B. Tech Degree IV Semester Examination, April 2008

ME 404 APPLIED THERMODYNAMICS

(2006 Scheme)

Time : 3 Hours Maximum Marks : 100

PART – A

(Answer ***ALL*** questions)

(8 x 5 = 40)

I. (a) Establish the existence of the property energy using first Law of Thermodynamics.
(b) Prove that the enthalpy of a fluid remains constant during throttling.
(c) What are the characteristics of Mollier diagram?
(d) Explain the Rankine cycle with the help of a T-S diagram.
(e) Describe Dalton's Law of partial pressures.
(f) Derive the expression for the shaft work done per cycle by a single stage air compressor
(g) Explain briefly the working of a Bomb Calorimeter.
(h) What is adiabatic flame temperature? How its maximum value can be attained for a given mixture?

PART – B

II. (a) Show that the inequality of Claussius is valid for all possible cycles. (8)
(b) A closed vessel contains 3Kg of CO_2 at pressure 70kPa and temperature 300K. Heat is supplied to the vessel.till the gas attains 140kPa of pressure. Calculate:
(i) Final temperature (ii) Work done or by the gas
(iii) heat added (iv) change in internal energy
For CO_2: take C_v=0.65kJ/KgK. (7)

OR

III. (a) Explain the concept, availability with special consideration to a SSSF process. (7)
(b) A steam turbine receives 100,000 Kg of steam per hour at 3MPa and 320^{0}C. At the point in the turbine where the pressure is 0.36MPa, steam is bled off for use in processing equipment at the rate of 25,000 Kg/hr. The temperature of the bled steam is 150^{0}C. The balance of the steam leaves the turbine at 0.014 MPa and 0.9 dry. Heat transfer to the surrounding is 186kW. Determine the availability per kg of steam entering and leaving the turbine and the reversible work per kg of steam for the given change of state. Neglect the change in kinetic and potential energies. (8)

IV. (a) Draw and explain the pressure-temperature diagram for any pure substance. (7)
(b) A rigid vessel of 2m^3 volume is filled with super healed steam at 20 bar and 300^{0}C. The vessel is cooled until the steam is just dry saturated. Calculate the mass of steam in the vessel, the final pressure of steam and the amount of energy transferred as heat to the surroundings. Represent, the process on T-S diagram. (8)

OR

V. (a) With the help of a neat sketch explain the working of a Cochran boiler. (6)
(b) A boiler evaporates 8.2Kg of water per Kg of coal fired from feed water at 40^{0}C when working at 10 bar abs. Determine the equivalent evaporation, from and at 100^{0}C per Kg coal fired,
(i) if the steam produced in 0.95 dry,
(ii) if the steam produced is dry saturated
(iii) if the steam produced is super heated to 240^{0}C. (9)

(Turn Over)

VI. (a) Differentiate between volumetric and gravimetric analysis of a gas mixture. How the volumetric analysis of a gas mixture can convert into gravimetric analysis? (7)

(b) A closed vessel contain $100m^3$ of an air-water vapour mixture at 0.1MPa, 35^0C, 70 percent relative humidity. Calculate the humidity ratio, dew point, mass of air, and mass of vapour. (8)

OR

VII. (a) Describe how a indicator diagram helps in studying the performance of reciprocating air compressor. (6)

(b) The following data refer to a single stage double acting air compressor in which air is drawn in at 1 bar and compressed to 16 bar according to the law $PV^{1.25} = C$. Indicated power of the compressor is 50kW at 300 rpm and the piston speed is 180m/min. Volumetric efficiency is 80%. Calculate the diameter and stroke of the cylinder. (9)

VIII. (a) Explain : (i) Theoretical air (ii) Excess air (iii) Distillation curve (9)

(b) Determine the molal analysis of the product of combustion when octane ($C_8 H_{18}$), is burned with 200 percent theoretical air, and determine the dew point of the products if the pressure is 0.1MPa. (6)

OR

IX. (a) Derive an expression for the heat of reaction with in a temperature range of T_1 and T_2. (6)

(b) At 35^0C and 1 atm. the degree of dissociation of N_2O_4 at equilibrium is 0.27.

(i) Calculate the equilibrium constant

(ii) Calculate the degree of reaction at equilibrium at the same temperature when the pressure is 100 mmHg.

(iv) The equilibrium constant for the dissociation of N_2O_4 has the values 0.664 and 0.141 at temperatures 318 and 298 K respectively.

Calculate the average heat of reaction within this temperature range. (9)

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