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10ME/AU43

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 steam and vapour tables is not permitted

PART – A

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

b. The volumetric composition of dry flue gases obtained by the combustion of an unknown hydrocarbon is 12.7% CO_2, 0.9% CO, 3.9% O_2 and 82.5% N_2. Determine:
i) Composition of the fuel; ii) Theoretical air required for complete combustion; iii) Percentage of excess air required. **(10 Marks)**

2 a. With the help of P-V and T-S diagram, derive an equation for theoretical air standard efficiency of a semi diesel (dual) cycle in terms of compression ration, cut off ratio and explosion ratio, with suitable assumptions. **(10 Marks)**

b. In an air standard diesel cycle the compression ratio is 15 and the fluid properties at the beginning of compression are 100 kPa and 300K. For a peak temperature of 1600K calculate i) the percentage of stroke at which cut-off occurs; ii) the cycle efficiency and iii) the work output/kg. **(10 Marks)**

3 a. Describe the following as applied to I.C. engine: i) Morse test; ii) Heat balance sheet. **(08 Marks)**

b. During a test on a single cylinder 4 stroke oil engine the following observations were made Bore = 30cm, stroke = 45cm, duration of trail = 1hr, total fuel consumption = 7.6kg calorific value of fuel = 45,000 kJ/kg, total revolutions made = 12000, mean effective pressure 6 bar, net brake load = 1.47 kN. Brake drum diameter 1.8m rope diameter 3cm. Mass of jacket cooling water circulated = 550kg water enters at 15°C water leaves at 60°C. Total air consumption 360kg room temperature 20°C, exhaust gas temperature = 300°C. Calculate:
i) Indicated and brake power; ii) Indicated thermal efficiency; iii) Mechanical efficiency; iv) Draw the heat balance sheet on minute basis. **(12 Marks)**

4 a. Why carnot cycle is not used as a reference cycle for steam power plant? **(03 Marks)**

b. Sketch the flow diagram and corresponding T – S diagram of a reheat vapour cycle and derive an expression for reheat cycle efficiency. **(07 Marks)**

c. A 40MW steam power plant working on Rankine cycle operates between boiler pressure of 4MPa and condenser pressure of 10 kPa. The steam leaves the boiler and enters the steam turbine at 400°C. The isentropic efficiency of steam turbine is 85%. Determine:
i) The cycle efficiency; ii) The quality of exhaust steam from the turbine and iii) Steam flow rate in kg/hr considering pump work.
Properties of steam. **(10 Marks)**

Pressure bar	ts °c	Specific volume m^3/kg		Specific enthalpy kJ/kg			Specific entropy kJ/kg K		
		v_f	v_g	h_f	h_{f_g}	h_g	s_f	s_{f_g}	s_g
40	250.3	0.00125	0.049	1087.4	1712.9	2800.3	2.797	3.272	6.069
0.1	45.83	0.0010	14.675	191.8	2392.9	2584.7	0.649	7.502	8.151

PART – B

5 a. State the advantages of multistage compression. **(04 Marks)**

b. Derive the relation among volumetric efficiency, the pressure ratio and index of compression and expansion. Plot the variations of volumetric efficiency with clearance for various pressure ratio. **(08 Marks)**

c. Atmospheric air at 1 bar and 27°C is taken into a single stage reciprocating compressor. It is compressed according to the law $PV^{1.3} = C$, to the delivery pressure of 6 bar. The compressor takes $1m^3$ of air/min. The speed of the compressor is 300 rpm. Stroke to diameter ratio is equal to 1.5:1 mechanical efficiency of the compressor 0.85 motor transmission efficiency 0.9 calculate:

i) The indicated power and isothermal efficiency.

ii) The cylinder dimensions and power of motor required to drive the compressor.

(08 Marks)

6 a. Discuss with the help of T-S diagrams the three methods of improving the thermal efficiency of an open cycle gas turbine plant. **(12 Marks)**

b. A gas turbine unit has a pressure ratio 6:1 and maximum cycle temperature of 610°C. The isentropic efficiency of the compressor and turbine are 0.80 and 0.82 respectively. Calculate the power output in kilowatts of an electric generator geared to the turbine when the air enters the compressor at 15°C and rate of 16kg/s. Assume $C_p = 1.005$ for $C_p = 1.11$ for $r = 1.4$ compression = expansion = $n = 1.33$. **(08 Marks)**

7 a. Write a short note on air cycle refrigeration. **(04 Marks)**

b. With the help of neat flow diagram explain the working of steam jet refrigeration system. **(08 Marks)**

c. An ammonia vapour compression refrigerating machine works between 25°C and -20°C. The ammonia leaves the compressor in dry and saturated condition. Liquid ammonia is under cooled to 21.5°C before passing through throttle valve. The average specific heat of liquid ammonia is 4.75 kJ/kg°C. Find the theoretical cop of machine. The following properties of NH_3 are given. If the net refrigeration required is 400×10^3 kJ/hr. Find the mass of ammonia circulated/min. Assume cop actual is 75% of cop theoretical:

Temp °C	Liquid kJ/kg		Vapour kJ/kg K	
	h_f kJ/kg	s_f	h_g	s_g
25	537.6	4.612	1708.5	8.534
-20	328.4	3.854	1661.0	9.118

(08 Marks)

8 a. Derive the equations for relative humidity and specific humidity of moist air. **(04 Marks)**

b. With neat sketch explain the working of air conditioning system for hot and dry weather. Present the process involved on a psychrometric chart **(06 Marks)**

c. Calculate: i) relative humidity; ii) humidity ratio; iii) dew point temperature; iv) density and v) Enthalpy of atmospheric air when the DBT is 35°C, WBT = 23°C and the barometer reads 750mm Hg. **(10 Marks)**

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