| Course code | Course Name | L-T-P-Credits | Year of Introduction |
|---|---|---|---|
| ME467 | Cryogenic Engineering | 3-0-0-3 | 2016 |

**Prerequisite : NIL**

**Course Objectives: :**

- To provide the knowledge of evolution of low temperature science
- To provide knowledge on the properties of materials at low temperature
- To familiarize with various gas liquefaction systems and to provide design aspects of cryogenic storage and transfer lines

**Syllabus:**

Introduction to Cryogenics, Applications of Cryogenics, Properties of materials at cryogenic temperature, Liquefaction systems, Gas liquefaction systems, Cryogenic Refrigeration systems, Cryogenic fluid storage and transfer systems, Cryogenic instrumentation, heat exchangers used in cryogenic systems

**Expected Outcomes:**

The students will be able to

i. Understand properties of material at cryogenic temperatures.
**ii.** Know about various liquefaction systems
iii. Get ideas on cryogenic refrigeration systems, cryogenic instrumentation and cryogenic heat exchangers

**Text books**

1. J. H. Boll Jr, Cryogenic Engineering
2. R. B. Scott, Cryogenic Engineering, Van Nostrand Co., 1959
3. Randal F.Barron, Cryogenic systems, McGraw Hill, 1986

**Reference books:**

1. Klaus D.Timmerhaus and Thomas M.Flynn, Cryogenic Process Engineering, Plenum Press, New York, 1989.

| Module | Contents | Hours | End Sem. Exam. Marks |
|---|---|---|---|
| I | Introduction to Cryogenic Systems, Historical development, Low Temperature properties of Engineering Materials, Mechanical properties- Thermal properties- Electric and magnetic properties – Cryogenic fluids and their properties.<br>Applications of Cryogenics: Applications in space, Food Processing, super conductivity, Electrical Power, Biology, Medicine, Electronics and Cutting Tool Industry. Low temperature properties of engineering materials | 8 | 15% |
| II | Liquefaction systems ideal system, Joule Thomson expansion, Adiabatic expansion, Linde Hampson Cycle, Claude & Cascaded System, Magnetic Cooling, Stirling Cycle Cryo Coolers. | 7 | 15% |
| **FIRST INTERNAL EXAMINATION** | | | |

| | | | |
|---|---|---|---|
| **III** | Gas liquefaction systems: Introduction-Production of low temperatures-General Liquefaction systems- Liquefaction systems for Neon. Hydrogen and Helium –Critical components of Liquefaction systems | **6** | **15%** |
| **IV** | Cryogenic Refrigeration systems: Ideal Refrigeration systems-Refrigeration using liquids and gases as refrigerant- Refrigerators using solids as working media;, | **6** | **15%** |
| **SECOND INTERNAL EXAMINATION** | | | |
| **V** | Cryogenic fluid storage and transfer systems: Cryogenic Storage vessels and Transportation, Thermal insulation and their performance at cryogenic temperatures, Super Insulations, Vacuum insulation, Powder insulation, Cryogenic fluid transfer systems. | **8** | **20%** |
| **V1** | Cryogenic instrumentation, Pressure flow-level and temperature measurements. Types of heat exchangers used in cryogenic systems(only description with figure) Cryo pumping Applications | **7** | **20%** |
| **END SEMESTER EXAMINATION** | | | |

**Question Paper Pattern**

**Maximum marks: 100** **Time: 3 hrs**

The question paper should consist of three parts

**Part A**

There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

**Part B**

There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

**Part C**

There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.