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06ME43

Fourth Semester B.E. Degree Examination, December 2010
Applied Thermodynamics

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Define the following: i) Adiabatic flame temperature ii) Stoichiometric air/ fuel ratio iii) Enthalpy of formation iv) Combustion efficiency v) Higher and lower calorific values **(10 Marks)**

b. A certain natural gas has the following volumetric analysis: 65 percent CH_4, 8 percent H_2, 18 percent N_2, 3 percent O_2, and 6 percent CO_2. This gas is now burned completely with the stoichiometric amount of dry air. Compute the air-fuel ratio and the analysis of products by volume. **(10 Marks)**

2 a. Show that the efficiency of air standard Brayton cycle is a function of isentropic pressure ratio. **(06 Marks)**

b. Sketch the ideal regenerative Brayton cycle in two stage compression and expansion with intercooling and reheat. Mark the points on the corresponding T-S diagram. (No Description) **(04 Marks)**

c. Consider an ideal gas-turbine cycle with two stages of compression and two stages of expansion. The pressure ratio across each stage of the compressor and turbine is 3. The air enters each stage of the compressor at 300 K and each stage of the turbine at 1200 K. Determine the back work ratio and the thermal efficiency of the cycle, when no regenerator is used. Assume an efficiency of 80 percent for each compressor stage and an efficiency of 85 percent for each turbine stage. **(10 Marks)**

3 a. Derive the expression for the air standard efficiency of an Otto cycle. **(06 Marks)**

b. Compare the efficiency of Otto and Diesel cycles for the same compression ratio and for the same state of air before compression. **(04 Marks)**

c. An ideal diesel engine has a compression ratio of 20 and uses air as the working fluid. The state of air at the beginning of the compression process is 95 kPa and 20°C. If the maximum temperature in the cycle is not to exceed 2200 K, determine (i) the thermal efficiency and (ii) the mean effective pressure. Assume constant specific heats for air at room temperature. **(10 Marks)**

4 a. Sketch the flow diagram and the corresponding temperature-entropy diagram of a reheat cycle and derive the expression for reheat cycle efficiency. What is the effect of reheat on i) specific output ii) cycle efficiency iii) steam rate and iv) heat rate of steam power plant? **(10 Marks)**

b. In a thermal power station, with a single reheat cycle, the steam at boiler outlet is at 8 MPa and 500°C. The reheating takes place at 3 MPa and the temperature at the end of reheat is the same as the boiler outlet temperature. If the condensate pressure is 20 kPa, calculate for the ideal process, using the Mollier chart, i) quality of steam at the turbine exhaust ii) work done by the pump ii) work done by the turbine iv) cycle efficiency v) steam rate. **(10 Marks)**

PART – B

5 a. Derive the condition for minimum work output to a two stage reciprocating air compressor with perfect intercooling. What are the assumptions you made? **(10 Marks)**

5 b. In a single acting two stage reciprocating air compressor, 4.5 kg of air per minute is compressed from 1.013 bar and 15°C through a pressure ratio of 9 to 1. Both stages have the same pressure ratio and the path of compression and expansion in both the stages is $PV^{1.3}$ = constant. If the intercooling is complete, calculate the indicated power and cylinder swept volume required. Assume that the clearance volume of both the stages is 5 % and the compressor runs at 280 rpm. **(10 Marks)**

6 a. Explain the working of a vapour absorption refrigeration system. **(10 Marks)**

b. A refrigerator uses R-134 a as the working fluid and operates on an ideal vapor-compression refrigeration cycle between 0.12 and 0.7 MPa. The mass flow rate of the refrigerant is 0.05 kg/s. Show the cycle on a T-s diagram with respect to saturation lines. Determine (i) the rate of heat removal from the refrigerated space and the power input to the compressor, (ii) the rate of heat rejection to the environment, and (iii) the coefficient of performance.

Properties of R-134a

Absolute pressure (kPa)	Saturation temperature°C	Enthalpy kJ/kg		Entropy kJ/kg	
		Saturated Liquid	Saturated Vapour	Saturated Liquid	Saturated Vapour
120	-22.32	22.29	236.97	0.09275	0.94779
700	26.69	88.82	265.03	0.33230	0.91994

Take vapour specific heat at 700 kPa = 1.0243 kJ/kgK. **(10 Marks)**

7 a. Define the following: i) Dry bulb temperature ii) Dew point temperature iii) Specific Humidity iv) Adibatic saturation temperature v) Psychrometrics. **(10 Marks)**

b. Air enters at 32°C and relative humidity of 70 % in a summer air conditioning system where the air is cooled and then dehumidified. The air leaving the cooling coil is saturated at the coil temperature. It is then heated to comfort condition of 24 C and 50 % relative humidity. Sketch the flow diagram of the system and represent the various processes in the skelton of psychrometric chart. Determine i) the temperature of the cooling coil ii) the amount of moisture removed per kg of dry air in the cooling coil iii) the heat removed per kg dry air in the cooling coil and iv) the heat added per kg dry air in the heating coil. **(10 Marks)**

8 a. Describe the Morse test. How can it be used for finding the friction power and the indicated power of an IC Engine? **(08 Marks)**

b. Morse test is conducted on a four stroke four cylinder petrol engine at a constant speed and the following power is measured :

With all cylinders working = 15.6 kW
With number 1 cylinder cut off =11.1 kW
With number 2 cylinder cut off = 11.3 kW
With number 3 cylinder cut off = 10.8 kW
With number 4 cylinder cut off = 11.0 kW

The bore and stroke of each cylinder is 75 mm and 100 mm respectively. The clearance volume of the cylinder is 100cc. The fuel is consumed at the rate 6 kg/hr. If the calorific value of the fuel is 42000 kJ/kg. Determine i) Indicated power ii) Frictional Power iii) Mechanical Efficiency iv) Brake thermal efficiency v) Relative efficiency with respect to brake thermal efficiency. **(12 Marks)**

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