GUJARAT TECHNOLOGICAL UNIVERSITY

BE-7 SEMESTER – OLD PAPER – W22 TO W25 – QUESTION BANK

Subject Name & Code: Cryogenics Engineering - 3171919

Chapter 1: Introduction (Properties, Hazards, Safety)

Repeated Questions:

1. Properties of Materials & Hydrogen:

- **Q.** Discuss variations of properties of materials at cryogenic temperature (e.g., Fatigue strength, Hardness, Ductility, Ultimate strength). **(WINTER 2022, 3 Marks; WINTER 2023, 4 Marks; SUMMER 2023, 4 Marks; WINTER 2024, 4 Marks; WINTER 2025, 7 Marks)**
- **Q.** Explain the concept of Ortho-hydrogen and Para-hydrogen. **(WINTER 2022, 4 Marks; WINTER 2025, 4 Marks)**
- **Q.** Write a short note on properties of liquid Hydrogen. **(WINTER 2023, 4 Marks; SUMMER 2023, 3 Marks)**

2. Hazards & Safety:

- **Q.** Explain different types of hazards and their prevention (Physical, Chemical, Physiological). **(WINTER 2022, 4 Marks; WINTER 2024, 3 Marks; WINTER 2025, 3 Marks)**
- **Q.** Describe the safety precautions for handling cryogens in industry. **(WINTER 2024, 7 Marks)**

3. Superconductivity:

- **Q.** Define superconductivity. What are Type-I and Type-II superconductors? **(WINTER 2023, 3 Marks; WINTER 2025, 4 Marks)**

Other Important Questions:

1. Cryogenic Basics, Strength & Liquid Helium:

- **Q.** What do you mean by cryogenics engineering? **(WINTER 2025, 3 Marks)**
- **Q.** Explain the significance of the strength to conductivity ratio for metals at cryogenic temperatures. **(WINTER 2024, 3 Marks)**
- **Q.** Discuss the unusual properties of liquid Helium-II. **(WINTER 2025, 7 Marks OR)**

2. Superconductivity (Theory):

- **Q.** Explain the Meissner effect with a sketch. **(WINTER 2023, 3 Marks)**
- **Q.** Explain magnetic properties of superconductors. **(WINTER 2022, 3 Marks)**
- **Q.** What do you mean by superconductivity and superconductive material? **(WINTER 2024, 3 Marks)**
- **Q.** Explain the terms (i) Transition temperature and (ii) Critical current of superconductors. **(WINTER 2025, 4 Marks)**

3. Storage, Transfer & Dewar:

- **Q.** Write a note on cryogenic fluid transfer systems. **(SUMMER 2023, 3 Marks)**
- **Q.** Explain about storage and transfer of cryogenic fluids in industry. **(WINTER 2022, 3 Marks)**
- **Q.** Explain about the dewar used in low-temperature research laboratories. **(WINTER 2022, 3 Marks)**
- **Q.** Draw a neat diagram of a dewar vessel showing its elements. [Diagram required – refer to the original question paper] **(WINTER 2023, 3 Marks)**

Chapter 2: Applications of Cryogenic Systems

Repeated Questions:

1. Food, Space & Propulsion Applications:

- **Q.** Discuss the applications of cryogenics in food preservation. **(WINTER 2022, 7 Marks OR; WINTER 2023, 7 Marks; WINTER 2024, 4 Marks; WINTER 2025, 7 Marks OR)**
- **Q.** Discuss the applications of cryogenics in space technology / space simulation chamber. **(WINTER 2022, 7 Marks; WINTER 2023, 4 Marks; WINTER 2024, 7 Marks)**
- **Q.** Discuss the applications of cryogenics in nuclear and chemical propulsions. **(WINTER 2023, 7 Marks; WINTER 2024, 7 Marks)**

2. Superconducting Devices & Biology:

- **Q.** Discuss the applications of cryogenics in superconducting devices. **(WINTER 2023, 7 Marks OR)**
- **Q.** Explain in brief "Applications of cryogenics in biology and medicine". **(WINTER 2023, 3 Marks; WINTER 2025, 3 Marks)**

Other Important Questions:

1. Biology, Metal Forming & Industry:

- **Q.** Write a note on the application of cryogenics in biology. **(SUMMER 2023, 3 Marks)**
- **Q.** How is cryogenic engineering useful in the field of metal forming and improving material properties? **(WINTER 2024, 4 Marks)**
- **Q.** Discuss the applications of cryogenics in industrial applications (general). **(From Syllabus; WINTER 2025, 7 Marks)**

2. Cryotrons & Superconducting Motors:

- **Q.** Explain in detail about cryotrons. **(WINTER 2024, 3 Marks)**
- **Q.** With a neat sketch, explain the construction and working of a cryotron. [Diagram required – refer to the original question paper] **(WINTER 2023, 7 Marks)**
- **Q.** Explain super conductive motors. **(WINTER 2025, 3 Marks OR)**

Chapter 3: Cryogenic Refrigeration & Liquefaction

Repeated Questions:

1. Performance Parameters:

- **Q.** Explain COP and FOM. **(WINTER 2022, 3 Marks; WINTER 2024, 4 Marks; WINTER 2025, 3 Marks)**

2. Liquefaction Systems:

- **Q.** Explain the Claude cycle/system with a suitable diagram. **(WINTER 2022, 4 Marks; WINTER 2024, 7 Marks)**
- **Q.** Explain the Linde-Hampson system (standard or precooled). **(SUMMER 2023, 3 Marks; WINTER 2024, 7 Marks; WINTER 2025, 7 Marks)**
- **Q.** Explain the Joule-Thomson effect/refrigeration system. **(WINTER 2023, 7 Marks; SUMMER 2023, 7 Marks; WINTER 2025, 7 Marks OR)**

3. Principle of Liquefaction & Ideal Systems:

- **Q.** Describe the principle of liquefaction. **(WINTER 2022, 3 Marks OR; WINTER 2025, 3 Marks OR)**
- **Q.** Explain the thermodynamic ideal isothermal and isobaric source system. **(WINTER 2024, 4 Marks; WINTER 2025, 4 Marks)**

Other Important Questions:

1. Liquefaction – Theory & Derivation:

- **Q.** Explain inversion temperature using the Joule-Thomson inversion curve. **(WINTER 2022, 4 Marks OR)**
- **Q.** Discuss payoff functions and performance parameters for gas liquefaction systems. **(WINTER 2023, 3 Marks)**
- **Q.** Derive an expression for the work requirement per unit mass of gas liquefied for an ideal system. [Important Numerical Derivation] **(SUMMER 2023, 7 Marks)**

2. Cycles & Cryo-coolers:

- **Q.** With a neat sketch, explain the mixed refrigerant cascade cycle. **(WINTER 2022, 7 Marks OR)**
- **Q.** How are cryo-coolers classified? Explain the Stirling cycle cryo-refrigerator with a neat sketch and write its COP. **(SUMMER 2023, 7 Marks)**
- **Q.** Explain Simon Helium liquefier and show the process path on a T-s diagram. **(SUMMER 2023, 7 Marks OR)**

Chapter 4: Cryogenic Insulation

Repeated Questions:

1. Powder & Fibrous Insulation:

- **Q.** Explain the mechanism of insulation in (a) Opacified powder insulation (b) Evacuated powder and fibrous insulation. **(WINTER 2022, 4 Marks; WINTER 2023, 4 Marks - Q2b; WINTER 2023, 4 Marks - Q5b; SUMMER 2023, 7 Marks; WINTER 2025, 4 Marks OR)**

2. Multi-Layer & Vacuum Insulation:

- **Q.** Explain in brief Multi-layer Insulation (MLI). **(WINTER 2022, 3 Marks OR; WINTER 2023, 3 Marks OR; WINTER 2024, 7 Marks)**
- **Q.** Write a short note on vacuum insulation. **(WINTER 2023, 3 Marks; WINTER 2025, 4 Marks OR)**

Other Important Questions:

1. Insulation – General:

- **Q.** Write a note on thermal insulation and their performance at cryogenic temperatures. **(SUMMER 2023, 4 Marks)**
- **Q.** Write the important properties to be considered for the selection of insulation. **(WINTER 2024, 3 Marks)**
- **Q.** Give a classification of cryogenic insulations and explain any one in detail. **(Implied from syllabus and papers)**

2. Types of Insulation:

- **Q.** Critically discuss Vacuum alone as insulation. **(WINTER 2024, 3 Marks OR)**
- **Q.** Compare insulations like expanded foam, gas-filled powder, and fibrous materials with their advantages and disadvantages. **(WINTER 2024, 4 Marks)**
- **Q.** Explain the merits and demerits of Opacified powder cryogenic insulations along with their applications. **(WINTER 2024, 4 Marks)**
- **Q.** Explain why MLI is better insulation than other insulation for cryogenics? **(WINTER 2025, 7 Marks)**
- **Q.** Explain in brief vacuum insulated transfer lines. **(WINTER 2022, 3 Marks)**

Chapter 5: Cryogenic System Requirements (Heat Exchangers, Storage, Equipment)

Repeated Questions:

1. Air Separation & Heat Exchangers:

- **Q.** Enlist air separation and purification systems. Explain any one system with a diagram. **(WINTER 2022, 7 Marks; WINTER 2023, 7 Marks; SUMMER 2023, 7 Marks)**
- **Q.** Give classification of cryogenic heat exchangers and explain plate fin type in detail / explain different types. **(WINTER 2022, 7 Marks; WINTER 2023, 7 Marks)**

2. Transfer of Cryogenic Fluid:

- **Q.** Explain the transfer of cryogenic fluid. **(WINTER 2024, 3 Marks; WINTER 2025, 3 Marks)**

Other Important Questions:

1. Heat Exchangers & Cycle Performance:

- **Q.** Explain the role of heat exchangers in cryogenic systems. **(WINTER 2023)**
- **Q.** Explain how critical the role of cryogenic heat exchangers is in a cryogenic system. **(WINTER 2024, 3 Marks OR)**
- **Q.** Explain the significance of heat exchanger effectiveness on the performance of a cryogenic liquefier. **(SUMMER 2023, 4 Marks)**
- **Q.** Discuss the effect of compressor and expander efficiencies on the performance of the Claude cycle. **(SUMMER 2023, 4 Marks)**
- **Q.** Write the desirable features of regenerative heat exchanger of Philips refrigerator. **(WINTER 2025, 4 Marks)**

2. Expanders & Process Equipment:

- **Q.** Write a note on reciprocating expanders in detail. **(WINTER 2022, 7 Marks OR)**
- **Q.** Explain different process equipment used in air separation and liquefaction plants. **(WINTER 2022, 4 Marks OR)**

3. Storage Vessels & Transfer Lines:

- **Q.** With the help of a neat sketch, explain a typical cryogenic liquid storage vessel. [Diagram required – refer to the original question paper] **(SUMMER 2023, 7 Marks)**
- **Q.** With a neat sketch, explain the horizontal dewar vessels for cryogenic fluid storage. [Diagram required – refer to the original question paper] **(WINTER 2024, 7 Marks OR)**
- **Q.** Explain the storage equipment for cryogenic fluids. **(WINTER 2025, 7 Marks)**
- **Q.** Briefly explain (1) Design of transfer line (2) Cryogenic valves. **(SUMMER 2023, 4 Marks)**

Chapter 6: Cryogenic Instrumentation

Repeated Questions:

1. Flow & Temperature Measurement:

- **Q.** Explain the construction and working of a turbine flow meter with a figure. **(WINTER 2022, 4 Marks; SUMMER 2023, 4 Marks)**
- **Q.** Explain the Metallic resistance thermometer used for cryogenic temperature measurement. **(WINTER 2022, 4 Marks OR; WINTER 2023, 4 Marks; SUMMER 2023, 3 Marks)**

Other Important Questions:

1. Level, Pressure & Flow Measurement:

- **Q.** Enlist various measurement systems used in cryogenic engineering. **(SUMMER 2023, 3 Marks)**
- **Q.** Explain the working of a capacitance liquid level probe with a figure. **(WINTER 2022, 7 Marks)**
- **Q.** Discuss liquid level measurement in the cryogenic range. **(WINTER 2024, 7 Marks)**
- **Q.** How does pressure measurement at low temperature differ from that at room temperature? Briefly discuss how you will carry out the measurement at low temperature? **(WINTER 2024, 7 Marks)**
- **Q.** Write a brief note on cryogenic flow control devices and explain any one of them. **(WINTER 2022, 7 Marks OR)**

2. Hazards:

- **Q.** Discuss hazards on account of (i) flammability (ii) high-pressure gas (iii) Material of construction (iv) personal exposure hazards. **(SUMMER 2023, 7 Marks)**

****