NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA
(An Autonomous Institute Affiliated to AKTU, Lucknow)
B. Tech
SEM: III - THEORY EXAMINATION (2024. - 2025)
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 extensive property of a thermodynamic system?   1
        (CO1,K1)

        (a)   Volume
        (b)   Pressure
        (c)   Temperature
        (d)   Density

1-b.   Work done in a free expansion process is: (CO1,K1)   1

        (a)   Positive
        (b)   Negative
        (c)   Zero
        (d)   Maximum

1-c.   The processes of a Carnot cycle are (CO2,K1)   1

        (a)   two isothermals and two isentropics
        (b)   two isobarics and two isentropics
        (c)   two isothermals and two isobarics
        (d)   two adiabatic and two constant volume

1-d.   If a heat engine produces net work output by exchanging heat with only one   1
        reservoir, then the heat engine will be, _____ (CO2,K1)

        (a)   PMM1

(b) PMM2

(c) PMM3

(d) none of the mentioned

1-e. Which of the following is the correct criteria for a spontaneous process? (CO3,K1) 1

(a) $\Delta S_{system} - \Delta S_{surroundings} > 0$

(b) $\Delta S_{surroundings} > 0$ only

(c) $\Delta S_{system} + \Delta S_{surroundings} > 0$

(d) $\Delta S_{system} > 0$ only

1-f. For a spontaneous reaction (CO3,K1) 1

(a) ΔS must be negative

(b) $(\Delta H - T\Delta S)$ must be negative

(c) ΔH must be negative

(d) $(\Delta H + T\Delta S)$ must be negative

1-g. Which of the following variables controls the physical properties of a perfect gas.[CO4,K1] 1

(a) Pressure

(b) Temperature

(c) Volume

(d) All of the above

1-h. The latent heat of vapourisation at critical point is (CO4,K1) 1

(a) less than zero

(b) greater than zero

(c) equal to zero

(d) none of the above

1-i. For a given compression ratio the work output of Otto cycle is (CO5,K1) 1

(a) increases with increase in r

(b) decreases with increase in r

(c) is not affected

(d) none of the above

1-j. For the same compression ratio and heat rejection (CO5,K1) 1

(a) $\eta_{Otto} > \eta_{Dual} > \eta_{Diesel}$

(b) $\eta_{Diesel} > \eta_{Dual} > \eta_{Otto}$

(c) $\eta_{Dual} > \eta_{Diesel} > \eta_{Otto}$

(d) $\eta_{Dual} > \eta_{Otto} > \eta_{Diesel}$

2. Attempt all parts:-

2.a. What is a quasi-static process ? (CO1,K2) 2

2.b. Explain reversible process with examples. (CO2,K3) 2

2.c.	What is the difference between a heat engine and a reversed heat engine? (CO3,K2)	2
2.d.	What is meant by mollier diagram? (CO4,K2)	2
2.e.	What does the area enclosed by the cycle represent on a T-S diagram? Define it. (CO5,K2)	2

SECTION-B 30

3. Answer any <u>five</u> 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,K2)	6
3-b.	What is the condition for displacement work? Determine the work done by the air which enters into an evacuated vessel from atmosphere when the valve is opened. The atmospheric pressure is 1.013 bar and 1.5 m^3 of air at atmospheric condition enters into the vessel. (CO1,K2)	6
3-c.	Why Carnot cycle is a theoretical cycle? Explain. (CO2,K3)	6
3-d.	A Carnot engine operating between two thermal reservoirs has an efficiency of 30%. Determine the COP if a device is used as a heat pump between the same temperature limits. (CO2,K3)	6
3-e.	10 kg of water undergoes transformation from initial saturated vapour at 150ºC, velocity of 25 m/s and elevation of 10 m to saturated liquid at 20ºC, velocity of 10 m/s and elevation of 3 m. Determine the availability for initial state, final state and change of availability considering environment to be at 0.1 MPa and 25ºC and g = 9.8 m/s^2. (CO3,K3)	6
3-f.	A rigid vessel of volume 0.86 m^3 contains 1 kg of steam at a pressure of 2 bar. Evaluate the specific volume, temperature, dryness fraction, internal energy, enthalpy, and entropy of steam. (CO4,K4)	6
3-g.	Explain the significance of cut-off ratio and compression ratio.(CO5,K3)	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 : (i) Work done ; (ii) Change in internal energy ; (iii) Heat transferred. (CO1,K2)	10
4-b.	State similarities between heat and work transfer. If a system returns to its original state, then what is the net change in internal energy? What are the limitations of first law of thermodynamics? (CO1,K2)	10

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

5-a.	What are the applications and assumptions of steady flow process? Explain briefly. (CO2,K3)	10
5-b.	What is a heat pump? A heat pump is run by a reversible heat engine operating	10

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,K3)

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

6-a.   In a steam generator, water is evaporated at 260°C, while the combustion gas (c_p = 1.08 kJ/kg K) is cooled from 1300°C to 320°C. The surroundingsare at 30°C. Determine the loss in available energy due to the above heat   transfer per kg of water evaporated (Latent heat of vaporization of water at 260°C = 1662.5 kJ/kg). (CO3,K3)   10

6-b.   In a thermodynamic system air contained at 20°C and 1.05 bar occupies 0.025 m^3 is heated at constant volume until the pressure becomes 4.5 bar. It is then cooled at constant pressure back to original temperature i.e. 20°C . Calculate :
(i) The net heat flow from the system
(ii) The net change in entropy of the system   (CO3,K3)   10

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

7-a.   A steam power plant operates on the simple ideal Rankine cycle. Steam enters the turbine at 4 MPa, 500 ^{o} C and is condensed in the condenser at a temperature of 40 ^{o} C. Show the cycle on a T-s and h-s diagram. If the mass flow rate is 10 kg/s, determine (a) the thermal efficiency of the cycle and (b) the net power output in MW. (CO4,K3)   10

7-b.   what do you mean by dryness fraction. what are the different process for measurement of dryness fraction. explain any one process with help of neat sketch. (CO4,K3)   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,K3)   10

8-b.   Explain diesel cycle with Pv and Ts diagram. An oil engine working on the diesel cycle has a compression ratio 14. If the cut-off occurs at 6 per cent of stroke, find the ideal efficiency. Take γ for air = 1.4. (CO5,K3)   10