Indian Maritime University

(A Central University, Govt of India)

Mar/Apr'26 SE
Programme Name: B Tech (ME)

Semester: II

Subject Code: UG11T4205

Subject Name: Basic Thermodynamics

Date: 13.04.2026	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 (Refrigerants, Gases) 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. Dryness fraction of steam is defined as
(a) mass of water vapour in suspension/(mass of water vapour in suspension + mass of dry steam)
(b) mass of dry steam/mass of water vapour in suspension
(c) mass of dry steam/(mass of dry steam + mass of water vapour in suspension)
(d) mass of water vapour in suspension/mass of dry steam.

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 the following is not a property of the system ?
(a) Temperature (b) Pressure (c) Specific volume (d) Heat

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. During throttling process:
(a) internal energy does not change
(b) pressure does not change
(c) enthalpy does not change
(d) volume does not change

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

9. The value of $\oint dQ/T$ for a reversible cycle is
(a) Equal to zero (b) Greater than zero (c) Less than zero (d) Unity

10. For a given temperature T1 and T2, as the difference between T1 and T2 increases, the COP of a Carnot Heat Pump
(a) Increases (b) Decreases (c) Does not change (d) First increases, then decreases

Section B

Five Questions of 02 Marks each

11. Why the second law is called as law of degradation of energy?

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. Define COP for a refrigerator and heat pump.

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

15. Define exergy and dead state.

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. Two Carnot Engines A and B are connected in series between two thermal reservoirs. Engine A receives 1600 kJ of heat from the high temperature reservoir maintained at 1200 K and rejects heat to the Carnot engine B. Engine B takes in heat rejected by engine A and rejects heat to the low temperature reservoir maintained at 200 K. If engines A and B have equal thermal efficiencies, determine

a. the heat rejected by engine B
b. temperature at which heat is rejected by engine A
c. work done by engine A and B. (3+3+4 Marks)

19. (a) Explain an adiabatic process (03 marks)
(b) What is Dryness Fraction? Does it have any meaning in the superheated vapour region? (03 marks)
(c) Explain the difference between Heat Engine and Heat Pump? (04 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. (10 Marks)

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. An iron block of unknown mass at 90°C is dropped into an insulated tank that contains 0.2 m^3 of water at 20 °C. At the same time, a paddle wheel driven by a 250 W motor is activated to stir the water. Thermal equilibrium is established after 20 min when the final temperature is 28 °C. Determine the mass of the iron block and the exergy destroyed during the process.

Take: Density and specific heat of water = 1000 kg/m^3 and c_p = 4.18 kJ/kg.K. The specific heat of iron at room temperature is c_p = 0.45 kJ/kg.K (10 Marks)