-conditioning
4. Jordan and Priester, Refrigeration and Air-conditioning
5. A.R. Trott, Refrigeration and Air-conditioning, Butterworths
12. Domkundwar,Arora, A course on refrigeration & air conditioning – DhanpatRai& sons
13. Norman C. Harris, Modern air conditioning
15. Hainer R. W., Control System for Heating, Ventilation and Air conditioning, Van
17. ASHRAE Handbooks
Objectives:
1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

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

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

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

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

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

REFERENCES:

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

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

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

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

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

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

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

REFERENCES:
Course Code | Course Name | Credits
--- | --- | ---
ILO 1013 | Management Information System | 03

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

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

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

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.
End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question
papers of end semester examination. **In question paper weightage of each module will be proportional to
number of respective lecture hours as mention in the syllabus.**

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

REFERENCES:

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th
**Objectives:**
1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

**Outcomes:** Learner will be able to…
1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Introduction</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.1 Strategy of Experimentation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.2 Typical Applications of Experimental Design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.3 Guidelines for Designing Experiments</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.4 Response Surface Methodology</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Fitting Regression Models</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.1 Linear Regression Models</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.2 Estimation of the Parameters in Linear Regression Models</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.3 Hypothesis Testing in Multiple Regression</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.4 Confidence Intervals in Multiple Regression</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.5 Prediction of new response observation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.6 Regression model diagnostics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.7 Testing for lack of fit</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td><strong>Two-Level Factorial Designs and Analysis</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.1 The $2^2$ Design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.2 The $2^3$ Design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.3 The General $2^k$ Design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.4 A Single Replicate of the $2^k$ Design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.5 The Addition of Center Points to the $2^k$ Design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.6 Blocking in the $2^k$ Factorial Design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.7 Split-Plot Designs</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td><strong>Two-Level Fractional Factorial Designs and Analysis</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.1 The One-Half Fraction of the $2^k$ Design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.2 The One-Quarter Fraction of the $2^k$ Design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.3 The General $2^{k-p}$ Fractional Factorial Design</td>
<td></td>
</tr>
</tbody>
</table>
## Assessment:

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

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

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

## REFERENCES:

5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T. Voss
Objectives:
1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

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

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
</table>
| 01     | **Introduction to Operations Research:** Introduction, Structure of the Mathematical Model, Limitations of Operations Research  
**Linear Programming:** Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method,  
**Duality:** Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis  
**Assignment Problem:** Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm. Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem  
**Integer Programming Problem:** Introduction, Types of Integer Programming Problems, Gomory’s cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms. | 14 |
| 02     | **Queueing models:** queueing 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 | 05 |
saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.

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

**Assessment:**

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

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

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

**REFERENCES:**

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

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

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

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

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

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

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

REFERENCES:
1. Nina Godbole, SunitBelapure, Cyber Security, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, Information Systems Security, Wiley India, New Delhi
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538
**Objectives:**
1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome/minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

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

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Introduction</td>
<td>03</td>
</tr>
<tr>
<td></td>
<td>1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Natural Disaster and Manmade disasters: 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.</td>
<td>09</td>
</tr>
<tr>
<td>03</td>
<td>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.</td>
<td>06</td>
</tr>
<tr>
<td>04</td>
<td>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.</td>
<td>06</td>
</tr>
</tbody>
</table>
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.

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.

Assessment:

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

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

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

REFERENCES:
5. ‘Disaster management & rehabilitation’ by RajdeepDasgupta, Mittal Publications, New Delhi.
6. ‘Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications. (Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)
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>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>02</td>
<td>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 &amp; targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td>Energy Performance Assessment: On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.</td>
<td>04</td>
</tr>
</tbody>
</table>
Assessment:

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

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

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

REFERENCES:
1. Handbook of Electrical Installation Practice, Geoery 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>MODULE</th>
<th>Detailed content</th>
</tr>
</thead>
</table>
| 01     | Trial on VCC as Heat pump  
|        | Trial on VCC- Effect of condensing and evaporator temperature on Performance |
| 02     | Trial on Water cooling tower apparatus.  
|        | Design air conditioning system with system selection, load estimation, duct design, Equipment selection, Control systems, lay out diagrams (line sketches) for any one application from: Departmental store, Restaurant, Auditorium, Computer lab, Theater etc. |
| 03     | Visit report on (Any one) or Presentation on (Any one)  
|        | a) Cold Storage  
|        | b) Ice Plant  
|        | c) Dairy  
|        | d) Pharmaceutical |

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners
Objectives
1. Differenciate 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

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
</tr>
</thead>
<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>
</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 Plat.

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

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.
References:
2. Stocker W, Modelling of thermal systems,
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPEC202</td>
<td>Advanced Fluid Mechanics</td>
<td>4</td>
</tr>
</tbody>
</table>

**Objectives**
1. Understand governing equations of motion and N-S equation
2. Understand boundary layer concept in turbulent as well as laminar flow regime
3. Knowledge of compressible fluid flow

**Outcomes:** Learner will be able to…
1. Find exact solution of Navier Stokes equations
2. Implement compressible flow concept to real life problems

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed content</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Basic Concepts and Fundamentals: Properties of Fluids, Continuum, Lagrangian and Eulerian description, Velocity and Stress field, Fluid statics, Fluid Kinematics.</td>
<td>5</td>
</tr>
<tr>
<td>02</td>
<td>Governing Equations of Motion: Reynolds’s Transport Theorem (RTT), Integral and differential forms of governing equations: mass, momentum and energy conservation equations, Euler’s equation, Navier-Stokes equations, Bernoulli’s Equation.</td>
<td>10</td>
</tr>
<tr>
<td>03</td>
<td>Exact solutions of Navier - Stokes Equations: Couette flows, Poiseuille Flows (Plane, Hagen), Fully developed flows in channel, flow between concentric rotating cylinders, Stokes First problem (Unsteady flow), Creeping flow.</td>
<td>07</td>
</tr>
<tr>
<td>04</td>
<td>Laminar Boundary Layers: 4.1 Boundary layer equations, flow over a flat plate, similarity (Blasius) solution, Falkner-Skan equation, momentum integral method, Approximate Methods, Flow separation, Entry flow into a duct. 4.2 External flows: drag, lift,</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td>Turbulent flow: 5.1 Introduction to hydrodynamic stability, characteristics of turbulence, governing equations, turbulent boundary layer, algebraic models (Prandtl's mixing length) and velocity profile over a flat plate and in pipes. 5.2 Turbulent Shear Flows: Equations for free shear layers: mixing layer, plane and axis symmetric jet, wake. Turbulent energy equation, two equation model (k-epsilon, k-omega), Large Eddy Simulation, Various Turbulent Models.</td>
<td>12</td>
</tr>
<tr>
<td>06</td>
<td>Compressible Flow: 6.1 One-dimensional Flow: speed of sound, variable cross-section flow, converging diverging nozzle, effect of friction and heat transfer, normal shock relations, introduction to oblique shocks, Two-dimensional flows (subsonic and supersonic) past slender bodies, compressible boundary layers. 6.2 Shocks: Normal and oblique shocks, Prandtl – Meyer expansion, Rankine – Hugoniot relation, Application of method of characteristics applied to two dimensional cases, simple supersonic wind tunnel, Design of supersonic wind tunnel and nozzle.</td>
<td>10</td>
</tr>
</tbody>
</table>
Assessment:

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

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

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

References:
4. Fluid Mechanics, Cengel, Tata Mcgraw Hill
10. Modern Compressible Flow with Historical Perspective, John D. Anderson, Mcgraw Hill.
### Objectives
1. Impart knowledge of sizing and designing of various heat exchangers using various methods
2. Learn performance analysis and maintenance aspects of heat exchangers

### 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

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
</tr>
</thead>
<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>
</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>
</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>
</tr>
<tr>
<td>06</td>
<td>Design of Special Purpose Heat Exchangers: corrosive environment. Marine/space applications, compact heat exchanger</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hrs.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

### Assessment:

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

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

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

3. W. M. Kays and A. L. London, Compact heat exchanger,
4. Mojtaba Sabet, Cooling tower fundamentals and best design practices,
Course Code | Course Name | Credits
---|---|---
HPEDLO 2021 | Cryogenics | 04

**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

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed content</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<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>
</tr>
</tbody>
</table>
Assessment:

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

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

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

References:
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.
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 Content</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Introduction to CFD and the Governing Equations of Fluid Dynamics: Historical background, Impact of CFD, Derivation, Discussion of physical meanings, and presentation of forms particularly suitable to CFD.</td>
<td>04</td>
</tr>
<tr>
<td>03</td>
<td>Few CFD Techniques The Lax-Wendroff Technique, MacCormack’s Technique, Space marching, Relaxation Technique, Numerical dissipation and dispersion, Artificial viscosity, The ADI Technique, Pressure correction Technique: Application to incompressible viscous flow, the SIMPLE algorithm. SIMPLE Procedure of Patankar and Spalding, Computation of Boundary layer flow, Finite deference approach.</td>
<td>10</td>
</tr>
<tr>
<td>05</td>
<td>Convection Heat Transfer And FEM: Steady One-Dimensional and Two-Dimensional Convection - Diffusion, Unsteady one-dimensional convection - Diffusion, Unsteady two-dimensional convection - Diffusion - Introduction to finite element method - Solution of steady heat conduction by FEM - Incompressible flow - Simulation by FEM.</td>
<td>10</td>
</tr>
<tr>
<td>06</td>
<td>Incompressible Couette Flow Solution by implicit method and the pressure correction method, Governing Equations, Stream Function - Vorticity method, Determination of pressure for viscous flow.</td>
<td>10</td>
</tr>
</tbody>
</table>

#### Numerical Solution of a 2D Supersonic Flow
Prandtl-Meyer Expansion Wave

#### Supersonic Flow over a Flat Plate
Numerical Solution by solving complete Navier Stokes equation.

### Assessment:

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

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

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

### References:

## Course Code
HPEDLO 2023

## Course Name
Advanced Turbo Machinery

## Credits
04

### 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

### Module
<table>
<thead>
<tr>
<th>Detailed Contents</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>01</strong> Basic concepts of Turbo Machines: Definition of Turbomachine, 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><strong>02</strong> Principles of Turbo Machinery: 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><strong>03</strong> Analysis of Centrifugal Machines: Centrifugal Compressors and Blowers: Theoretical characteristic curves, Euler's characteristics and Euler's 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><strong>04</strong> Analysis of Axial Flow Machines: 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><strong>05</strong> Design and Applications of Blowers and Fans: Special design and applications of blower induced and forced draft fans for air-conditioning plants, cooling towers, ventilation systems, booster systems.</td>
<td>09</td>
</tr>
<tr>
<td><strong>06</strong> Testing and control of Blowers and Fans: Performance testing, noise control, speed control, throttling control at discharge and inlet.</td>
<td>06</td>
</tr>
</tbody>
</table>

### Assessment:

**Internal:**
Assessment consists of two tests out of which, one should be compulsory class test (on minimum Two Modules) and the other is either a class test or assignment on live problems or course project.
End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

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

References:

6. BudugurLakshminarayana, Fluid Dynamics and heat Transfer of Turbomachinery, John Wiley and Sons, Inc
<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<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>10</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>10</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:**
Assessment consists of two tests out of which; one should be compulsory class test (on minimum Two Modules) and the other is either a class test or assignment on live problems or course project.
End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

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

References:

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Project Management Foundation:</strong> Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical &amp; atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).</td>
<td>5</td>
</tr>
<tr>
<td>02</td>
<td><strong>Initiating Projects:</strong> How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development &amp; growth (forming, storming, norming &amp; performing), team dynamics.</td>
<td>6</td>
</tr>
<tr>
<td>03</td>
<td><strong>Project Planning and Scheduling:</strong> Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).</td>
<td>8</td>
</tr>
<tr>
<td>05</td>
<td><strong>5.1 Executing Projects:</strong> Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. <strong>5.2 Monitoring and Controlling Projects:</strong> Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. <strong>5.3 Project Contracting</strong> Project procurement management, contracting and outsourcing,</td>
<td>8</td>
</tr>
<tr>
<td>06</td>
<td><strong>6.1 Project Leadership and Ethics:</strong> Introduction to project leadership, ethics in projects. Multicultural and virtual projects. <strong>6.2 Closing the Project:</strong> Customer acceptance; Reasons of project termination, Various types of projects</td>
<td>6</td>
</tr>
</tbody>
</table>
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:**

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

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

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

**References:**

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7th Ed.
4. Gopalan, Project Management, Wiley India
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILO 2022</td>
<td>Finance Management</td>
<td>03</td>
</tr>
</tbody>
</table>

**Objectives:**

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

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

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

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

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

References:
### Course Information

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILO2023</td>
<td>Entrepreneurship Development and Management</td>
<td>03</td>
</tr>
</tbody>
</table>

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

#### Outcomes:
Learner will be able to…
1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

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

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

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

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

**References:**
1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in
Objectives:
1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today’s organizations.
3. To familiarize the students about the latest developments, trends & different aspects of HRM.
4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

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

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Introduction to HR</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>• Human resource development (HRD); changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td><strong>Organizational Behavior (OB)</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor);</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 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.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Case study</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td><strong>Organizational Structure &amp; Design</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Structure, size, technology, Environment of organization; Organizational Roles &amp; conflicts: Concept of roles; role dynamics; role conflicts and stress.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Human resource Planning</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>-------------------------</td>
<td></td>
</tr>
</tbody>
</table>
| 04 | **Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale.**  
    | **Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning.**  
    | **Training & Development: Identification of Training Needs, Training Methods** |

<table>
<thead>
<tr>
<th></th>
<th>Emerging Trends in HR</th>
</tr>
</thead>
</table>
| 05 | **Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment**  
    | **Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.** |

<table>
<thead>
<tr>
<th></th>
<th>HR &amp; MIS</th>
</tr>
</thead>
</table>
| 06 | **Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries**  
    | **Strategic HRM**  
    | **Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals**  
    | **Labor Laws & Industrial Relations**  
    | **Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act** |

**Assessment:**

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

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

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

**References:**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILO2025</td>
<td>Professional Ethics and Corporate Social Responsibility (CSR)</td>
<td>03</td>
</tr>
</tbody>
</table>

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

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

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

**Assessment:**

**Internal:**
Assessment consists of two tests out of which; one should be compulsory class test (on minimum Two Modules) and the other is either a class test or assignment on live problems or course project.
End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

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

References:
1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
### Course: Research Methodology

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILO2026</td>
<td>Research Methodology</td>
<td>03</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Introduction and Basic Research Concepts</strong>&lt;br&gt;1.1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology&lt;br&gt;1.2 Need of Research in Business and Social Sciences&lt;br&gt;1.3 Objectives of Research&lt;br&gt;1.4 Issues and Problems in Research&lt;br&gt;1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical</td>
<td>09</td>
</tr>
<tr>
<td>02</td>
<td><strong>Types of Research</strong>&lt;br&gt;2.1. Basic Research&lt;br&gt;2.2. Applied Research&lt;br&gt;2.3. Descriptive Research&lt;br&gt;2.4. Analytical Research&lt;br&gt;2.5. Empirical Research&lt;br&gt;2.6. Qualitative and Quantitative Approaches</td>
<td>07</td>
</tr>
<tr>
<td>03</td>
<td><strong>Research Design and Sample Design</strong>&lt;br&gt;3.1 Research Design – Meaning, Types and Significance&lt;br&gt;3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors</td>
<td>07</td>
</tr>
<tr>
<td>05</td>
<td><strong>Formulating Research Problem</strong>&lt;br&gt;5.1 Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis</td>
<td>04</td>
</tr>
<tr>
<td>06</td>
<td><strong>Outcome of Research</strong>&lt;br&gt;6.1 Preparation of the report on conclusion reached&lt;br&gt;6.2 Validity Testing &amp; Ethical Issues&lt;br&gt;6.3 Suggestions and Recommendation</td>
<td>04</td>
</tr>
</tbody>
</table>
**Assessment:**

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

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

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

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

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

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Introduction to Intellectual Property Rights (IPR): Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. Importance of IPR in Modern Global Economic Environment: Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development</td>
<td>05</td>
</tr>
<tr>
<td>02</td>
<td>Enforcement of Intellectual Property Rights: Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement Indian Scenario of IPR: Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.</td>
<td>07</td>
</tr>
<tr>
<td>03</td>
<td>Emerging Issues in IPR: Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.</td>
<td>05</td>
</tr>
<tr>
<td>04</td>
<td>Basics of Patents: Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent</td>
<td>07</td>
</tr>
<tr>
<td>05</td>
<td>Patent Rules: Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)</td>
<td>08</td>
</tr>
</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:

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

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

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

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

**References:**

2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
Objectives:
1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

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

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

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

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.
1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.
References:

2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclllan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed contents</th>
</tr>
</thead>
</table>
| 1      | Simulation study using mathematical simulation software (or any programming language) on  
|        | • Steady state conduction in solids  
|        | • Steady state convection in solids  
|        | • Steady state radiation in solids |
| 2      | Simulation study using finite element software on  
|        | • Combined conduction and convection  
|        | • Unsteady state conduction and convection  
|        | • Unsteady state conduction and radiation |
| 3      | Simulation study using FEM, FDM and FVM  
|        | • Steady state conduction in fluids  
|        | • Steady state convection in fluids  
|        | • Two phase flows  
|        | • Condensation and boiling heat transfer |

**Note:** Software used should be Fluent/Star CD/ANSYS/CFX user defined codes

**Assessment:**

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

1. Finding energy saving potential from specific power consumption and EER of Air conditioner.
2. Illuminance calculation and lighting design for an interior.
3. Centrifugal Pump efficiency calculation and ENCON opportunities.
4. 3-Φ/1-Φ motor loading calculation and ENCON opportunities.
5. Fan/Blower efficiency calculation and ENCON opportunities.
6. Performance testing of Air compressor and ENCON opportunities.
7. Leakage testing of Air compressor and ENCON opportunities.
8. Study of an Electricity bill and ENCON opportunities

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 (Heat Power 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 Panel of Examiners appointed by the Head of the Department/Institute of respective Programme.
- Seminar should be assessed jointly by the pair of Internal and External Examiners
- Seminar should be assessed based on following points
  - Quality of Literature survey and novelty in the topic
  - Relevance to the specialization
  - Understanding of the topic
  - Quality of Written and Oral Presentation
Guidelines for Dissertation
- Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.

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

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

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

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