Indian Maritime University

(A Central University, Govt of India)

End Semester Examinations – June 2023

Programme Name: B Tech (ME)

Semester: II

Subject Code: UG11T4205

Subject Name: Basic Thermodynamics

Date: 05.06.2023	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.

QP setters to specify the following as applicable:-

(iii) Steam Tables and Thermal properties (Refrigerants) 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. Which among the following is an extensive property?

a. Temperature
b. Specific Enthalpy
c. Pressure
d. Entropy

3. "No process is possible whose sole result is the transfer of heat from a colder object to a hotter object", this statement is related to the:
(A) Kelvin Planck statement
(B) Clausius statement
(C) First law of thermodynamics
(D) None of these

4. 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

5. There is no work transfer involved in this process
a. Adiabatic Expansion
b. Isothermal Expansion
c. Polytropic Expansion
d. Free Expansion

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

7. Carnot cycle consists of
a) Two constant volume & two isentropic processes
b) Two isothermal and two isentropic processes
c) Two constant pressure and two isentropic processes
d) One constant volume, one constant pressure and two isentropic processes

8. Increase in entropy of a system represents
a. Increase in availability of energy
b. Decrease in pressure
c. Degradation of energy
d. Increase in temperature

9. The maximum work output obtainable from a certain heat input in a cyclic heat engine is called the _____.
(A) Kinetic energy
(B) Unavailable energy
(C) Electrical energy
(D) Available energy

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 PMM I and PMM II
12. Define the flow work and write an expression of the flow work.
13. Draw TS diagram, when system undergoes isothermal expansion (1-2) followed by adiabatic expansion (2-3)

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

15. What is Exergy and Dead State?

Section C

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

16. a) In an air compressor air flows steadily at the rate of 0.5 kg/s through an air compressor. It enters the compressor at 6 m/s with a pressure of 1 bar and a specific volume of 0.85 m^3/kg and leaves at 5 m/s with a pressure of 7 bar and a specific volume of 0.16 m^3/kg. The internal energy of the air leaving is 90 kJ/kg greater than that of the air entering. Cooling water in a jacket surrounding the cylinder absorbs heat from the air at the rate of 60 kJ/s. Calculate power required to drive the compressor in MW

(5 marks)

b) Establish relation among C_p, C_v and R of perfect gas

(5 marks)

17. 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 (3 marks)
    b. temperature at which heat is rejected by engine A (3 marks)
    c. Calculate the work done by engine A and B. (4 marks)

18. (i) Explain P-T diagram of a pure substance. (5 marks)

(ii) Prove that, for a closed system

$$s_2 - s_1 = C_v \ln\left(\frac{T_2}{T_1}\right) + R \ln\left(\frac{V_2}{V_1}\right)$$ (5marks)

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.
(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. A 0.04 m^3 of nitrogen contained in cylinder behind a piston is initially at 1.05 bar and 15^0C. The gas is compressed isothermally and reversibly until the pressure is 4.8 bar. Calculate change in entropy in kJ/K also sketch P-V and T-S diagram (R = 0.297 kJ/kgK)

(3+2 mark)

b) Define entropy with T-s diagram and state any two characteristics of entropy

(5 mark)

21. **a)** Define Reversible work and second law of efficiency

(4 mark)

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 mark)

22 .Write the short notes of the following:

a) First law of Thermodynamics for closed fixed system (4 mark)
b) Enthalpy (3 mark)
c) Internal energy (3 mark)