B. Tech Degree IV Semester Examination, April 2010

ME 404 APPLIED THERMODYNAMICS

(2006 Scheme)

Time : 3 Hours Maximum Marks : 100

PART- A

(Answer ***ALL*** questions)

(8 x 5 = 40)

I. (a) Apply the steady flow energy equation to flow through a nozzle, boiler and turbine.

(b) Using the Claussius-Clapeyron equation estimate the value of enthalpy of vapourization of water at 50^0C and compare it with the tabulated value.

(c) Why do the isobars on Mollier diagram diverge from one another?

(d) What are the effects of Rankine cycle efficiency when steam supplied at the inlet of the turbine is

(i) dry saturated (ii) wet with the dryness fraction 'n'

(iii) super heated

(e) Show that adiabatic mixing of two fluids is irreversible.

(f) Give the mathematical expression for calculating the molecular weight of mixture of reacting ideal gases on

(i) mole basis (ii) mass basis

(g) Discuss about enthalpy and internal energy of combustion.

(h) What is meant by adiabatic flame temperature?

PART- B

(4 x 15 = 60)

II. (a) Prove that quality of heat energy at higher temperature is more than that at lower temperature. (7)

(b) Three identical bodies A,B and C of constant heat capacity are at temperatures of 300, 300 and 100K. A heat engine is operated between A and B and a heat pump working as a refrigerator is operated between B and C. The heat pump is operated by the output of heat engine. If no work or heat supplied from outside, find the highest temperature to which anyone of the body can be raised by the operation of heat engine or refrigerator. (8)

OR

III. (a) Show that co-efficient of volume expansion is a function of temperature only. (4)

(b) Prove that two reversible adiabatic paths cannot intersect each other. (3)

(c) A single stage air turbine is to operate with air inlet pressure and temperature of 1 bar and 600K. During the expansion the turbine losses are 20KJ/Kg to the surroundings which is at 1 bar and 300K. For 1 Kg of mass flow rate determine –

(i) decrease in availability (ii) maximum work

(iii) the irreversibility (8)

IV. (a) Steam comes out of a boiler at 10 bar and 0.9 dry and expands in a turbine to 0.1 bar with internal efficiency of 75%. The expansion is adiabatic . Neglecting pump work find the power developed for mass flow rate of 500Kg/hr. (8)

(b) Discuss the reheat regenerative cycle is steam power plants with one reheating and two feed heaters. Plot the t-s diagram. (7)

OR

V. In a regenerative steam cycle employing two open feed water heater, the steam is supplied to the turbine at 30 bar and 500^0C and is exhausted to the condenser at 0.04 bar. The extraction points for two heaters are at 3.5 bar and 0.75 bar respectively. Calculate the thermal efficiency of the plant. (15)

(Turn Over)

VI. (a) Compare the actual pressure volume recording (indicator card) for a reciprocating compressor with the ideal pressure volume diagram. (7)

(b) 0.5 Kg helium and 0.5Kg nitrogen are mixed at 20^0C at a total pressure of 100KPa. Find -
(i) the volume of the mixture
(ii) the partial pressures of the components
(iii) specific heats of the mixture
(iv) gas constant of the mixture
Assume MW_{He} = 4Kg/Kmol; MW_{N2} = 28Kg/Kmol and γ_{He} = 1.667 and γY_{N2} = 1.4. (8)

OR

VII. (a) Obtain an expression for optimum work in a two stage compressor (reciprocating) assuming pressure drop between stages and intercooling to be not perfect. (7)

(b) A two-cylinder single acting air compressor is to deliver 16Kg of air per minute at 7 bar from suction conditions 1 bar and 15^0C. Clearance may be taken as 4% of stroke volume and the index for both compression and re-expansion as 1.3. Compressor is directly coupled to a four-cylinder four stroke petrol engine which runs at 2000rpm with a brake mean effective pressure of 5.5 bar. Assuming a stroke-bore ratio of 1.2 for both engine and compressor and a mechanical efficiency of 82% for compressor, calculate the required cylinder dimensions. (8)

VIII. (a) Explain the applications of first law and second law of thermodynamics to chemical reaction. (10)

(b) Determine the gravimetric analysis of the products of complete combustion of acetylene with 200% stoichiometric air. (5)

OR

IX. (a) Explain the procedure of determining the calorific value of a gaseous fuel by a Junker's gas calorimeter. (7)

(b) A sample of fuel has the following percentage composition by weight :

Carbon	=	84%
Hydrogen	=	10%
Oxygen	=	3.5%
Nitrogen	=	1.5%
Ash	=	1%

(i) Determine the stoichiometric air fuel ratio by mass
(ii) If 20% excess air is supplied, find the percentage composition of dry flue gases by volume. (8)

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