Indian Maritime University

(A Central University, Govt of India)

Supplementary Examinations – March/April 2025

Programme Name: B Tech (ME)

Semester: II

Subject Code: UG11T4205

Subject Name: Basic Thermodynamics

Date: 19.03.2025	Max Marks: 70
Duration: 03 Hrs	Pass Marks: 35

General Instructions

(i) All Sections (A, B & C) are to be attempted.
(ii) Options, if any, are specified in respective section.
(iii) Steam Tables and Thermal properties Tables can be used.

Section A

Ten MCQs/Fill in the Blanks of 01 Mark each – Choose the correct answer as applicable.

1. In an irreversible process, there is a
(a) loss of heat (b) no loss of heat (c) gain of heat (d) no gain of heat.

2. The latent heat of vapourisation at critical point is
(a) less than zero (b) greater than zero (c) equal to zero (d) none of the above.

3. For dry saturated vapour, the value of dryness fraction will be
a) 0 b) 0.5 c) 0.75 d) 1

4. If all the variables of a stream are independent of time it is said to be in
(a) steady flow (b) unsteady flow (c) uniform flow (d) closed flow

5. Which of following is NOT an extensive property?
a) enthalpy b) entropy c) sp. Enthalpy d) none

6. A frictionless heat engine can be 100% efficient only if its exhaust temperature is
(a) equal to its input temperature (b) less than its input temperature
(c) 0°C (d) 0°K

7. A piston-cylinder device contains 5 kg of air at 400 kPa and 30°C. During a quasi-equilibrium isothermal expansion process, 15 kJ of boundary work is done

by the system, and 3 kJ of paddle-wheelwork is done on the system. Determine heat transfer during this process
(a) 12 kJ (b) 5 kJ (c) 18 kJ (d) 45 kJ

8. Isentropic flow is
(a) irreversible adiabatic flow (b) ideal fluid flow (c) reversible adiabatic flow
(d) frictionless reversible flow

9. A unit mass of a substance undergoes an irreversible process from state 1 to state 2 while gaining heat from the surroundings at temperature T in the amount of q. If the entropy of the substance is s_1 at state 1, and s_2 at state 2, the entropy change of the substance Δs during this process is
(a) $\Delta s = s_2 - s_1$ (b) $\Delta s = s_2 - s_1 + q/T$ (c) $\Delta s = 0$ (d) $\Delta s = s_2 - s_1 - q/T$

10. A furnace can supply heat steadily at a 1600 K at a rate of 800 kJ/s. The maximum amount of power that can be produced by using the heat supplied by this furnace in an environment at 300 K is
(a) 150 kW (b) 210 kW (c) 325 kW (d) 650 kW

Section B

Five Questions of 02 Marks each

11. Define Exergy and Dead State?

12. An experimentalist claims to have raised the temperature of a small amount of water to 150°C by transferring heat from high-pressure steam at 120°C. Is this a reasonable claim? Why? Assume no refrigerator or heat pump is used in the process.

13. What is Dryness Fraction? Does it have any meaning in the superheated vapour region?

14. Define the Clausius statement of second law of thermodynamics.

15. A steam power plant receives heat from a furnace at a rate of 280 GJ/h. Heat losses to the surrounding air from the steam as it passes through the pipes and other components are estimated to be about 8 GJ/h. If the waste heat is transferred to the cooling water at a rate of 145 GJ/h, determine the thermal efficiency of this power plant.

Section C

Seven Questions of 10 Marks each of which any 05 questions to be answered.

16. A vessel having a capacity of 0.05 m^3 contains a mixture of saturated water and saturated steam at a temperature of 245°C. The mass of the liquid present is 10 kg. Find the following :
(a) The specific volume, (b) The specific enthalpy, (c) The specific internal energy (4 +3 +3 Marks)

17. Steam at 5 MPa and 400°C enters a nozzle steadily with a velocity of 80 m/s, and it leaves at 2 MPa and 300°C. The inlet area of the nozzle is 50 cm^2, and heat is being lost at a rate of 120 kJ/s. Determine (a) the exit area of the nozzle, (b) the exit velocity of the steam. (4 + 6 Marks).

18. A fish freezing plant requires 40 tons of refrigeration. The freezing temperature is – 35°C while the ambient temperature is 30°C. If the performance of the plant is 20% of the theoretical reversed Carnot cycle working within the same temperature limits, calculate the power required. (1 ton of refrigeration = 210 kJ/min.)

19. A piston–cylinder device contains 5 kg of steam at 100°C with a quality of 50 percent. This steam undergoes two processes as follows:
(1-2): Heat is transferred to the steam in a reversible manner while the temperature is held constant until the steam exists as a saturated vapor.
(2-3): The steam expands in an adiabatic, reversible process until the pressure is 15 kPa.
Determine the (a) heat added to the steam in process 1-2, in kJ, (b) work done by the steam in process 2-3, in kJ. (5 +5 Marks)

20. Steam enters an adiabatic turbine at 8 MPa and 500°C at a rate of 3 kg/s and leaves at 20 kPa. If the power output of the turbine is 2.5 MW, determine the temperature of the steam at the turbine exit. Neglect kinetic energy changes.

21. A 0.5 m^3 rigid tank contains refrigerant-134a initially at 200 kPa and 40 percent quality. Heat is transferred now to the refrigerant from a source at 35°C until the pressure rises to 400 kPa. Determine (a) the entropy change of the refrigerant, (b) the entropy change of the heat source. (5 + 5 Marks)

22. a) Define Reversible work and second law of efficiency (4 marks)

b) One kg of air is compressed adiabatically from 1 bar pressure and temperature of 300 K to a pressure of 6.8 bar and temperature of 370 K. Determine irreversibility if the sink temperature is 293 K. Assume R = 0.287 kJ/kgK, C_p = 1.004 kJ/kgK, C_v = 0.716 kJ/kgK, γ = 1.4 (6 marks)