



**B.E DEGREE EXAMINATIONS: MAY 2017**

(Regulation 2014)

Sixth Semester

**AERONAUTICAL ENGINEERING**

U14AEE604 : Introduction to Cryogenic Engineering

**COURSE OUTCOMES**

- CO1:** Apply classical thermodynamics principles to various cryogenics systems.  
**CO2:** Calculate the rate of heat transfer for various cryogenic systems.  
**CO3:** Design typical cryogenic insulation system for space propulsion.  
**CO4:** Analyze the performance parameters of cryogenic rockets.  
**CO5:** Apply general safety principles to various cryogenics systems.

**Time: Three Hours**

**Maximum Marks: 100**

**Answer all the Questions:-**

**PART A (10 x 1 = 10 Marks)**

1. Matching the following cryogens with its triple point

CO1 [K<sub>1</sub>]

Cryogens	Triple point (K)
A. Methane	i. 54.36
B. Oxygen	ii. 59.75
C. Argon	iii. 90.69
D. Air	iv. 83.81

- |    | A   | B  | C   | D  |
|----|-----|----|-----|----|
| a) | ii  | i  | iii | iv |
| b) | iii | iv | i   | ii |
| c) | ii  | iv | iii | i  |
| d) | iii | i  | iv  | ii |

2. Systems cool down faster at low temperatures due to decrease in

CO1 [K<sub>1</sub>]

- |                  |                    |
|------------------|--------------------|
| a) Pressure      | b) Enthalpy        |
| c) Specific heat | d) Specific volume |

3. 1. Magnetic levitation concept based on superconductivity principle CO2 [K<sub>2</sub>]  
2. The value of elastic modulus of the materials increases while temperature decreases.  
3. Boiling point for liquid Neon is 90 K.  
4. Reduction in dimensions of a material occurs when cooled to low temperatures.  
Which are correct statements?
- a) 1,2 b) 1,3  
c) 1,4 d) 2,3
4. Carbon steel undergoes ductile - brittle transition at the temperature around \_\_\_\_\_ CO2 [K<sub>2</sub>]
- a) 40-60K b) 60-80K  
c) 80-100K d) 100-120K
5. Assertion (A): LHe-II is called as a super fluid CO2 [K<sub>2</sub>]  
Reason (R): LHe-II exhibits property like zero and large thermal conductivity
- a) Both A and R are Individually true and R is the correct explanation of A b) Both A and R are Individually true but R is not the correct explanation of A  
c) A is true but R is false d) A is false but R is true
6. The thermodynamic process involved during throttling is \_\_\_\_\_ CO1 [K<sub>1</sub>]
- a) Isenthalpic expansion b) Isentropic expansion  
c) Isothermal expansion d) Isobaric expansion
7. Rearrange the following cryogenes in ascending order based on their boiling point CO2 [K<sub>1</sub>]  
1. Liquid Oxygen    2. Liquid Nitrogen    3. Liquid Helium    4. Liquid Hydrogen
- a) 3-4-1-2 b) 3-1-2-4  
c) 3-4-2-1 d) 1-4-3-2
8. Which one of the following factors causes major losses in rocket engines CO4 [K<sub>1</sub>]
- a) Incomplete chemical reaction b) Losses due to nozzle  
c) Losses due to pumps d) All the above
9. The specific impulse of Saturn V3 stage rocket engine is CO4 [K<sub>2</sub>]
- a) 259s b) 260s  
c) 424s d) 455s
10. The boiling point of liquid Neon is \_\_\_\_\_ CO5 [K<sub>1</sub>]
- a) 29.3K b) 27.1K  
c) 25.5K d) 23.7K

**PART B (10 x 2 = 20 Marks)**

**(Answer not more than 40 words)**

- |                                                                          |     |                   |
|--------------------------------------------------------------------------|-----|-------------------|
| 11. What is meant by superfluid?                                         | CO1 | [K <sub>2</sub> ] |
| 12. Differentiate between ortho and para hydrogen                        | CO1 | [K <sub>2</sub> ] |
| 13. Differentiate convection and advection                               | CO2 | [K <sub>2</sub> ] |
| 14. Draw the T-s diagram of a cryogen.                                   | CO1 | [K <sub>2</sub> ] |
| 15. Classify the types of insulation.                                    | CO3 | [K <sub>2</sub> ] |
| 16. What are the factors to be considered while choosing the insulation? | CO3 | [K <sub>2</sub> ] |
| 17. What is meant by cooling duty?                                       | CO2 | [K <sub>2</sub> ] |
| 18. List any four application of cryogenic fluid.                        | CO1 | [K <sub>2</sub> ] |
| 19. What is mixture ratio and how it affects the exit velocity?          | CO4 | [K <sub>2</sub> ] |
| 20. Define the term flammability.                                        | CO5 | [K <sub>2</sub> ] |

**Answer any FIVE Questions:-**

**PART C (5 x 14 = 70 Marks)**

**(Answer not more than 300 words)**

**Q.No. 21 is Compulsory**

- |                                                                                                                            |     |                       |
|----------------------------------------------------------------------------------------------------------------------------|-----|-----------------------|
| 21. Explain in detail the working principle of Gifford-McMahon refrigerator with neat T-s plot.                            | CO2 | [K <sub>3</sub> ]     |
| 22. i) Draw the phase and T-s diagram for liquid helium and also briefly discuss about its properties and applications.    | (8) | CO1 [K <sub>2</sub> ] |
| ii) With neat sketch explain the working principle cryogenic rocket engine.                                                | (6) | CO1 [K <sub>2</sub> ] |
| 23. Write short notes on the following methods.                                                                            | CO2 | [K <sub>3</sub> ]     |
| i) Joule-Thomson expansion                                                                                                 |     |                       |
| ii) Adiabatic reversible turbine expansion                                                                                 |     |                       |
| iii) Cooling by external refrigerant                                                                                       |     |                       |
| 24. With neat sketch explain the working principle of hydrostatic gauge and diaphragm gauge used for pressure measurement. | CO3 | [K <sub>2</sub> ]     |

25. Write short notes on the following design features for cryogenic propulsion. CO4 [K<sub>2</sub>]  
i). Boil-off rate ii). Storage tanks iii). Propellant feed systems iv). Tank pressurization and vent systems
26. Discuss in detail about the response of mechanical properties in the material when it's subjected to cryogenic temperature. CO2 [K<sub>3</sub>]
27. Elaborate the safety considerations for liquid hydrogen. CO5 [K<sub>3</sub>]

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