Scheme of Studies

M.Tech in Mechanical Engineering

Specialization: Industrial Refrigeration & Cryogenics
### M.Tech. Programme
**Mechanical Engineering – Industrial Refrigeration & Cryogenics**

**Curriculum and Scheme of Examinations (2013 Admission)**

#### SEMESTER I

<table>
<thead>
<tr>
<th>Code No.</th>
<th>Name of Subject</th>
<th>Credits</th>
<th>Hrs / week</th>
<th>End Sem Exam hours</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Internal Assessment</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Continuous Assessment</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>End Semester Exam</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Remarks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MRM1001</td>
<td>Mathematics</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>60</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>100</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Of the 40 marks of internal Assessment, 25 marks for test and 15 marks for assignment. End sem exam is Conducted by the University</td>
<td></td>
</tr>
<tr>
<td>MRC1002</td>
<td>Measurements in Thermal Engineering</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>60</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>100</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>do</td>
<td></td>
</tr>
<tr>
<td>MRC1003</td>
<td>Adv. Thermodynamics &amp; Fluid Mechanics</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>60</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>100</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>do</td>
<td></td>
</tr>
<tr>
<td>MRC1004</td>
<td>Heat and Mass Transfer</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>60</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>100</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>do</td>
<td></td>
</tr>
<tr>
<td>MRC1005</td>
<td>Refrigeration Systems</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>60</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>100</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>do</td>
<td></td>
</tr>
<tr>
<td>MRC1006</td>
<td>Cryogenic Engineering</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>60</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>100</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>do</td>
<td></td>
</tr>
<tr>
<td>MRC 1101</td>
<td>Industrial Refrigeration Lab</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>100</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No End Sem Examinations</td>
<td></td>
</tr>
<tr>
<td>MRC1102</td>
<td>Seminar</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>100</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>do</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td>21</td>
<td>22</td>
<td>440</td>
<td>360</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>800</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7 hours of Departmental assistance work</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Remarks</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL: 21 Credits, 22 Hrs/week, 440 End Sem Exam Hours, 360 Internal Assessment Hours, 800 Total Marks**
### SEMESTER II

<table>
<thead>
<tr>
<th>Code No.</th>
<th>Name of Subject</th>
<th>Credits</th>
<th>Hrs / week</th>
<th>End Sem Exam hours</th>
<th>Internal Assessment</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRC 2000</td>
<td>Research Methodology</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>40</td>
<td>60 100</td>
</tr>
<tr>
<td>MRC2001</td>
<td>Refrigeration Machinery &amp; Components</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>40</td>
<td>60 100</td>
</tr>
<tr>
<td>MRC2002</td>
<td>Design of cryogenic equipments &amp; systems</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>40</td>
<td>60 100</td>
</tr>
<tr>
<td>***</td>
<td>Stream Elective I</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>40</td>
<td>60 100</td>
</tr>
<tr>
<td>***</td>
<td>Stream Elective II</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>40</td>
<td>60 100</td>
</tr>
<tr>
<td>**</td>
<td>Department Elective</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>40</td>
<td>60 100</td>
</tr>
<tr>
<td>MRC2101</td>
<td>Computational Fluid Dynamics Lab</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>100</td>
<td>- 100</td>
</tr>
<tr>
<td>MRC 2102</td>
<td>Thesis – Preliminary – Part I</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>100</td>
<td>- 100</td>
</tr>
<tr>
<td>MRC 2103</td>
<td>Seminar</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>100</td>
<td>- 100</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>22</td>
<td>23</td>
<td>---</td>
<td>540</td>
<td>360 900</td>
</tr>
</tbody>
</table>

* Students can select a subject from the subjects listed under stream/department electives for the second semester as advised by the course coordinator.

Of the 40 marks of internal Assessment, 25 marks for test and 15 marks for assignment. End Sem Exam is conducted by the Individual Institutions.

End sem exam is Conducted by the University.

No End Sem Examinations

6 hours of Departmental assistance work
**List of Stream Electives for Second Semester**

<table>
<thead>
<tr>
<th>STREAM ELECTIVE I</th>
<th>STREAM ELECTIVE II</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRE 2001  Space Cryogenics</td>
<td>MRE 2004  Air-Conditioning Systems And Design</td>
</tr>
<tr>
<td>MRE 2003  Heat Pump And Energy Recovery Systems</td>
<td>MRE 2006  Computational Fluid Dynamics</td>
</tr>
</tbody>
</table>

**List Of Department Electives** **For Second Semester**

1. MID 2001 Reliability Engineering
2. MID 2002 Modern Information System
3. MDD 2001 Computational Plasticity
4. MDD 2002 Bio Mechanics
5. MDD 2003 Introduction to Signal Processing
6. MPD 2001 Finite volume method for fluid flow and heat transfer
7. MPD 2002 Transport Phenomena
9. MTD 2002 Cryogenics Engineering

**SEMESTER III**

<table>
<thead>
<tr>
<th>Code No.</th>
<th>Name of Subject</th>
<th>Credits</th>
<th>Hrs / week</th>
<th>End Sem Exam hours</th>
<th>Continuous Assessment</th>
<th>End Semester Exam</th>
<th>Total</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>***</td>
<td>Stream Elective III</td>
<td>3</td>
<td>3 3 3</td>
<td>40 60</td>
<td></td>
<td></td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>***</td>
<td>Stream Elective IV</td>
<td>3</td>
<td>3 3 3</td>
<td>40 60</td>
<td></td>
<td></td>
<td>100</td>
<td>do</td>
</tr>
<tr>
<td>**</td>
<td>Non-Dept. (Interdisciplinary) Elective</td>
<td>3</td>
<td>3 3 3</td>
<td>40 60</td>
<td></td>
<td></td>
<td>100</td>
<td>do</td>
</tr>
<tr>
<td>MRC 3101</td>
<td>Thesis – Preliminary – Part II</td>
<td>5</td>
<td>14 -</td>
<td>200 -</td>
<td></td>
<td></td>
<td>200</td>
<td>No End Sem Examinations</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>14</td>
<td>23 -</td>
<td>320 180</td>
<td></td>
<td></td>
<td>500</td>
<td>6 hours of Departmental assistance work</td>
</tr>
</tbody>
</table>

***Students can select a subject from the subjects listed under stream electives/Interdisciplinary electives for the third semester as advised by the course coordinator***
### List of Stream Electives for Third Semester

<table>
<thead>
<tr>
<th>STREAM ELECTIVE III</th>
<th>STREAM ELECTIVE IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRE 3001  Cryogenic Heat Transfer</td>
<td>MRE 3003  Food Processing, Preservation And Transport</td>
</tr>
<tr>
<td>MRE 3002  Vacuum Technology</td>
<td>MRE 3004  Experimental Methods In Engineering</td>
</tr>
</tbody>
</table>

### List of Non-Department Electives** for Third Semester

1. **MRI 3001** Energy Conservation In Refrigeration And **Air-Conditioning** Systems
2. **MRI 3002** Energy Conservation In Buildings
3. **MRI 3003** Energy Conservation In Industrial Processes & Equipments

### SEMESTER IV

<table>
<thead>
<tr>
<th>Code No</th>
<th>Subject Name</th>
<th>Credits</th>
<th>Hrs/week</th>
<th>Marks</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>15</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>MRC 4101</td>
<td>Thesis</td>
<td>12</td>
<td>21</td>
<td>200</td>
<td>8 hours of Departmental</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100</td>
<td>assistance work</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>12</td>
<td>21</td>
<td>600</td>
<td></td>
</tr>
</tbody>
</table>
SEMESTER I
MRM 1001 MATHEMATICS

Structure of the Course
Lecture : 3 hrs/ Week           Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives
To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject.
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes
To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module 1

Module 2

Module 3

References:
2. Venkitaraman M. K., Higher Mathematics for Engineering and Science TMH 2002

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
MRC 1002 MEASUREMENTS IN THERMAL ENGINEERING

Structure of the Course

Lecture : 3 hrs/ Week  Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives
To provide the students with a foundation in the subject, To produce knowledgeable users of the subject, To introduce the subject, To recognize the aspect of engineering problems solvable by applying the subject, To make the students aware of the capabilities and limitations of the subject for engineers. Understand the various processes related to the subject. To study advanced features of the subject, To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes
To synthesize and apply the concepts learnt, Describe various operations in Mechanical Engineering using the subject, Undertake, under supervision, laboratory experiments incorporating the subject.

Module 1
Instrument classification, characteristics of instruments- static and dynamic, error analysis, systematic, and gross errors, statistical analysis. Different types of sensors and transducers- resistance, inductance, capacitance, piezoelectric, thermoelectric, photoelectric, strain gauges, indicating recording and integrating instruments

Module 2
Measurement methods of temperature and heat flux, pressure, flow, linear motion, force torque, shaft power vibration, liquid level, viscosity.

Module 3
Measurements in refrigeration and air conditioning practice- different instruments for measuring mass flow, air flow, velocity, temperature, humidity, sound, solar radiation, air purity Data logging and acquisition, elements of microcomputer interfacing, use of intelligent instruments for physical variable

References:
1. Doeblin, Measurement system application and design, Mc Graw Hill 2006

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
MRC1003 ADVANCED THERMODYNAMICS & FLUID MECHANICS

Structure of the Course

Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives
To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject.
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes
To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module 1

Module 2

Module 3
Concept of thermal boundary layer.

References:

2. Asad M., Thermodynamics for Engineers –, Prentice Hall of India Ltd. 2000

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students
MRC 1004 HEAT AND MASS TRANSFER

Structure of the Course

Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes

To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module 1


Module 2

Heat transfer with change of phase, melting and solidification, application in food freezing and ice making - boiling and condensation - Two phase flows - two phase flow pressure drop Cryogenic heat transfer - forced convection boiling. Flow induced vibrations. Stratification in cryogenic vessels- frost formations.

Module 3

Introduction to mass transfer. Molecular diffusion and diffusivity - Ficks law of diffusion. Temperature and pressure dependence of mass diffusivity for a binary liquid mixture, diffusion in binary mixtures - basic definitions. The differential mass balance for single component systems and two component systems. Diffusion of component A through stagnant B. Steady state equimolar counter diffusion- The analogy between momentum, heat

References:


Structure of the Question paper

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students
MRC 1005 Refrigeration systems

Structure of the Course

Lecture : 3 hrs/ Week     Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives
To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes
To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module 1

Module 2
Properties of refrigerants - primary, secondary and mixtures. Ozone friendly refrigerants, ozone depletion and global warming, lubricants. Absorption refrigeration system - LiBr-water and aqua-ammonia systems, calculations by h-x diagrams, Platen-Munter’s system and solar energy applications. Steam jet refrigeration, vortex tube, Pulse tube, thermoelectric refrigeration and gas cycle refrigeration.

Module 3

References:
3. Transactions of ASHRAE. 2008

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.

**MRC 1006 CRYOGENIC ENGINEERING**

**Structure of the Course**

- **Lecture**: 3 hrs/ Week  
  Credits: 3
- **Internal Continuous Assessment**: 40 Marks
- **End Semester Examination**: 60 Marks

**Course Objectives:**
- To provide the students with a foundation in the subject.
- To produce knowledgeable users of the subject.
- To introduce the subject.
- To recognize the aspect of engineering problems solvable by applying the subject.
- To make the students aware of the capabilities and limitations of the subject for engineers.
- Understand the various processes related to the subject.
- To study advanced features of the subject.
- To understand the associativity between the subject and Mechanical Engineering.

**Learning Outcomes**
- To synthesize and apply the concepts learnt.
- Describe various operations in Mechanical Engineering using the subject.
- Undertake, under supervision, laboratory experiments incorporating the subject.

**Module 1**

Thermodynamics of gas liquefaction- liquefaction cycles- cryogenic refrigeration systems down to milli Kelvin range. Properties of cryogenic liquids, superfluidity, properties of solids at cryogenic temperatures: mechanical, thermal, electrical and magnetic properties, superconductivity. Storage and transfer of cryogenic liquids, liquid level.

**Module 2**

Thermocouples, platinum resistance and semiconductor thermometry. Cool down of cryogenic transfer lines, frost phenomena, cryogenic insulation. Applications of cryogenics in engineering, space technology, liquid fuel rockets, space simulation chambers.

**Module 3.**

Cryogenic heat pipes, nuclear research, bubble chambers, spectroscopy, vacuum technology, cryo pumping, food processing, preservation during transport, biology, medicine and LNG technology, cryocooler and its applications.

**References:**


Structure of the Question paper

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
MRC 1101 INDUSTRIAL REFRIGERATION LAB.

Structure of the Course

Practical : 2 hrs/ Week                 Credits : 1
Internal Continuous Assessment : 100 Marks

Experiments to illustrate different techniques of measurements of various quantities like temperature, humidity, pressure, velocity, etc. study of components of refrigeration and air conditioning systems and testing their performance, simple heat transfer experiments with condensers and evaporators. Experiments on cooling tower, walk-in coolers. Cooling and Freezing characteristics of food products; Production of liquid argon and liquid oxygen using liquid nitrogen, Measurements of their boiling points at atmospheric pressure. Study of data acquisition system, Simple exercises using Labview.

MCC 1102 Seminar

Structure of the Course

Seminar : 2 hrs/ Week                 Credits : 2
Internal Continuous Assessment : 100 Marks

The student is expected to present a seminar in one of the current topics in Mechanical, Refrigeration, Cryogenics and related areas. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject and submit seminar report at the end of the semester.

Marks: Seminar Report Evaluation: 50
Seminar Presentation: 50
SEMESTER II
Structure of the Course

Lecture: 2 hrs/ Week  
Credits: 2
Internal Continuous Assessment: 40 Marks
End Semester Examination: 60 Marks

Course Objective:
To formulate a viable research question
To distinguish probabilistic from deterministic explanations
To analyze the benefits and drawbacks of different methodologies
To understand how to prepare and execute a feasible research project

Outcome
Students are exposed to the research concepts in terms of identifying the research problem, collecting relevant data pertaining to the problem, to carry out the research and writing research papers/thesis/dissertation.

Module 1
Introduction to Research Methodology - Objectives and types of research: Motivation towards research - Research methods vs. Methodology. Type of research: Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, and Conceptual vs. Empirical.
Research Formulation - Defining and formulating the research problem -Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem.
Literature review: Primary and secondary sources - reviews, treatise, monographs, patents. Web as a source: searching the web. Critical literature review - Identifying gap areas from literature review - Development of working hypothesis.

Module 2
Research design and methods: Research design - Basic Principles- Need for research design — Features of a good design. Important concepts relating to research design: Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction. Development of Models and research plans: Exploration, Description, Diagnosis, Experimentation and sample designs.
Data Collection and analysis: Execution of the research - Observation and Collection of data - Methods of data collection - Sampling Methods- Data Processing and Analysis strategies - Data Analysis with Statistical Packages - Hypothesis-Testing - Generalization and Interpretation.

Module 3
Reporting and thesis writing - Structure and components of scientific reports - Types of report - Technical reports and thesis - Significance - Different steps in the preparation, Layout, structure and Language of typical reports, Illustrations and tables, Bibliography, referencing and footnotes. Presentation; Oral presentation - Planning - Preparation - Practice - Making presentation - Use of audio-visual aids - Importance of effective communication.

Application of results of research outcome: Environmental impacts - Professional ethics - Ethical issues - Ethical committees. Commercialization of the work - Copy right - royalty - Intellectual property rights and patent law - Trade Related aspects of Intellectual Property Rights - Reproduction of published material - Plagiarism - Citation and acknowledgement - Reproducibility and accountability.

References:
1. C.R Kothari, Research Methodology, Sultan Chand & Sons, New Delhi, 1990
York.

**Structure of the Question paper**

For the End semester Examination There will be three questions from each module out of which two questions are to be answered by the students.
MRC 2001 REFRIGERATION MACHINERY AND COMPONENTS

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives
To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes
To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module 1

Module 2
Evaporators: Types, effect of air quantity and surface area on capacity, LMTD, chiller selection, direct and indirect systems, secondary refrigerants, anti freeze solutions, defrosting of evaporators. Expansion devices: capillary tube, thermostatic expansion valve, automatic expansion valve and float valve etc , design and constructional features. Interdependence of refrigeration systems and overall system performance. Compressor motors.

Module 3

References:

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
MRC 2002 DESIGN OF CRYOGENIC EQUIPMENT AND SYSTEMS

Structure of the Course

Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objective:

- To provide the students with a foundation in the subject.
- To produce knowledgeable users of the subject.
- To introduce the subject.
- To recognize the aspect of engineering problems solvable by applying the subject.
- To make the students aware of the capabilities and limitations of the subject for engineers.
- To understand the various processes related to the subject.
- To study advanced features of the subject.
- To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes

- To synthesize and apply the concepts learnt.
- To describe various operations in Mechanical Engineering using the subject.
- To undertake, under supervision, laboratory experiments incorporating the subject.

Module 1

Theory of Air separation, design of air separation plants, argon recovery systems; inert gas recovery systems, design and construction of high pressure air compressors, after coolers, turbines and expansion devices, Cryogenic heat exchangers, regenerators. Stirling cycle machines, Helium liquefiers.

Module 2


Module 3

Recent developments in application of cryogenics: magnetic levitation, super conducting bearings, superconducting generators, Production of very high magnetic fields, cryosurgical probes, material science, purification of industrial gases.

Reference:


Structure of the Question paper

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students
MRC 2101 COMPUTATIONAL FLUID DYNAMICS LAB

Structure of the Course

Practical : 2 hrs/ Week
Internal Continuous Assessment : 100 Marks

The purpose of this course is to acquaint the students with the practical use of CFD tools for investigating fluid flow and heat transfer problems. Study of commercial CFD packages.

The following exercises are to be done using commercial software packages.

Fluid flow problems (internal and external flows)
Heat conduction problems, Natural convection & forced convection problems
Conjugate heat transfer problems, Hydrodynamic boundary layer problems
Simulation of flow in turbo machines
Cooling of electronic packages

MRC 2102 Thesis – Preliminary – Part 1

Structure of the Course

Thesis: 2 hrs/ Week
Internal Continuous Assessment : 100 Marks

For the thesis- preliminary Part I the student is expected to start the preliminary background studies towards the Thesis by conducting a literature survey in the relevant field. He/ she should broadly identify the area of the thesis work, familiarize with the design and simulation tools required for the thesis work and plan the experimental platform, if any, required for the thesis work. The student should submit a detailed report of these activities at the end of the semester.

Evaluation of marks for the thesis preliminary part I
Evaluation of the thesis – preliminary work by the guide - 50 marks
Evaluation of the thesis – preliminary by the Evaluation Committee - 50 marks
MRC 2103 Seminar

Structure of the Course

Seminar : 2 hrs/ Week  Credits : 2

Internal Continuous Assessment : 100 Marks

The student is expected to present a seminar in one of the current topics in Mechanical, Cryogenics, Industrial Refrigeration and related areas. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject and submit seminar report at the end of the semester.

Marks:  Seminar Report Evaluation: 50
       Seminar Presentation: 50
MRE 2001 SPACE CRYOGENICS

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives
To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject.
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes
To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module I
Chemical rocket propulsion, Definitions and fundamentals: thrust, total impulse, specific impulse, mixture ratio, bulk density, characteristics velocity, thrust to weight ratio, exhaust velocity, mass ratio, multistaging; Types of chemical propellants: solid, liquid, hybrid, Physical properties of common earth storable propellants, semi-cryo and cryogenic propellants; Pressure fed system – sources of pressurising gas, Pump fed systems - engine operating cycles, pumps and turbines – general configuration, Fluid circuits of various cryogenic engines and semi-cryogenic engines;

Module II
Design of regeneratively cooled combustion chamber, film cooling, dump cooling, transpiration cooling and radiation cooling. Design of expansion nozzle- characteristics, Design of injector– hydraulic characteristics; Engine thrust and mixture ratio control, Igniters, Propellant tanks, Valves: shut off valve, flow control valves, check valve, isolation valve, relief valves, Common materials used in cryogenic propulsion; Problems in storage and handling of cryogenic propellants: safety aspects, Thermal protection systems for stage tanks, Thermal stratification-destratification, Geysering effect, geysering elimination, Zero “g” problems – restart mechanism.

Module III
References:

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students
MRE 2002 UTILISATION OF SOLAR ENERGY

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives
To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject.
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes
To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module 1
Extraterrestrial radiation, solar constant, spectral distribution of extraterrestrial radiation, solar radiation at earth's surface, beam radiation, diffuse radiation, air mass, variation of extraterrestrial radiation, Data pertaining to solar radiation, estimation of available solar energy based on longitude, latitude, time of year and atmospheric conditions.

Module 2
Solar collectors- Flat plate collectors, general description, the basic flat plate energy balance equation, general characteristics of flat plate solar collectors, collector overall heat transfer coefficient. Focusing collectors, the solar disk and theoretical solar images, concentrators, receivers and orienting systems.

Module 3

References:

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
MRE 2003 HEAT PUMP AND ENERGY RECOVERY SYSTEMS

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives

To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject.
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes
To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module I

Module II

Module II

References:

3) Reay D.A. "Industrial energy conservation", Pergamon press 1977


**Structure of the Question paper**

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
MRE 2004 AIR CONDITIONING SYSTEMS & DESIGN

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives
To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject.
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes
To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module 1
Properties of moist air - Psychrometry, Psychrometric Processes, sensible heat ratio; sensible heating and cooling, Humidification and dehumidification devices; Airwashers and evaporative coolers.

Module 2
Air-Conditioning systems; unitary equipments, split unit; packaged systems, central air-conditioning systems- all air, all water and air-water systems, 3 and 4 pipe system, constant volume, variable temperature systems, multi zone, dual duct; dual air, induction fan coil systems.

Module 3
Air movement in rooms, air jets, air distribution devices; Duct design - noise and noise control; Estimation of cooling load (ASHRAE or CARRIER method). Special purpose air-conditioning, schools, hospitals, theatres, computer rooms, automobiles etc. Control systems used in air-conditioning plants.

References:

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students
MRE 2005 DESIGN OF HEAT TRANSFER EQUIPMENTS

Structure of the Course
Lecture : 3 hrs/ Week          Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives
To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject.
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes
To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
 Undertake, under supervision, laboratory experiments incorporating the subject.

Module 1
Heat Exchangers; Classification and General features; range of application- Overall heat transfer coefficient. The controlling film coefficient-LMTD- Effectiveness-NTU- Calculation of heat transfer area by different methods- caloric or average fluid temperature, the pipe wall temperature. Flow and pressure drop analysis- computation of total pressure drop of shell side and tube side for both baffled and unbaffled types-pressure drop in pipes and pipe annulii stream analysis method.

Module 2

Module 3
Condensers, Condensation of a single vapour - drop wise and film wise condensation-process application - condensation on a surface - development of equation for calculation - comparison between horizontal and vertical condensers- the allowable pressure drop for a condensing vapour - influence of impurities on condensation - condensation of steam- design of a surface condenser- different types of boiling. Heat Pipes: Theory, Practical Design Considerations - the working fluid, wick structure, thermal resistance of saturated wicks, the container, compatibility, fluid inventory, priming, starting procedure- special types of heat pipes- Applications.

References:
1. TEMA Standards 2000

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students
MRE 2006 COMPUTATIONAL FLUID DYNAMICS

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives
To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject.
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes
To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module 1
Methods of prediction, theoretical calculation, Experimental investigation, Choice of prediction method, computational fluid dynamics as a research tool, CFD code. Pre-processor, solver, postprocessor, problem solving with CFD. Review of governing equations of fluid flow and heat transfer. Forms of governing equations particularly suited for CFD. Turbulence and its modeling- turbulence, effect of turbulence, turbulent models.

Module 2
Finite volume method for diffusion problems. Finite volume method for one dimensional, two -dimensional and three dimensional steady state diffusion. Finite volume method for convection diffusion problems- steady state one dimensional convection and diffusion, Central differencing method, properties of discretization schemes, upwind differencing scheme, hybrid differencing scheme, the power scheme, Higher order differencing schemes for convection diffusion problems. Solution algorithms for pressure velocity coupling in steady flows, staggered grid-momentum equation, SIMPLE algorithm, SIMPLER algorithm, SIMPLEC algorithm, PISO algorithm. solution of discretised equations:

Module 3
Tri diagonal matrix algorithm. Applications of TDMA to two and three dimensional problems, other solutions in CFD. The finite volume method for unsteady flows- one dimensional heat conduction-explicit scheme, Crank-Nicholson scheme, fully implicit scheme, two and three dimensional problems, solution procedures for unsteady flow calculations, transient SIMPLE, transient PISO, steady state calculations using pseudo transient approach. Implementation of boundary conditions- inlet boundary condition, outlet boundary condition, wall boundary condition, constant pressure boundary condition, symmetry boundary condition, periodic or cyclic boundary condition. Applications like combustion modelling etc. (simple cases only)

References :
1. Patankar S. V.- Numerical heat transfer and fluid flow, Taylor & Francis 1990
3. Hofman K. F - Computational fluid dynamics 2001

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students
MID 2001 RELIABILITY ENGINEERING

Structure of the Course

Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objective:

The objective of this course is to understand the theories and their practical uses with real-world examples and problems to solve. The course focuses on system reliability estimation for time independent and failure dependent models. It helps the students in assembling necessary components and configuring them to achieve desired reliability objectives, conducting reliability tests on components, and using field data from similar components. Also to provide more complex aspects regarding both the Maintainability, Availability and some fundamental techniques such as FMECA (Failure Mode, Effects, and Criticality Analysis) and FTA (Fault Tree Analysis) with examples.

Learning Outcome

After the completion of the course one should be able to know:

- Reliability and Hazard Functions
- System Reliability Evaluation
- Time- and Failure-Dependent Reliability
- Estimation Methods of the Parameters of Failure-Time Distributions
- Parametric Reliability Models
- Models for Accelerated Life Testing
- Renewal Processes and Expected Number of Failures
- Preventive Maintenance and Inspection


Module I

Introduction to reliability: definition, Reliability and Quality, failure and failure modes

Failure data analysis: Reliability and rates of failure, Reliability function, expected life, failure rate, hazard function, constant and time dependent hazard models, state dependent hazard models, Markov Analysis.

Module II

System Reliability models – Series, parallel, mixed configurations, k-out-of-m models
Redundancy techniques – component vs unit redundancy, mixed redundancy, Standby redundancy, weakest link technique
Reliability improvement, Reliability allocation
Module III

Fault tree analysis, use of Boolean algebra, Load strength analysis. Understanding of FMECA.
Maintainability- Definition, relationship between reliability and maintainability
Availability- Definition, relationship between reliability and availability, simple Markov models.

Case studies from industries demonstrating Reliability aspects. Computer softwares in reliability.

References

1) Charles E Eblings – An Introduction to Reliability and Maintainability Engineering, McGraw Hill
3) L S Srinath – Reliability Engineering, East West Press

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.
MID 2002 MODERN INFORMATION SYSTEMS

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

To learn about different information systems.
To effectively use and manage information technology in today’s network enterprises.
To study interconnected networks of information systems for end user collaboration.
To learn systems for making timely decisions based on organized information

Learning Outcomes
After the completion of the course the student is expected to

- Widen his knowledge about information technology that will enable him to solve management problems.
- Explore full potential of computer as a problem solving tool.

MODULE I

Introduction to information systems, Types and examples of information systems, information technology infrastructure. System concepts, system design, development and analysis

MODULE II

Decision support systems: Overview, Data Mining and Warehousing, Modeling and Analysis, Knowledge based DSS. Model management, modeling processes, modeling languages.

MODULE III

Neural computing, applications, advanced artificial intelligent systems and applications. Intelligent software agents, Impact of Management support systems.

REFERENCES
2. Burch John.GJr and Others , Information Systems theory And Practice, John wiley&Sons
5. Marakas, Decision Support System, Pearson Education

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.
MDD 2001: COMPUTATIONAL PLASTICITY

Structure of the Course
Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives:

At the end of this course, the students will
➢ gain insight into the behavior of metals under loading and heating conditions,
➢ be able to use elementary theory of plasticity to formulate bulk forming processes,
➢ be able to master the basic formulations and their applications to sheet forming Processes,
➢ be able to master and apply the basic theory of metal cutting,
➢ have the basic knowledge about the cutting tools, cutting fluids and the cutting parameters and how they affect the cutting performance,
➢ be able to optimize metal cutting operations for the selected criteria

Learning Outcomes:

At the completion of the course, students will be able to…
➢ Predict the changes in the mechanical behavior of materials due to thermo-mechanical processing based finite element modeling.
➢ Interpret and quantitatively determine elastoplastic behavior of metals.

Module I


Module II

Overview of the program structure of FEM for plasticity
The mathematical theory of plasticity – Phenomenological aspects - One-dimensional constitutive model - General elastoplastic constitutive model - Classical yield criteria – Plastic flow rules - Hardening laws

Module III

Finite elements in small-strain plasticity problems – Preliminary implementation aspects - General numerical integration algorithm for elastoplastic constitutive equations - Application: integration algorithm for the isotropically hardening vonMises model - The consistent tangent modulus – Numerical examples with the vonMises model - Further application: the von Mises model with nonlinear mixed hardening
References:

1. Eduardo de Souza Neto, DjordjePeric, David Owens, Computational methods for plasticity : theory and applications - 2008 John Wiley & Sons Ltd
2. A. Anandarajah, Computational Methods in Elasticity and Plasticity – 2010 Springer
3. Han-Chin Wu, Continuum mechanics and plasticity - CRC Press
5. Jacob Lubliner, Plasticity theory – 2006
7. D W A Rees, Basic engineering plasticity an introduction with engineering and manufacturing applications - BH

Structure of the Question paper

For the End Semester Examination There will be three questions from each module out of which two questions are to be answered by the students.
MDD 2002 BIO MECHANICS

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment: 40 Marks
End Semester Examination: 60 Marks

Objective:

➢ To gain knowledge of bio mechanics
➢ To gain knowledge of designing of artificial implants
➢ To gain knowledge of viscoelastic material modeling
➢ Understand various bio materials

Outcome:

➢ Students will understand how the theory is used in analyzing human body and motions
➢ At the end of the course students will know the different bio materials

Industrial relevance:

This course is having direct application to industry. In medical field, implementation of theory of mechanics will help in implementing various designs

Module I

Human Anatomy & physiology: Anatomy & Physiology of major systems of the body Basic Terminology-Major Joints - Major Muscle Groups -Tissue Biomechanics -Hard and Soft - Bones - Bone Cells and Microstructure- Physical Properties of Bone- Bone Failure (Fracture and Osteoporosis)- Muscle Tissue-Cartilage-Ligaments- Scalp, Skull, and Brain -Skin Tissue

Module II

Kinetics of Human Body -Forces Exerted across Articulating Joints -Contact Forces across Joints - Ligament and Tendon Forces- Joint Articulation
Rheology of body material-Viscoelasticity-Definition of Viscoelasticity 1D Linear Viscoelasticity (Differential Form Based on Mechanical Circuit Models- Maxwell Fluid-Kelvin–Voigt Solid- 1-D Linear Viscoelasticity (Integral Formulation)- 3-D Linear Viscoelasticity -Dynamic Behavior of Viscoelastic Materials

Module III

References:

1. Principles of Biomechanics by Ronald L Huston-CRC Press
2. Introduction to continuum biomechanics by Kyriacos A. Athanasiou and Roman M. Natoli-Morgan & Claypool
3. Duane Knudson  Fundamentals of Biomechanics –Springer

Structure of the Question paper

For the End semester Examination There will be three questions from each module out of which two questions are to be answered by the students.
MDD 2003 INTRODUCTION TO SIGNAL PROCESSING

Structure of the Course

Lecture: 3 hrs/ Week     Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- Understand Fundamentals of DSP and its use in Noise and Vibration Enhancement
- Understand how to correctly implement and use the results of an FFT
- Interpretation of common Frequency Domain Measurements
- Understand the fundamentals and applications of Digital Filters
- Application and interpretation of Order Tracking analysis

Learning Outcomes:

As an outcome of completing this course, students will be able to:
- Understand how the combination of A/D conversion, digital filtering, and D/A conversion may be used to filter analog signals such as speech and music (1-D), and images (2-D).
- Understand the time- and frequency-domain concepts related to A/D conversion.
- Understand the time- and frequency-domain concepts related to D/A conversion.
- Understand the role of oversampling in A/D and D/A conversion.
- Understand the roles of downsampling and upsampling in digital processing of analog signals.
- Understand the respective roles of the magnitude and phase response of a digital filter.
- Understand the concepts of phase delay and group delay of a digital filter.
- Understand the relations between the DTFT, the DFT, and the FFT.
- Understand the computational issues in the implementation of digital filters.
- Understand the notion of random signals as an aid to filter design.
- Design FIR filters using the Windowing Method.
- Write reports on filter design and DSP applications projects
- Assess the societal impact of DSP, and the engineer’s responsibilities in this regard.

Module I

Module II


Module III


Reference:

3. Digital Signal Processing, Alan V. Oppenheim, Ronald W. Schafer, Prentice hall

Structure of the Question paper

For the End Semester Examination There will be three questions from each module out of which two questions are to be answered by the students.
MPD 2001: FINITE VOLUME METHOD FOR FLUID FLOW AND HEAT TRANSFER

Structure of the Course

Lecture : 3 hrs/ Week Credits :3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives:
- A number of physical problems related to Propulsion Engineering and Thermal Engineering can be modeled as partial differential equation and often non-linear. These equations can not be solved by analytical methods and suitable numerical techniques are to be applied. The objective this stream elective is to give the students the necessary fundamentals ideas and their applications for real problems. An exposure to open source computational tools is also aimed. Reading and understanding at least two Journal Publications dealing with later developments in solution algorithms for flow and heat transfer.

Learning Outcomes:
- Mathematical formulation of physical problems and their solution.
- Capability to write computer programs based on the techniques learned.
- Development of a directory containing the basic and applied computer programs, tutorials and their document.

Module I
Governing equations of fluid flow and heat transfer-Programming in object oriented C++, Classes, Structures and Union (Portions up to this is for study by students themselves. Questions may be asked for the examinations). Governing equations in primitive variables – general scalar form for incompressible flow-conservative vector form for compressible flow-Linearisation -Jacobian-Mathematical nature of governing equations- Governing equations in terms of stream function and vorticity (2D and 3D).
Finite difference approximations for differential coefficients, order of accuracy, numerical examples-Stability, convergence and consistency of numerical schemes - Von-Neumann analysis for stability-Courant-Friedrich-Lewi criterion.

Module II

Module III
References:

1. Applied finite element analysis, Larry J. Segerlind
2. Numerical heat transfer and fluid flow, Suhas V. Patankar
3. Computational fluid dynamics: the basics with applications, John D. Anderson
5. Introduction to Computational Fluid Dynamics, Anil W. Date

Structure of the Question paper

For the End Semester Examination There will be three questions from each module out of which two questions are to be answered by the students.
Structure of the Course

Lecture: 3 hrs/ Week  Credits: 3
Internal Continuous Assessment  : 40 Marks
End Semester Examination  : 60 Marks

Course Objectives

1. To develop and detailed understanding of the physics behind transport phenomena in engineering systems.
2. To learn solution techniques in advanced transport phenomana.

Learning Outcomes

1. Student will be capable of applying theoretical knowledge in various industrial and academic situations
2. They will be in a position to develop models for a particular problem involving heat and mass transfer.

Module I


Diffusivity and the mechanism of mass transport- definitions of concentrations, velocities and mass fluxes-Fick’s law of diffusion- temperature and pressure dependence of mass diffusivity- theory of ordinary diffusion in gases at low density- theories of ordinary diffusion in liquids.

Module II

Shell balance for momentum, energy and mass, boundary conditions, Adjacent flow of two immiscible fluids- heat conduction with a nuclear heat source-diffusion through a stagnant gas film-diffusion with heterogeneous chemical reaction- diffusion with homogeneous chemical reaction-diffusion into a falling liquid film: Forced convection mass transfer-diffusion and chemical reaction inside a porous catalyst; the ‘Effectiveness factor’.
The equations of change for isothermal, non isothermal and multi component systems- the equations of continuity of species A in curvilinear co-ordinates-dimensional analysis of the equations of change for a binary isothermal mixture.
Module III

Concentration distributions in turbulent flow - concentration fluctuations and the time smoothed concentration-time smoothing of the equations of continuity of A.

Inter phase transport in multi component systems - definition of binary mass transfer coefficients in one phase – correlations of binary mass transfer coefficients in one phase at low mass transfer rates - definition of binary mass transfer coefficients in two phases at low mass transfer rates - definition of the transfer coefficients for high mass transfer rates.

Macroscopic balances for multi component systems- the macroscopic mass, momentum, energy and mechanical energy balance - use of the macroscopic balances to solve steady state problem.

References:

Text book: Transport Phenomena Bird R B, Stewart W E and Lightfoot F N

Note: Use of approved charts & tables are permitted in the examinations.

Structure of the Question paper

There will be three questions from each module out of which two questions are to be answered by the students.
MTD2001: FINITE ELEMENT ANALYSIS FOR HEAT TRANSFER  3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week  Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

To impart an awareness regarding various types of equations and their methods of solving
To analyse a given situation to find out the temperature profiles and rate of heat transfer

Learning Outcomes

The students will be capable of analyzing theoretically any heat transfer problems by using FEM

Module I

Review of the fundamentals of the three modes of heat transfer. Governing differential equations. Initial and boundary conditions.

Review of the numerical techniques for the solution of matrix equations. Basic concepts of Finite Element method. Mesh generation-

Module II

Steps involved in a thermal analysis. Analysis of linear and nonlinear conduction problems in steady and transient heat transfer. 1D, 2D and 3D analysis with simple examples. Axisymmetric heat transfer. Finite element solution in the time domain.


Module III


Computer programming and implementation of FEM. Introduction to general purpose FEM packages.
References:

2. H C Huang and A Usmani: Finite Element Analysis for Heat Transfer
3. L J Segerland: Applied Finite Element Analysis

Structure of the Question paper

For the End semester Examination There will be three questions from each module out of which two questions are to be answered by the students.
MTD 2002 CRYOGENIC ENGINEERING 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

• To impart a basic concepts of low temperature production and utilization
• To study various systems for low temperature production

Learning Outcomes

• The students will be capable of designing a liquefaction system
• They will be able to produce liquefaction systems with minimum energy consumption

Module I

Introduction: Historical development-present areas involving cryogenic engineering. Low
temperature properties of engineering materials-Mechanical properties-Thermal properties-
Electric and magnetic properties-Properties of cryogenic fluids.

Module II

Gas liquefaction systems: Introduction-Production of low temperatures-General liquefaction
systems-Liquefaction systems for Neon, Hydrogen and Helium-Critical components of
liquefaction systems.
Cryogenic Refrigeration systems: Ideal Refrigeration systems-Refrigerators using liquids and
gases as refrigerants-refrigerators using solids as working media.

Module III

Cryogenic fluid storage and transfer systems: Cryogenic fluid storage vessels-Insulation-
Cryogenic fluid transfer systems.
Applications of Cryogenics: Super conducting devices-Cryogenics in Space Technology-
Cryogenics in biology and medicine.

References:
1. Cryogenic Systems – Randall Barron
2. Cryogenic Engineering- R.B.Scott

Structure of the Question paper

For the End semester Examination There will be three questions from each module out of
which two questions are to be answered by the studen
SEMESTER III

MRC 3101 Thesis Preliminary Part II

**Structure of the Course**

Thesis: 14 hrs/ Week  
Credits: 5  
Internal Continuous Assessment: 200 Marks

The student has to continue the thesis work identified in the Second semester. The student has to present two seminars and submit an interim thesis report.

Evaluation of marks for the thesis preliminary part II  
Evaluation of the thesis – preliminary work by the guide - 100 marks  
Evaluation of the thesis – preliminary by the Evaluation Committee - 100 marks
Stream Electives Offered For Third Semester
STREAM ELECTIVE III

MRE 3001 CRYOGENIC HEAT TRANSFER

Structure of the Course

Lecture : 3 hrs/ Week  Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

To provide the students with a foundation in the subject.
To recognize the aspect of engineering problems solvable by applying the subject.
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes

To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

Module 1

Introduction & Conductive Heat Transfer:
Introduction to cryogenic heat transfer, Special problems in cryogenic heat transfer, Applications in cryogenic heat transfer. Conduction heat transfer- Governing equations, one dimensional steady state conduction, Conduction shape factor, Conduction in composite materials, Thermal contact resistance, Conduction in fins. Properties of frost at cryogenic temperature levels, Cool down with coated surfaces, Cool down of cryogenic fluid storage vessels.

Convective Heat Transfer:

Module 2

Two-phase Heat Transfer and pressure drop:

Radiation Heat Transfer:

Module 3

Cryogenic Heat Exchangers:
NTU-effectiveness design method, Giauque-Hampson heat exchanger design, Plate-fin heat exchanger design, Perforated plate heat exchanger design, Regenerators, Regenerator design.

References:
1) Barron R F. - Cryogenic heat transfer, Taylor and Francis, 1999
2) Long C A- Essential heat transfer, First Indian reprint, Pearson Education Pvt Ltd, India 2000
5) Sachdeva R.S.- Fundamentals of engineering heat and mass transfer, Wiley Eastern limited 2000

Structure of the Question paper

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
MRE 3002 VACUUM TECHNOLOGY

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives:
To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject.
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes
To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

MODULE I
Vacuum: Definition, Artificial and natural vacuum, Applications of vacuum technique, importance of vacuum technology. Rarefied gas theory for vacuum technology. Perfect and real gas laws, motion of molecules in rarefied gases, pressure and mean free path; transport phenomena in viscous states and molecular states, thermal diffusion and energy transport.

MODULE II

MODULE III
Production of vacuum; Mechanical pumps, vapour pumps, Ion pumps, Sorption pumps, Cryo pumping, Gettering. Measurement of low pressures: Mechanical gauges, thermal conductivity gauges, Ionization gauges.

References :
1. Roth A.- Vacuum Technology, North Holland 2005

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
MRE 3003 FOOD PROCESSING, PRESERVATION AND TRANSPORT

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives
To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject.
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes
To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject

MODULE I
Introduction to microbiology of food products. Pre cooling of food stuffs- methods, equipments; calculation of time, refrigeration load, recommended conditions for storage of foods.

MODULE II
Design, operation and maintenance of cold stores, controlled environment storage for food product, insulation and vapour barriers for cold stores.

MODULE III
Packaging of food products, food dehydration, theory, techniques and equipment, Freeze drying. Considerations in road, rail, air and sea transport of food products.

References :

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students
MRE 3004 EXPERIMENTAL METHODS IN ENGINEERING

Structure of the Course

Lecture : 3 hrs/ Week Credit : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

To provide the students with a foundation in the subject.
To produce knowledgeable users of the subject.
To introduce the subject.
To recognize the aspect of engineering problems solvable by applying the subject.
To make the students aware of the capabilities and limitations of the subject for engineers.
Understand the various processes related to the subject.
To study advanced features of the subject.
To understand the associativity between the subject and Mechanical Engineering.

Learning Outcomes

To synthesize and apply the concepts learnt.
Describe various operations in Mechanical Engineering using the subject.
Undertake, under supervision, laboratory experiments incorporating the subject.

MODULE I

Basic concepts of measurement methods and planning and documenting experiments. Sensors, transducers, and measurements system behavior. Data sampling and computerised data acquisition systems. Statistical methods and uncertainty analysis applied to data reduction. Measurement of selected material properties. Thermal conductivity measurement- Guarded hot plate apparatus; measurement of conductivity of metals-thermal conductivity of liquids and gases, concentric cylinder method apparatus for determination of thermal conductivity of gases at high temperatures.

MODULE II


MODULE III

Cantilever beam used as frequency measuring device. Principles of seismic instrument- practical considerations for seismic instruments-electrical resistance strain gauge seismic instrument, Piezo-electric transducer type seismic instrument. Sound measurement microphones-characteristics of microphones- psycho acoustic factors- sound level meter, acoustic properties of materials- sound absorption coefficients- noise reduction coefficients. Pollution measurement-units for pollution measurement- air pollution standards Air sampling train.

References :-

1) Holman J.P, Experimental methods for Engineers TMH 2000
3) Eckman D P, Industrial Instrumentation 2004 TMH 2001
5) Bentley J P, Principles of measurement systems TMH 2006

Structure of the Question paper

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
SEMESTER IV

MRC 4101 THESIS

Structure of the Course

<table>
<thead>
<tr>
<th>Component</th>
<th>Hours/WEEK</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thesis</td>
<td>21</td>
<td>12</td>
</tr>
<tr>
<td>Internal Continuous Assessment</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Thesis Evaluation + Viva-Voce</td>
<td>300</td>
<td></td>
</tr>
</tbody>
</table>

The student has to continue the thesis work identified in the Second semester. There shall be two seminars (a mid-term evaluation on the progress of the work and the pre-submission seminar to assess the quality and quantum of the work). At least one technical paper is to be prepared for possible publication in journals / conferences. The final evaluation of the thesis shall be an external evaluation. The marks for the Thesis-Final may be proportionally distributed between external and internal evaluation as follows.

Distribution of marks allotted for the Thesis

<table>
<thead>
<tr>
<th>Component</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal evaluation of the thesis work by the guide</td>
<td>150</td>
</tr>
<tr>
<td>Internal evaluation of the thesis by the evaluation committee</td>
<td>150</td>
</tr>
<tr>
<td>Final evaluation of the thesis work by internal and External examiners</td>
<td>300</td>
</tr>
</tbody>
</table>

(Evaluation of Thesis :200 marks + Viva voce :100 marks) – 300 Marks