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06ME43

Fourth Semester B.E. Degree Examination, June / July 2014
Applied Thermodynamics

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Define the following: (i) Theoretical air (ii) Excess air (iii) Incomplete combustion (iv) Enthalpy of formation (v) Adiabatic flame temperature. **(10 Marks)**

b. An unknown fuel has the following orsat analysis CO_2 – 12.5%, CO – 0.3%, N_2 – 84.1%. Determine the air fuel ratio, the fuel composition on mass basis and the percentage theoretical air. **(10 Marks)**

2 a. Derive an expression for thermal efficiency of an air standard diesel cycle with P-V and T-S diagram and define the term mean effective pressure. **(08 Marks)**

b. An engine operates on the air standard otto cycle. The conditions at the start of compression are 27°C and 100 KPa. The heat supplied is 1840 KJ/kg. The compression ratio is 8. Determine the temperature and pressure at each point in the cycle, the air standard thermal efficiency and mean effective pressure. (Assume standard assumptions) **(12 Marks)**

3 a. Explain with a neat sketch turbojet and ramjet propulsions. **(08 Marks)**

b. The air enters the compressor of an open cycle. Constant pressure gas turbine at a pressure of 1 bar and temperature of 20°C. The pressure of the air after compression is 4 bar. The Isentropic efficiencies of compressor and turbine are 80% and 85% respectively. The air-fuel ratio used is 90: 1. If flow rate of air is 3.0 kg/s find (i) Power developed (ii) Thermal efficiency of the cycle. Assume C_P = 1.0 KJ/kgK and γ = 1.4 for air and gases. **(12 Marks)**

4 a. Explain the effect of the following on Rankine cycle:
(i) Increasing boiler pressure (ii) Decreasing condenser pressure. **(04 Marks)**

b. Derive an expression for a modified Rankine cycle efficiency with P-V and T-S diagram. **(06 Marks)**

c. A steam power plant operates on a theoretical reheat cycle. Steam at boiler is 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. Find (i) Quality of steam at turbine exhaust (ii) Cycle efficiency (iii) Steam rate in kg/kwh. **(10 Marks)**

PART – B

5 a. For perfect intercooling obtain an expression for the intermediate pressure in terms of initial and final pressure. Hence show that pressure ratio per stage is equal. **(08 Marks)**

b. A two cylinder single acting compressor is to deliver 16 kg of air/minute at 7 bar from suction conditions 1 bar and 15°C. 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. 4 stroke petrol engine which runs at 2000 rpm, with a brake mean effective pressure of 5.5 bar. Assuming a stroke-bore ratio of 1.2 for both engine and compressor, mechanical efficiency of 82% for compressor. Calculate the required cylinder dimensions for compressor and engine. **(12 Marks)**

6 a. Explain a vapour compression refrigeration with suitable diagrams. **(06 Marks)**

b. What are the desirable properties of refrigerants? List out a few refrigerants that are used. **(06 Marks)**

c. A vapour compressor refrigerator uses Freon-12 as refrigerant. The temperature of the refrigerant in the evaporator is -10°C. The condensing temperature is 40°C. The enthalpy of the refrigerant at the end of compression is 220 KJ/kg. Calculate (i) The COP of the cycle. (ii) Refrigerating capacity and (iii) Compressor powel. The flow rate of refrigerant is to be assumed as 1 kg/min. **(08 Marks)**

7 a. Define the following terms applied to psychrometrics: (i) DBT (ii) WBT (iii) Relative humidity (iv) Specific humidity. **(06 Marks)**

b. Briefly explain the following processes by representing them on psychrometric chart: (i) Sensible heating (ii) Cooling and dehumidification. **(06 Marks)**

c. The atmospheric conditions are 20°C and specific humidity of 0.0095 kg/kg of dry air. Calculate (i) Partial pressure of vapour (ii) Relative humidity (iii) Dew point temperature. **(08 Marks)**

8 a. In a test of a four cylinder, 4-stroke petrol engine of 75 mm bore and 100 mm stroke, the following results were obtained at full throttle at a constant speed and with a fixed setting of fuel supply of 0.082 kg/min.
BP with all cylinders working = 15.24 kW
BP with cylinder number 1 cutoff = 10.45 kW
BP with cylinder number 2 cutoff = 10.38 kW
BP with cylinder number 3 cutoff = 10.23 kW
BP with cylinder number 4 cutoff = 10.45 kW
If the calorific value of the fuel is 44 MJ/kg and clearance volume of one cylinder being 115 C.C. Find (i) Mechanical efficiency (ii) Indicated thermal efficiency (iii) Air standard efficiency. **(08 Marks)**

b. During the trial of a single-cylinder 4-stroke oil engine. The following results were obtained:
Cylinder diameter = 20 cm,
Stroke = 40 cm,
Mean effective pressure = 6 bar,
Torque = 407 Nm,
Speed = 250 rpm,
Oil consumption = 4 kg/h
CV of fuel = 43 MJ/kg
Cooling water flow rate = 4.5 kg/min
Air used per kg of fuel = 30 kg
Rise in cooling water temperature = 45°C
Temperature of exhaust gases = 420°C
Room temperature = 20°C
Specific heat of exhaust gases = 1 KJ/kgK
Specific heat of water = 4.18 KJ/kgK
Find (i) IP (ii) BP and draw up a heat balance sheet for the test in KJ/h. **(12 Marks)**

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