R19

Code No: 5621AA

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech I Semester Examinations, January - 2020

ADVANCED THERMODYNAMICS

(Thermal Engineering)

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

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART - A

5 × 5 Marks = 25

1.a) State and explain the Claussius inequality based on second law of thermodynamics. [5]
b) Explain throttling process along with its practical applications. [5]
c) What is chemical equilibrium? Derive its condition for general chemical reaction. [5]
d) Discuss the Onsagar reciprocity relations for the coupled energy flows. [5]
e) Differentiate between direct energy conversion and indirect energy conversion systems. [5]

PART - B

5 × 10 Marks = 50

2.a) An insulated 0.75 kg copper calorimeter can containing 0.2 kg water is in equilibrium at a temperature of 20^0C. An experimenter now places 0.05 kg of ice at 0^0C in the calorimeter and encloses it with a heat insulating shield. i) When all the ice has melted and equilibrium has reached, what will be the temperature of heater and the can? The specific heat of copper is 0.418 kJ/kg k and the latent heat of fusion of ice is 333 kJ/kg. ii) Compute the entropy increase of the universe resulting from the process. iii) What will be the minimum work needed by a stirrer to bring back the temperature of water to 20^0C?
b) What is the significance of Maxwell relations? How does they use for the development of energy transfer relations? [7+3]

OR

3.a) Derive the availability energy and irreversibility equations for the steady flow process in terms of availability function and discuss their importance.
b) Air at a pressure of 5 bar and 20^0C flows into an evacuated tank until the pressure in the tank is 5 bar. Assume that the process is adiabatic and the temperature of the surroundings is 20^0C, then (i) what is the final temperature of the air? (ii) What is the reversible work produced between the initial and final states of air? (iii) What is the net entropy change of the air entering the tank? (iv) Calculate the irreversibility of the process? [4+6]

4.a) Prove that PV^{γ} = constant for an adiabatic process and derive the heat transfer and work transfer for adiabatic process.
b) A container of 2 m^3 capacity contains 10 kg of CO_2 at 27^0C. Estimate the pressure exerted by CO_2 by using i) perfect gas equation and also using ii) Vander Waal's equation. [3+7]

OR

5.a) In the vicinity of the triple point, the vapour pressure of liquid Nitrogen is given by ln p = 15.16 – 3081/T and for solid Nitrogen ln p = 18.70 –3777/T. Calculate the temperature and pressure at the triple point. And also calculate the latent heats of sublimation and vaporization and fusion.

b) Determine individual gas constant and molecular weight of a mixture containing 25% oxygen, 25% nitrogen and 50% CO_2 on volume basis. [7+3]

6.a) Gaseous Butane at 25^0C is mixed with air at 400 K and burned with 400% theoretical air. Determine the adiabatic flame temperature.

b) Derive the equation for the adiabatic flame temperature for the given fuel and draw the curve for adiabatic flame temperature versus excess air. [7+3]

OR

7.a) Liquid ethanol (C_2H_5OH) is burned with 150% theoretical oxygen in a steady flow process. The reactants enter the combustion chamber at 25^0C, and the products are cooled and leave at 65^0C, 0.1 MPa. Calculate the heat transfer per kg mol of ethanol. The enthalpy of formation of C_2H_5OH (l) is -2, 77, 634 kJ/kg mol.

b) Explain the terms enthalpy of formation, heat of reaction and enthalpy of products based on the given chemical reaction. [7+3]

8.a) What are different applications of phenomenological relations in order to understand the entropy generation?

b) In a Cogeneration plant, the power load is 5.6 MW and the heating load is 1.163 MW. Steam is generated at 40 bar and 500^0C and is expanded isentropically through a turbine to a condenser at 0.06 bar. The heating load is supplied by extracting steam from the turbine at 2 bar which condensed in the process heater to saturated liquid at 2 bar and then pumped back to the boiler. Compute i) The steam generation capacity of the boiler in tonnes/hr, ii) The heat input to the boiler in MW. [4+6]

OR

9.a) How to apply the second law of thermodynamics for power cycles? Explain with suitable example.

b) Draw the schematic, P-V and T-s diagrams for the combined cycle power generation and derive first law and second law efficiency equations. [4+6]

10.a) Draw the schematic diagram solar photo voltaic power generation unit and discuss the advantages of these plants over conventional power generation units.

b) Differentiate between direct and indirect oxidation fuel cells and discuss their major applications. [5+5]

OR

11.a) What is thermionic emission effect? How space charge effect is minimized? Explain the principle of thermo ionic power generation system.

b) Derive the expression for power and efficiency for a thermo electric power generator and explain them. [5+5]

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