Code No: 153BZ **R18**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech II Year I Semester Examinations, February -2024
THERMODYNAMICS
(Mechanical Engineering)

Time: 3 Hours **Max. Marks: 75**

Note: i) Question paper consists of Part A, Part B.
ii) Part A is compulsory, which carries 25 marks. In Part A, answer all questions.
iii) In Part B, Answer any one question from each unit. Each question carries 10 marks and may have a, b as sub questions.

PART – A

(25 Marks)

1.a) Should the automobile radiator be analyzed as a closed system or as an open system? Support your answer. [2]
b) Also discuss thermal, chemical and mechanical equilibrium with suitable examples. [3]
c) Explain the difference between heat pump and refrigerator, also find the C.O.P [2]
d) An inventor claims to develop an engine which absorbs 100KW of heat from a reservoir at 1000 K produces 60 kW of work and rejects heat to a reservoir at 500 K. Will you advise investment in its development? [3]
e) Draw P-T (Pressure-Temperature) diagram of a pure substance. [2]
f) State the assumptions made in deriving ideal gas equation using the kinetic theory of gases. [3]
g) How does the Vander Waals equation differ from the ideal gas equation of state? [2]
h) Define i) Specific Humidity ii) Relative Humidity iii) Degree of saturation. [3]
i) Represent Atkinson Cycle on P-v and T-s diagrams. [2]
j) Differentiate between Bell-Coleman cycle and Simple VCRS. [3]

PART – B

(50 Marks)

2.a) Classify different work transfers? Explain any three types of work transfer.
b) What is Zeroth law of TD? Explain its importance in defining TD temperature scale. [5+5]

OR

3.a) Explain the 'concept of continuum'? What is its importance in defining state of a system? How will you define density and pressure using this concept?
b) The following data referred to a 12 cylinder, single acting, two stroke marine diesel engine. Speed = 150rpm; cylinder diameter = 0.8m; Stroke of piston = 1.2m; Area of indicator diagram = $5.5\times10^{-4}m^2$, length of the indicator diagram = 0.06m; spring value = 147MPa/m. Find the net rate of work transfer from the gas to piston in kW. [5+5]

4.a) A Carnot heat engine draws heat from a reservoir at temperature 600K and reject heat to another reservoir at temperature T_3. The Carnot forward cycle engine drives a Carnot reversed cycle engine or Carnot refrigerator which absorbs heat from reservoir at temperature 300 K and reject heat to a reservoir at temperature T_3, determine: i) The temperature T_3 such that heat supplied to engine Q_1 is equal to the heat absorbed by refrigerator Q_2. ii) The efficiency of Carnot engine and COP of Carnot refrigerator.

b) A turbine operates under steady flow conditions, receiving steam at the following state: Pressure 1.2MPa, temperature 188°C, enthalpy 2785 KJ/Kg, velocity 33.3m/s and elevation 3m. The steam leaves the turbine at the following state: Pressure 20 MPa, temperature 188^0C, enthalpy 2512 KJ/Kg, velocity 100m/s and elevation 10m. Heat is lost to the surroundings at the rate of 0.29 KJ/s. If the rate of steam flow through the turbine is 0.42 Kg/s, what is the power output of the turbine? [5+5]

OR

5. A reversible heat engine operates between two reservoirs at temperatures of 700°C and 50°C. The engine derives a reversible refrigerator which operates between 50 °C and -25°C. The heat transfer to the heat engine is 2500kJ and the network output of the combined engine refrigerator plant is 400kJ. a) Evaluate the heat transfer to the refrigerant and the net heat transfer to the reservoir at 50°C. b) Reconsider c) given that the efficiency of the heat engine and the C.O.P of the refrigerator are each 45% of their maximum possible values. [10]

6.a) Wet steam of 0.5Mpa and 95% dry occupies 500litres of volume. What is its internal energy? If this steam is heated in a closed rigid vessel till the pressure becomes 1MPa, find the heat added. Plot the process on Mollier chart. What is dryness fraction and degree of superheat?

b) A fluid at 200 kPa and 300^0C has a volume of 0.8 m^3 .In a frictionless process at constant volume the pressure changes to 100 kPa. Find the final temperature and the heat transfer i) the fluid is air ii) the fluid is steam. [5+5]

OR

7.a) A pressure cooker contains 1.5kg of saturated steam at 5bar. Find the quantity of heat which must be rejected so as to reduce the quality to 60%dry. Determine the pressure and temperature of the steam at the new state.

b) Write the Clapeyron equation and point out its utility. [5+5]

8.a) The exhaust gas of an internal combustion engine is found to have 9.8% CO_2, 0.3% CO, 10.6% H_2O, 4.5% O and 74.8% N_2 by volume. Calculate molar mass and gas constant of the exhaust gas. If the volume flow rate of exhaust gas is 2 m^3/hr at 100KPa and 573K, calculate its mass flow rate.

b) The sling psychrometer in a laboratory test recorded the following readings: Dry bulb temperature = 35°C Wet bulb temperature = 25°C. Calculate the following: (i) Specific humidity (ii) Relative humidity (iii) Vapour density in air (iv) Dew point temperature Take atmospheric pressure = 1.0132 bar. [5+5]

OR

9.a) Deduce the importance of i) Vader Waals Equation of State and ii) Compressibility charts.

b) 50m^3 of air per min at 30^0C DBT and 65% relative humidity is passed through adiabatic humidifier. The air is coming out at 25^0C DBT and 20^0C WBT. Find: i) Dew Point Temperature ii) Relative Humidity iii) Water carried by the air per min. [5+5]

10.a) Represent Otto cycle, Diesel cycle, Dual cycle on P-v and T-s Co-ordinates and compare among them.

b) A refrigeration system operates between evaporator and condenser temperatures of -10°C and 40°C respectively. Consider R-22 as working fluid, calculate the COP of a standard refrigeration system. [5+5]

OR

11.a) Two engines are to operate on Otto and Diesel cycles with the following data: Maximum temperature 1400 K, exhaust temperature 700 K. State of air at the beginning of compression 0.1 MPa, 300 K. Estimate the compression ratios, the maximum pressures, efficiencies, and rate of work outputs (for 1 kg/min of air) of the respective cycles.

b) Represent Bell-Coleman cycle on p-v and t-s coordinates. Derive expression for its performance parameter. [5+5]

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