Printed Page:- **Subject Code**:- **AME0304**

Roll. No:

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech

SEM: III - CARRY OVER THEORY EXAMINATION - APRIL 2023

Subject: Basic Thermodynamics

Time: 3 Hours **Max. Marks: 100**

General Instructions:

IMP: *Verify that you have received the question paper with the correct course, code, branch etc.*

1. *This Question paper comprises of* **three Sections -A, B, & C.** *It consists of Multiple Choice Questions (MCQ's) & Subjective type questions.*

2. *Maximum marks for each question are indicated on right -hand side of each question.*

3. *Illustrate your answers with neat sketches wherever necessary.*

4. *Assume suitable data if necessary.*

5. *Preferably, write the answers in sequential order.*

6. *No sheet should be left blank. Any written material after a blank sheet will not be evaluated/checked.*

SECTION A **20**

1. Attempt all parts:-

1-a. Which one of the following is the intensive property of a thermodynamic system? (CO1) 1

(a) Volume

(b) Kinetic energy

(c) Pressure

(d) Internal energy

1-b. For every thermodynamic cycle, the net amount of energy transfer by heat is _____ the net amount of energy transfer by work per cycle. (CO1) 1

(a) equal to

(b) not equal to

(c) less than

(d) more than

1-c. If a heat engine produces net work output by exchanging heat with only one reservoir, then the heat engine will be, _____ (CO2) 1

(a) PMM1

(b) PMM2

(c) PMM3

(d) none of the mentioned

1-d. A _____ converts some heat to work and reject some heat to the surrounding. (CO2) 1

(a) PMM1

(b) heat engine

(c) PMM2

(d) PMM3

1-e. Entropy change is depend on _____ . (CO3) 1

(a) Mass transfer

(b) Heat transfer

(c) Work transfer

(d) Pressure transfer

1-f. Entropy principle is the quantitative statement of the _____ law of thermodynamics. (CO3) 1

(a) second

(b) first

(c) third

(d) zeroth

1-g. The area under the temperature-entropy curve (T – s curve) of any thermodynamic process represents _____. (CO4) 1

(a) Heat absorbed

(b) Heat rejected

(c) Either heat absorbed or heat rejected

(d) None of these

1-h. Above the _____, the isotherms are continuous curves. (CO4) 1

(a) critical point

(b) triple point

(c) saturation point

(d) boiling point

1-i. ɣ (adiabatic index) for _____ is equal to 1.4. (CO5) 1

(a) nitrogen

(b) air

(c) hydrogen

(d) oxygen

1-j. _____ = TdS - pdV (CO5) 1

(a) dU

(b) dH

(c) dG

(d) dP

2. Attempt all parts:-

2.a. Define enthalpy and internal energy. (CO1) 2

2.b. What is PMM2? (CO2) 2

2.c. Why and when is exergy completely destroyed? (CO3) 2

2.d. Calculate the dryness fraction of steam which has 2.5 kg of water in suspension with 55 kg of steam. (CO4) 2

2.e. Draw p-V and T-s diagram of dual cycle. (CO5) 2

SECTION B **30**

3. Answer any five of the following:-

3-a. A gas contained in a cylinder is compressed, the work required for compression being 5000 kJ. During the process, heat interaction of 2000 kJ causes the surroundings to the heated. Calculate the change in internal energy. Is internal energy exact differential? (CO1) 6

3-b. A gas contained in a cylinder is compressed, the work required for compression being 6000 kJ. During the process, heat interaction of 3000 kJ causes the surroundings to the heated. Calculate the change in internal energy. Is internal energy exact differential? Explain. (CO1) 6

3-c. Using an engine of 30% thermal efficiency to drive a refrigerator having a COP of 5, what is the heat input into the engine for each MJ removed from the cold body by the refrigerator? If this system is used as a heat pump, how many MJ of heat would be available for heating for each MJ of heat input to the engine? (CO2) 6

3-d. An inventor claims that his engine has the following specifications : 6
Temperature limits - 750°C and 25°C
Power developed = 75 kW
Fuel burned per hour =3.9 kg
Heating value of the fuel .=74500 kJ/kg

State whether his claim is valid or not. (CO2)

3.e. Differentiate between: 6
i) Available energy and Unavailable energy
ii) Useful work and Maximum useful work in reference to the availability. (CO3)

3.f. Write short notes on the following; 6
i) Critical point,
ii) Triple point (CO4)

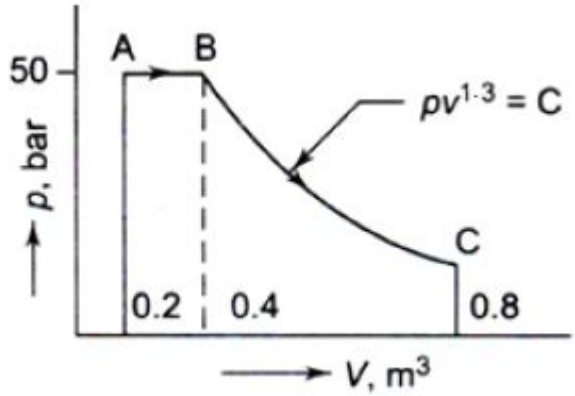
3.g. Starting with the relation dh = T ds + v dP, show that the slope of a constant-pressure line on an h-s diagram increases with temperature in the superheated region. (CO5) 6

SECTION C **50**

4. Answer any <u>one</u> of the following:-

4-a. What is a isothermal process? Air enters a compressor at 105 Pa and 25°C having volume of 1.8 m^3/kg and is compressed to 5 × 10^5 Pa isothermally. Determine : 10
(i) Work done ;
(ii) Change in internal energy ;
(iii) Heat transferred. (CO1)

4-b. What is area under the P-V diagram? Determine the total work done by a gas system following an expansion process as shown in Figure. (CO1) 10



5. Answer any <u>one</u> of the following:-

5-a. 12 kg of a fluid per minute goes through a reversible steady flow process. The properties of fluid at the inlet are p_1 = 1.4 bar, ρ_1 = 25 kg/m^3, C_1 = 120 m/s and u_1 = 920 kJ/kg and at the exit are p_2 = 5.6 bar, ρ_2 = 5 kg/m^3, C_2 = 180 m/s and u_2 = 720 kJ/kg. During the passage, the fluid rejects 60 kJ/s and rises through 60 m. Determine : 10
(i) the change in enthalpy (Δh) and
(ii) work done during the process (W). (CO2)

5-b. Two Carnot engines A and B are connected in series between two thermal reservoirs maintained at 1000 K and 100 K respectively. Engine A receives 1680 kJ of heat from the high-temperature reservoir 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. If engines A and B have equal thermal efficiencies, determine: 10

(a) The heat rejected by engine B.

(b) The temperature at which heat is rejected by engine, A.

(c) The work done during the process by engines, A and B respectively.

If engines A and B deliver equal work, determine:

(d) The amount of heat taken in by engine B.

(e) The efficiencies of engines A and B. (CO2)

6. Answer any <u>one</u> of the following:-

6-a. A copper rod is of length 1 m and diameter 0.01 m. One end of the rod is at 100°C, and the other at 0°C. The rod is perfectly insulated along its length and the thermal conductivity of copper is 380 W/mK. Calculate the rate of heat transfer along the rod and the rate of entropy production due to irreversibility of this heat transfer. (CO3) 10

6-b. Determine the change in entropy in each of the processes of a thermodynamic cycle having following processes; 10

(i) Constant pressure cooling from 1 to 2, P_1 = 0.5 MPa, V_1 = 0.01 m^3

(ii) Isothermal heating from 2 to 3, P_3 = 0.1 MPa, T_3 = 25°C, V_3 = 0.01 m^3

(iii) Constant volume heating from 3 to 1.

Take C_p = 1 kJ/kg . K for perfect gas as fluid. (CO3)

7. Answer any <u>one</u> of the following:-

7-a. Consider a 210-MW steam power plant that operates on a simple ideal Rankine cycle. Steam enters the turbine at 10 MPa and 500°C and is cooled in the condenser at a pressure of 10 kPa. Show the cycle on a T-s diagram with respect to saturation lines, and determine (a) the quality of the steam at the turbine exit, (b) the thermal efficiency of the cycle, and (c) the mass flow rate of the steam. (CO4) 10

7-b. Steam is the working fluid in an ideal Rankine cycle. Saturated vapor enters the turbine at 8.0 MPa and saturated liquid exits the condenser at a pressure of 0.008 MPa. The net power output of the cycle is 100 MW. Determine for the cycle: 10

a) pump work

b) heat supplied

c) turbine work

d) the thermal efficiency (CO4)

8. Answer any <u>one</u> of the following:-

8-a.	Explain Joules Kelvin effect. What are its significance? (CO5)	10
8-b.	Derive Clausius-Claperyon Equation and explain its significance. (CO5)	10