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06ME43

Fourth Semester B.E. Degree Examination, Dec.2013/Jan.2014
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 thermodynamics data handbook permitted.***

PART – A

1 a. Explain the following: i) Air fuel ratio ii) Enthalphy of formation. iii) Combustion efficiency. **(06 Marks)**

b. With a neat sketch, explain the analysis of exhaust gases by Orsat apparatus. **(08 Marks)**

c. A producer gas used as a fuel has the following volumetric composition: $H_2 = 28\%$, $CO = 12\%$, $CH_4 = 2\%$, $CO_2 = 16\%$, $N_2 = 42\%$ Find the volume of air required for complete combustion of 1 m^3 of this gas. Air contains 21% by volume of oxygen. **(06 Marks)**

2 a. With a help of P-V and T-S diagram of the air standard duel combustion cycle. Derive the expression for the ideal efficiency. **(10 Marks)**

b. The stroke and cylinder diameter 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. Note the engine is working on the diesel cycle. **(10 Marks)**

3 a. Explain any one method employed for improvement of thermal efficiency of open cycle gas turbine plant. **(08 Marks)**

b. State the fundamental difference between the jet propulsion and rocket propulsion. **(04 Marks)**

c. In a gas turbine the compressor takes in air at a temperature of 15°C and compresses it to four times the initial pressure with an isentropic efficiency of 82%. The air is then passed through a heat exchanger heated by the turbine exhaust before reaching the combustion chamber. In the heat exchanger 78% of the available heat is given to air. The maximum temperature after constant pressure combustion is 600°C and the efficiency of the turbine is 70%. The working fluid have the characteristics of air. Neglect all losses except those mentioned. Find the efficiency of the cycle. Take $R = 0.287 \frac{KJ}{kgK}$ and $\gamma = 1.4$. **(08 Marks)**

4 a. Derive an expression for modified Rankine cycle with P-V and T-S diagram. **(08 Marks)**

b. Comment Carnot cycle cannot be used practically. **(02 Marks)**

c. A turbine is supplied with steam at a pressure of 32 bar and a temperature of 410°C. The steam then expands isentropically to a pressure of 0.08 bar. Find the dryness fraction of the end of expansion and thermal efficiency of the cycle. If the steam is reheated at 5.5 bar to a temperature of 395°C and then expands isentropically to a pressure of 0.08 bar. What will be the dryness fraction and thermal efficiency of the cycle? **(10 Marks)**

PART – B

5 a. In a two stage air compressor, prove that the work done is minimum with perfect intercooling when $P_2 = \sqrt{P_1 P_3}$. **(06 Marks)**

5 b. Define the following:
i) Volumetric efficiency.
ii) Isentropic efficiency.
iii) Mechanical efficiency. **(06 Marks)**

c. A two stage air compressor operates at 200 rpm and delivers 2 m^3/min at suction condition. At suction the temperature and pressure are 27°C and 0.1 MPa respectively. The air is delivered at 5 MPa, the clearance of both L.P and H.P cylinder is 5%. Assuming perfect intercooling and a constant compression and expansion index of 1.25. Determine
i) Minimum power required.
ii) Volumetric efficiency of both L.P. and H.P. cylinders.
Take R = 0.287 KJ/kgK. **(08 Marks)**

6 a. Define the following: i) COP. ii) Ton of refrigeration. **(06 Marks)**

b. Explain the working principle of a vapour absorption refrigeration system. **(06 Marks)**

c. An ammonia ice plant operates between a condenser temperature of 30°C and an evaporator temperature of -15°C. It produces 10 tons of ice per day from water at 30°C to ice at -5°C. Assume the state at the end of compression process as dry saturated. Determine,
i) Mass flow rate of refrigerant. ii) Capacity of refrigerant plant. iii) COP.
Take : Cp of water = 4186 J/kgK
Specific heat of ice = 194 J/kgK
L.T of fusion at 0°C for water = 335×10^3 J/kg
Saturation data for ammonia (NH_3)

Temp = °C	Sat.Pr. KPa	SP = Volume m^3/kg		Enthalpy KJ/kgK		Entropy KJ/kgK	
		Vf	Vg	hf	hg	Sf	Sg
30°	1169.49	0.00168	0.1106	322.9	1467.9	1.2028	4.9805
-15°	236.48	0.001518	0.5093	112.35	1425.7	0.4544	5.545

(08 Marks)

7 a. Define the following with respect to air-water vapour mixture:
i) Specific humidity ii) Wet bulb temperature iii) Relative humidity
iv) Adiabatic saturation temperature v) Dew point temperature. **(10 Marks)**

b. Air at 30°C, 60% RH, 0.8808 m^3/kg specific volume, 71.2 KJ/kg enthalpy, flows over a cooling coil at 250 m^3/min. From the chart the corresponding dew point is 21.5°C. After flowing over the coil the temperature reduces to 23°C; with 64.2 KJ/kg enthalpy:
i) Sketch the process on a psychrometric chart.
ii) Find the refrigeration capacity of the coil in tons. **(10 Marks)**

8 a. Explain how Morse test will help you in finding the indicated power of the multi-cylinder engine. **(08 Marks)**

b. 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. Average speed = 200 rpm.
m.e.p = 5.8 bar, Calorific value of fuel = 41800 KJ/kg,
Mass of fuel (used) = 8.8 kg, Brake friction load = 1860 N
Quality of cooling water = 650 kg, Temperature rise = 22°C
Diameter of brake wheel = 1.22 m
Determine : i) Brake thermal efficiency
ii) Mechanical efficiency.
Draw the heat balance sheet. **(12 Marks)**

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