

GUJARAT TECHNOLOGICAL UNIVERSITY

BE-7 SEMESTER – OLD PAPER – S23 & W22,23,24 – QUESTION BANK

Subject Name & Code:

Cryogenics Engineering- 3171919

Chapter 1: Introduction (Properties, Hazards, Safety)

Repeated Questions:

- **Q:** Discuss variations of properties of materials at cryogenic temperature (e.g., Fatigue strength, Hardness, Ductility, Ultimate strength).
 - **Appeared in:** Winter 2022 (Q1a, 03 Marks), Winter 2023 (Q2b, 04 Marks), Summer 2023 (Q1b, 04 Marks), Winter 2024 (Q1b, 04 Marks).
- **Q:** Explain the concept of Ortho-hydrogen and Para-hydrogen.
 - **Appeared in:** Winter 2022 (Q1b, 04 Marks).
- **Q:** Write a short note on properties of liquid Hydrogen.
 - **Appeared in:** Winter 2023 (Q1b, 04 Marks), Summer 2023 (Q1a, 03 Marks).
- **Q:** Explain different types of hazards and their prevention (Physical, Chemical, Physiological).
 - **Appeared in:** Winter 2022 (Q2b, 04 Marks), Winter 2024 (Q2a, 03 Marks).
- **Q:** Describe the safety precautions for handling cryogens in industry.
 - **Appeared in:** Winter 2024 (Q2c, 07 Marks).

Other Important Questions:

- Explain the significance of the strength to conductivity ratio for metals at cryogenic temperatures. (Winter 2024, Q1a, 03M)
- Define superconductivity. What are Type-I and Type-II superconductors? (Winter 2023, Q2a, 03M)
- Explain the Meissner effect with a sketch. (Winter 2023, Q1a, 03M)
- Explain magnetic properties of superconductors. (Winter 2022, Q2a, 03M)
- What do you mean by superconductivity and superconductive material? (Winter 2024, Q3a, 03M)
- Write a note on cryogenic fluid transfer systems. (Summer 2023, Q2a, 03M)
- Explain about storage and transfer of cryogenic fluids in industry. (Winter 2022, Q5a, 03M)
- Explain about the dewar used in low-temperature research laboratories. (Winter 2022, Q5a, 03M)
- Draw a neat diagram of a dewar vessel showing its elements. (Winter 2023, Q5a, 03M)

Chapter 2: Applications of Cryogenic Systems

Repeated Questions:

- **Q:** Discuss the applications of cryogenics in food preservation.
 - **Appeared in:** Winter 2022 (Q2c-OR, 07 Marks), Winter 2023 (Q2c, 07 Marks), Winter 2024 (Q3b, 04 Marks).
- **Q:** Discuss the applications of cryogenics in space technology / space simulation chamber.
 - **Appeared in:** Winter 2022 (Q1c, 07 Marks), Winter 2023 (Q3b, 04 Marks), Winter 2024 (Q3c, 07 Marks).
- **Q:** Discuss the applications of cryogenics in nuclear and chemical propulsions.
 - **Appeared in:** Winter 2023 (Q3c, 07 Marks), Winter 2024 (Q3c, 07 Marks).
- **Q:** Discuss the applications of cryogenics in superconducting devices.
 - **Appeared in:** Winter 2023 (Q2c-OR, 07 Marks).

Other Important Questions:

- Explain in brief "Applications of cryogenics in biology and medicine". (Winter 2023, Q3a, 03M)
- Write a note on the application of cryogenics in biology. (Summer 2023, Q4a, 03M)
- How is cryogenic engineering useful in the field of metal forming and improving material properties? (Winter 2024, Q3b, 04M)
- Explain in detail about cryotrons. (Winter 2024, Q3a, 03M)
- With a neat sketch, explain the construction and working of a cryotron. (Winter 2023, Q3c, 07M)
- Discuss the applications of cryogenics in industrial applications (general). (From Syllabus)

Chapter 3: Cryogenic Refrigeration & Liquefaction

Repeated Questions:

- **Q:** Explain COP and FOM.
 - **Appeared in:** Winter 2022 (Q3a, 03 Marks), Winter 2024 (Q5b, 04 Marks).
- **Q:** Explain the Claude cycle/system with a suitable diagram.
 - **Appeared in:** Winter 2022 (Q3b, 04 Marks), Winter 2024 (Q5c, 07 Marks).
- **Q:** Explain the Linde-Hampson system (standard or precooled).
 - **Appeared in:** Summer 2023 (Q3a, 03M), Winter 2024 (Q5c, 07M).
- **Q:** Explain the Joule-Thomson effect/refrigeration system.
 - **Appeared in:** Winter 2023 (Q1c, 07 Marks), Summer 2023 (Q2c, 07 Marks).

Other Important Questions:

- Describe the principle of liquefaction. (Winter 2022, Q3a-OR, 03M)
- Explain inversion temperature using the Joule-Thomson inversion curve. (Winter 2022, Q3b-OR, 04M)
- With a neat sketch, explain the mixed refrigerant cascade cycle. (Winter 2022, Q3c-OR, 07M)
- Discuss payoff functions and performance parameters for gas liquefaction systems. (Winter 2023, Q4a, 03M)
- Derive an expression for the work requirement per unit mass of gas liquefied for an ideal system. (Summer 2023, Q1c, 07M) [*Important Numerical Derivation*]
- How are cryo-coolers classified? Explain the Stirling cycle cryo-refrigerator with a neat sketch and write its COP. (Summer 2023, Q3c, 07M)
- Explain the thermodynamic ideal isothermal and isobaric source system. (Winter 2024, Q5b, 04M)
- Explain Simon Helium liquefier and show the process path on a T-s diagram. (Summer 2023, Q2c-OR, 07M)

Chapter 4: Cryogenic Insulation

Repeated Questions:

- **Q:** Explain the mechanism of insulation in (a) Opacified powder insulation (b) Evacuated powder and fibrous insulation.
 - **Appeared in:** Winter 2022 (Q4b, 04 Marks), Winter 2023 (Q2b & Q5b, 04 Marks), Summer 2023 (Q4c, 07 Marks).
- **Q:** Explain in brief Multi-layer Insulation (MLI).
 - **Appeared in:** Winter 2022 (Q4a-OR, 03 Marks), Winter 2023 (Q3a-OR, 03 Marks), Winter 2024 (Q1c, 07 Marks).

Other Important Questions:

- Write a note on thermal insulation and their performance at cryogenic temperatures. (Summer 2023, Q2b, 04M)
- Write the important properties to be considered for the selection of insulation. (Winter 2024, Q4a, 03M)
- Critically discuss Vacuum alone as insulation. (Winter 2024, Q4a-OR, 03M)
- Compare insulations like expanded foam, gas-filled powder, and fibrous materials with their advantages and disadvantages. (Winter 2024, Q4b, 04M)
- Explain the merits and demerits of Opacified powder cryogenic insulations along with their applications. (Winter 2024, Q4b, 04M)
- Give a classification of cryogenic insulations and explain any one in detail. (Implied from syllabus and papers).
- Explain in brief vacuum insulated transfer lines. (Winter 2022, Q4a, 03M)
- Write a short note on vacuum insulation. (Winter 2023, Q5a, 03M)

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

Repeated Questions:

- **Q:** Enlist air separation and purification systems. Explain any one system with a diagram.
 - **Appeared in:** Winter 2022 (Q3c, 07 Marks), Winter 2023 (Q4c, 07 Marks), Summer 2023 (Q4c, 07 Marks).
- **Q:** Give classification of cryogenic heat exchangers and explain plate fin type in detail / explain different types.
 - **Appeared in:** Winter 2022 (Q4c, 07 Marks), Winter 2023 (Q5c, 07 Marks).

Other Important Questions:

- Explain the role of heat exchangers in cryogenic systems. (Winter 2023, Q5c)
- Explain how critical the role of cryogenic heat exchangers is in a cryogenic system. (Winter 2024, Q5a-OR, 03M)
- Explain the significance of heat exchanger effectiveness on the performance of a cryogenic liquefier. (Summer 2023, Q4b, 04M)
- Discuss the effect of compressor and expander efficiencies on the performance of the Claude cycle. (Summer 2023, Q4b, 04M)
- Write a note on reciprocating expanders in detail. (Winter 2022, Q4c-OR, 07M)
- Explain different process equipment used in air separation and liquefaction plants. (Winter 2022, Q4b-OR, 04M)
- With the help of a neat sketch, explain a typical cryogenic liquid storage vessel. (Summer 2023, Q5c, 07M)
- With a neat sketch, explain the horizontal dewar vessels for cryogenic fluid storage. (Winter 2024, Q2c-OR, 07M)
- Explain the transfer of cryogenic fluid. (Winter 2024, Q5a, 03M)
- Briefly explain (1) Design of transfer line (2) Cryogenic valves. (Summer 2023, Q5b, 04M)

Chapter 6: Cryogenic Instrumentation

Repeated Questions:

- **Q:** Explain the construction and working of a turbine flow meter with a figure.
 - **Appeared in:** Winter 2022 (Q5b, 04 Marks), Summer 2023 (Q5b, 04 Marks).
- **Q:** Explain the Metallic resistance thermometer used for cryogenic temperature measurement.
 - **Appeared in:** Winter 2022 (Q5b-OR, 04 Marks), Winter 2023 (Q4b, 04 Marks), Summer 2023 (Q5a, 03M).

Other Important Questions:

- Explain the working of a capacitance liquid level probe with a figure. (Winter 2022, Q5c, 07M)
- Discuss liquid level measurement in the cryogenic range. (Winter 2024, Q4c, 07M)
- 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, Q4c, 07M)
- Write a brief note on cryogenic flow control devices and explain any one of them. (Winter 2022, Q5c-OR, 07M)
- Enlist various measurement systems used in cryogenic engineering. (Summer 2023, Q5a, 03M)
- Discuss hazards on account of (i) flammability (ii) high-pressure gas (iii) Material of construction (iv) personal exposure hazards. (Summer 2023, Q5c, 07M)
