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10ME/AU43

Fourth Semester B.E. Degree Examination, Dec.2015/Jan.2016
Applied Thermodynamics

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer FIVE full questions, selecting at least TWO questions from each part.***
2. ***Use of thermodynamic data hand book / charts / tables is permitted.***

PART – A

1 a. Define the terms: i) Stoichiometric air ii) Enthalpy of formation iii) Enthalpy of combustion iv) Adiabatic flame temperature v) Combustion efficiency. **(10 Marks)**

b. Methane (CH_4) is burned with atmospheric air. The analysis of the products on a dry basis is as follows : $CO_2 = 10\%$, $O_2 = 2.37\%$, CO = 0.53%, N_2 = 87.10%. i) Determine the combustion equation ii) Calculate the air-fuel ratio iii) Percent theoretical air. **(10 Marks)**

2 a. With the help of P-V and T-S diagrams, derive an expression for the air standard efficiency of a petrol cycle (Otto cycle). **(08 Marks)**

b. Compare the Otto and diesel cycle, on the basis of same compression ratio and same heat input, with the help of T-S and P-V diagrams. **(04 Marks)**

c. The stroke and cylinder diameters of a compression ignition engine are 250 mm and 150 mm respectively. If the clearance volume is 0.0004 m^3 and fuel injection takes place at constant pressure for 5 percent of the stroke determine the efficiency of the engine. Assume the engine working on the diesel cycle. **(08 Marks)**

3 a. Explain briefly the following frictional power determination methods: i) William's line method ii) Morse test method. **(08 Marks)**

b. Define following terms : i) Indicated power ii) Brake power iii) Mechanical efficiency iv) Specific fuel consumption v) Relative efficiency. **(05 Marks)**

c. The following observations were recorded in a test of one hour duration on a single cylinder oil engine working on four stroke cycle. Bore = 300 mm, Stroke = 450 mm, Fuel used = 8.8 kg, Calorific value of fuel = 41800 kJ/kg, Average speed = 200 rpm, m.e.p. = 5.8 bar, Brake friction load = 1860 N, Quantity of cooling water = 650 kg. Temperature rise = 22°C, Diameter of the brake wheel = 1.22 m, calculate : i) Mechanical efficiency ii) Draw the heat balance sheet. **(07 Marks)**

4 a. Why is Carnot cycle not practicable for a steam power plant? Briefly explain. **(04 Marks)**

b. Discuss the effect of, i) Boiler pressure ii) Condenser pressure iii) Superheat on the performance of a Rankine cycle. **(06 Marks)**

c. A steam power plant operates on a theoretical reheat cycle. Steam at boiler at 150 bar, 550°C expands through the high pressure turbine. It is reheated at a constant pressure of 40 bar to 550°C and expands through the low pressure turbine to a condenser at 0.1 bar. Draw T-S and h-S diagrams. Find i) Quality of steam at turbine exhaust ii) Cycle efficiency iii) Steam rate in kg/kwh. **(10 Marks)**

PART – B

5 a. What are the different methods to increase isothermal efficiency of air compressor? **(04 Marks)**

b. What are the advantages of multi-stage compression? **(04 Marks)**

c. A two stage single-acting reciprocating compressor takes in air at the rate of 0.2 m^3/s. The intake pressure and temperature of air are 0.1 MPa and 16°C. The air is compressed to a final pressure of 0.7 MPa. The intermediate pressure is ideal and inter cooling is perfect. The compression index in both stages is 1.25 and the compressor runs at 600 rpm. Neglecting clearance determine i) The intermediate pressure ii) The total volume of each cylinder iii) Power required to drive the compressor and iv) The rate of heat rejection in the intercooler take C_p = 1.005 kJ/kgK and R = 0.287 kJ/kgK. **(12 Marks)**

6 a. Derive an expression for the work output of a gas turbine in terms of pressure ratio and maximum and minimum temperature T_3 and T_1. Hence show that the pressure ratio for maximum specific work output is given by $R_P = \left[\frac{T_3}{T_1}\right]^{\frac{\gamma}{2(\gamma-1)}}$. **(10 Marks)**

b. In a regenerative gas turbine cycle air enters the compressor at 1 bar, 15°C, pressure ratio 6. The isentropic efficiencies of compressor and turbine are 0.8 and 0.85 respectively. The maximum temperature in the cycle is 800°C. The regenerator efficiency is 0.78. Assume C_P = 1.1 KJ/kgK, γ = 1.32 for the combustion products find the cycle efficiency. **(10 Marks)**

7 a. Write a brief note on properties of refrigerants. **(04 Marks)**

b. With a neat sketch, describe clearly the working of a Bell-Coleman cycle. **(06 Marks)**

c. A refrigeration system of 10.5 Tonnes capacity at a evaporator temperature of -12°C and a condenser temperature of 27°C is needed in a food storage locker. The refrigerant Ammonia is sub cooled by 6°C before entering the expansion valve. The vapour is 0.95 dry as it leaves the evaporator coil. The compression in the compressor is of adiabatic type. Using P-H chart find i) Condition of vapour at the outlet of the compressor ii) Condition of vapour at entrance to evaporator iii) COP iv) Power required in kW Neglecting valve Throttling and clearance effect. **(10 Marks)**

8 a. Define the following clearly: i) Dry bulb temperature ii) Wet bulb temperature iii) Specific humidity. **(06 Marks)**

b. With a neat sketch, briefly describe a Summer-air conditioning system. **(06 Marks)**

c. It is required to design an air conditioning plant for a small office room for following winter conditions: Outdoor conditions: 14°C DBT and 10°C WBT, Required conditions = 20°C DBT and 60% RH, Amount of air circulation = 0.30 m^3/min/person, Seating capacity of office = 60.

The required condition is achieved first by heating and then by adiabatic humidifying. Determine the following: i) Heat capacity of the coil in kW and the surface temperature required if the by-pass factor of coil is 0.4 ii) The capacity of the humidifier using psychrometric chart. **(08 Marks)**

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