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NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

B. Tech

SEM: III - THEORY EXAMINATION (2023 - 2024)

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. A closed thermodynamic system is one in which (CO1) 1

(a) There is no energy or mass transfer across the boundary,

(b) There is no mass transfer, but energy transfer exists.

(c) There is no energy transfer, but mass transfer exists.

(d) Both energy and mass transfer take place across the boundary, but the mass transfer is controlled by valves.

1-b. Ice kept in a well insulated thermo flask is an example of which system? (CO1) 1

(a) Open system

(b) Closed system

(c) Isolated system

(d) Non flow adiabatic system

1-c. The processes or systems that do not involve heat are called (CO2) 1

(a) Adiabatic

(b) Isothermal

(c) Isobaric

(d) Steady

1-d. Which of the following is the correct statement ? (CO2) 1

(a) All the reversible engines have the same efficiency

(b) All the reversible and irreversible engines have the same efficiency

(c) Irreversible engines have maximum efficiency

(d) All engines are designed as reversible in order to obtain maximum efficiency

1-e. What is the unit of entropy? (CO3) 1

(a) J mol^{-1}

(b) J K mol^{-1}

(c) J^{-1} K^{-1} mol^{-1}

(d) J K^{-1} mol^{-1}

1-f. Which of the following is correct for the net entropy change in an irreversible process? (CO3) 1

(a) It is positive

(b) It is negative

(c) It is zero

(d) None of the mentioned

1-g. Choose the correct answer (CO4) 1

(a) Critical point involves equilibrium of solid and vapour phases

(b) Critical point involves equilibrium of solid and liquid phases

(c) Critical point involves equilibrium of solid, liquid and vapour phases

(d) Triple point involves equilibrium of solid, liquid and vapour phases

1-h. Dryness fraction of steam is defined as (CO4) 1

(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)

(d) mass of water vapour in suspension/mass of dry steam

1-i. Joule Thompson coefficient for ideal gas is (CO5) 1

(a) >0

(b) <0

(c) 0

(d) 1

1-j. Slope of curve is given by the clausius-clapeyron by (CO5) 1

(a) P-T plot

(b) S-T plot

(c) V-T plot

(d) H-T plot

2. Attempt all parts:-

2.a. Explain briefly the Zeroth law of thermodynamics. (CO1) 2

2.b. Distinguish between heat engine and heat pump. [CO2] 2

2.c. What do you mean by the term ‘Entropy’ ? (CO3) 2

2.d.	Can dryness fraction be greater than 1 or less than 0? (CO4)	2
2.e.	Draw the p-V and T-s diagram of Otto cycle. (CO5)	2

SECTION-B 30

3. Answer any five of the following:-

3-a.	A system composed of 2 kg of the above fluid expands in a frictionless piston and cylinder machine from an initial state of 1 MPa, 100°C to a final temperature of 30°C. If there is no heat transfer, find the net work for the process. (CO1)	6
3-b.	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-c.	With help of neat sketch explain the working of Carnot heat engine. [CO2]	6
3-d.	How coefficient of performance of heat pump and efficiency of a heat engine are related? (CO2)	6
3.e.	0.2 kg of air at 300°C is heated reversibly at constant pressure to a temperature of 2066 K. Find the available and unavailable energies of the heat added. Take T_0 = 30°C and c_p = 1.0047 kJ/kg K. (CO3)	6
3.f.	Write short notes on the following; i) Critical point, ii) Triple point (CO4)	6
3.g.	Using the cyclic relation and the first Maxwell relation, derive the other three Maxwell relations (CO5)	6

SECTION-C 50

4. Answer any one of the following:-

4-a.	Differentiate between macroscopic and microscopic view points of thermodynamics. Explain paddle wheel work, shaft work and flow work. (CO1)	10
4-b.	With help of neat sketch explain steady flow energy equation. also write down the assumption of steady flow energy equation. [CO1]	10

5. Answer any one of the following:-

5-a.	What are the applications and assumptions of steady flow process? Explain briefly. (CO2)	10
5-b.	What is a heat pump? A heat pump is run by a reversible heat engine operating between reservoirs at 800°C and 50°C. The heat pump working on Carnot cycle picks up 15 kW heat from reservoir at 10°C and delivers it to a reservoir at 50°C. The reversible engine also runs a machine that needs 25 kW. Determine the heat received from highest temperature reservoir and heat rejected to reservoir at 50°C. (CO2)	10

6. Answer any one of the following:-

6-a.	Derive and explain Helmholtz Gibbs Function. (CO3)	10
6-b.	2 kg of air at 5 bar, 80°C expands adiabatically in a closed system until its volume	10

is doubled and its temperature becomes equal to that of the surroundings which is at 1 bar, 5°C. For this process, determine :
(i) The maximum work ;
(ii) The change in availability ;
(iii) The irreversibility. (CO3)
For air take : c_v = 0.718 kJ/kg K, u = c_vT, where c_v is constant and pV = mRT, where p is in bar, V volume in m^3, m mass in kg, R is constant equal to 0.287 kJ/kg K, and T temperature in K.

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

7-a.	A steam power plant operates on Rankine cycle. Steam in boiler at 150 bar, 550°C expands in turbine to a condenser pressure of 0.1 bar. Draw T-s and h-s diagrams. Find : (i) Quality of steam at turbine exhaust ; (ii) Cycle efficiency ; (iii) Steam rate in kg/kWh. (CO4)	10
7-b.	Explain briefly about Rankine cycle with P-v, T-s and h-s chart. (CO4)	10

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

8-a.	With the help of P-V and T-S diagram explain the Otto cycle. also derive the efficiency of Otto cycle.[CO5]	10
8-b.	With the help of p-v and T-S diagram explain diesel cycle. also derive the formula for efficiency of diesel cycle..**[CO5]**	10