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10ME/AU43

Fourth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Applied Thermodynamics

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selectingatleast TWO questions from each part.***
2. ***Use of Thermodynamic data handbook and steam tables permitted.***

PART - A

1 a. Explain i) Enthalpy of Formation ii) Enthalpy of combustion iii) Stochiometric Air iv) Combustion efficiency. **(10 Marks)**

b. A Petrol sample was found to have 86% C, 14% H_2 by weight , when used in an engine the air supply is 90% of that theoretical required for complete combustion. Assuming that, as all the hydrogen is burnt and that the carbon burns to carbon monoxide and carbon dioxide such that there is no free carbon left. Calculate the percentage analysis of dry exhaust gases by volume. **(10 Marks)**

2 a. Explain briefly the different method of determining Frictional Power. **(08 Marks)**

b. A six cylinder four stroke diesel engine has bore 360mm and stroke 500mm. A trial on the engine provides the following data. Mean area of indicator diagram = $780mm^2$, Length of the indicator diagram = 75mm , Spring number = 0.7 bar/mm , Brake Torque = 14000 Nm , Speed = 500 rpm , Fuel consumption = 240 kg/hour , Calorific value of fuel = 44000 kJ/kg , Jacket cooling water = 320 kg/min , Rise in temperature of cooling water = 40^0C , Piston cooling oil = 140 kg/min , Specific heat = 2.1 kJ/kg K , Temperature rise of oil = 28^0C , Circulating water in gas calorimeter = 300kg/min , Rise in temperature of this water = 42^0C. All the heat of the exhaust gases is absorbed in the calorimeter. Estimate the specific fuel consumption and mechanical efficiency of the engine. Draw up the heat balance sheet of the engine on 1kg of fuel oil basis. **(12 Marks)**

3 a. Sketch neatly the P-V and T-S diagrams of the air standard dual combustion cycle and derive the expression for the ideal efficiency of the cycle in terms of the compression ratio, the explosion ratio , the cut off ratio and the ratio of specific heats. **(12 Marks)**

b. An ideal diesel engine has a bore diameter 150mm and stroke 200mm. The clearance volume is 10 percent of the swept volume. Determine the compression ratio and the air standard efficiency of the engine if the cut off takes place at 6 percent of the stroke. **(08 Marks)**

4 a. Explain briefly the Carnot cycle is not a realistic model for the steam power plants. **(04 Marks)**

b. Explain any two methods of increasing efficiency of a Rankine cycle. **(08 Marks)**

c. In a steam power cycle , the steam supply is at 15 bar and dry and saturated. The condenser pressure is 0.4 bar. Calculate the Carnot and Rankine efficiencies of the cycle. Neglect pump work. **(08 Marks)**

PART - B

5 a. What do you understand by multistage air compressor? Mention the advantages of multistage air compressor. **(06 Marks)**

b. Derive the conditions for work input to a two stage reciprocating air compressor with perfect intercooling. State clearly the assumptions made. **(08 Marks)**

c. A single stage reciprocating compressor takes $1m^3$ of air per minute at 1.013 bar and 15^0C and delivers it at 7 bar. Assuming that the law of compression is $PV^{1.35}$ = constant and the clearance is negligible , calculate the indicated power. **(06 Marks)**

6 a. With neat sketch, explain Turbojet and Ramjet propulsions. **(08 Marks)**

b. A Gas turbine unit has a pressure ratio of 6:1 and maximum cycle temperature of 610^0C. The isentropic efficiency of the compressor and turbine are 0.80 and 0.82 respectively. Calculate the power output in kilo watts of an electric generator geared to the turbine when the air enters the compressor at 15^0C at the rate of 16kg/sec.
Take Cp = 1.005 kJ/kg K and $\nu = 1.4$ for the compression process and
Cp = 1.11 kJ/kg and $\nu = 1.333$ for the expansion process. **(12 Marks)**

7 a. Derive an expression for COP of an air refrigeration system working on reversed Brayton cycle. **(08 Marks)**

b. A vapour compression refrigerator uses F-12 as refrigerant and liquid evaporates in the evaporator at -15^0C. The temperature of this refrigerant at the delivery from the compressor is 15^0C. The vapour is condensed at 10^0C. Determine the COP if i) There is no undercooling ii) The liquid is cooled by 5^0C before throttling.
Take specific heat at constant pressure for superheated vapour as 0.64 kJ/kg K and that for liquid as 0.938 kJ/kg K. **(12 Marks)**

Properties of F – 12

Temp ^0C	Enthalpy kJ/kg			Entropy kJ/kg K		
	h_f	h_{fg}	h_g	s_f	s_{fg}	s_g
-15	22.312	158.534	180.946	0.0906	0.6141	0.7046
10	45.337	146.265	191.602	0.1750	0.5165	0.6916

8 a. Define the following : i) DBT ii) Dew Point Temperature
iii) Specific Humidity iv) Relative Humidity. **(08 Marks)**

b. It is required to design an Air conditioning system for the following conditions :
Outdoor conditions 32^0C DBT and 65% RH
Required Indoor conditions 25^0C DBT and 60% RH.
Amount of Air circulated 250 m^3/min
Coil dew Temperature 13^0C.
If the required condition is achieved first by cooling and dehumidifying and then by heating.
Calculate i) Cooling capacity of the coil and its Bypass factor.
ii) Heating coil capacity and its surface temperature if its BPF is 0.3.
iii) Mass of water vapour removed per hour. **(12 Marks)**

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