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10ME/AU43

Fourth Semester B.E. Degree Examination, Aug./Sept.2020
Applied Thermodynamics

Time: 3 hrs. Max. Marks:100

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

PART – A

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

b. The products of combustion of hydrocarbon fuel of unknown composition have the following composition as measured on dry basis. CO_2 = 8.0%, CO = 0.9%, O_2 = 8.8%, N_2 = 82.3%. Calculate: i) Air fuel ratio ii) Composition of fuel on mass basis iii) The percentage of theoretical air on mass basis. **(10 Marks)**

2 a. With the help of T-S and P-V diagram, derive the expression for an air-standard efficiency of an otto cycle with usual notations showing all the process involved. **(10 Marks)**

b. In a diesel engine during the compression process, pressure is seen to be 1.4bar at $1/8^{th}$ of stroke and 14 bar at $7/8^{th}$ of stroke. The cut-off occurs at $1/15^{th}$ of stroke. Calculate air-standard efficiency and compression ratio. Assume initial air at 1 bar and temperature is 27°C. Also estimate the mean effective pressure of the engine. **(10 Marks)**

3 a. Explain the following in details: i) Morse Test ii) Willan's line method. **(08 Marks)**

b. The following observations were recorder in a test of one hour duration on a single cylinder oil engine working on four stroke cycle:
Bore = 300mm
Stroke = 450mm
Fuel used = 8.8kg
Calorific value of fuel = 41800kJ/kg
Average speed = 200rpm
m.e.p = 5.8bar
brake friction load = 1860N
quantity of cooling water = 650kg
temperature rise = 22°C
diameter of brake wheel = 1.22m
Calculate: i) Mechanical efficiency ii) Brake thermal efficiency
Draw the heat balance sheet n hourly basis. **(12 Marks)**

4 a. With the help of a schematic diagram and T-S and H-S diagram, explain the working of a re-heat vapour cycle and derive an expression for the overall efficiency. **(10 Marks)**

b. A steam power station uses the following cycle. Steam boiler outlet: 150bar, 550°C, Reheat pressure = 40bar, reheat temperature = 550°C, condenser pressure = 0.1bar, using the Mollier chart and assuming the ideal process.
Find: i) Quality of steam of turbine exhaust ii) Cycle efficiency iii) Steam rate. **(10 Marks)**

PART – B

5 a. Derive an expression for maximum work required by a two stage air compressor with perfect inter cooling between stages. **(10 Marks)**

b. A single stage double acting Air Compressor required to deliver $14m^3$ air per minute measured at 1.013 bar and 150°C. The delivery pressure is 7bar and speed is 300rpm. Take the clearance volume as 5% of swept volume with the compression and expansion index n = 1.3, Calculate:

i) Swept volume of cylinder
ii) Delivery temperature
iii) Indicated power. **(10 Marks)**

6 a. Derive an expression for the work output of a gas turbine in terms of pressure ratio and maximum and minimum temperature T_3 and T_1. Hence show that the pressure ratio for maximum specific work output is given by $r_p = \left(\frac{T_3}{T_1}\right)^{\frac{\gamma}{2(\gamma-1)}}$ **(10 Marks)**

b. In a regenerative gas turbine cycle air enters the compressor at 1bar, 15°C, pressure ratio 6. The isentropic efficiency of compressor and turbines are 0.8 and 0.85 respectively. The maximum temperature in the cycle is 800°C. The regenerative efficiency is 0.78. Assume C_p = 1.1kJ/kgK, γ = 1.32 for the combustion products. Find the cycle efficiency. **(10 Marks)**

7 a. Define the following:

i) Refrigerating effect
ii) Ton of refrigeration
iii) Ice making capacity
iv) Relative C.O.P **(04 Marks)**

b. Write a brief note on properties of refrigerants. **(04 Marks)**

c. A refrigeration system of 10.5 tonnes capacity at an evaporator temperature of -12°C and a condenser temperature of 27°C is needed in a food storage locker. The refrigerant ammonia is sub-cooled by 6°C before entering the expansion valve. The vapour is 0.95 dry as it leaves the evaporator coil. The compression in the compressor is of adiabatic type using P-h chart find:

i) Condition of volume of outlet of the compressor
ii) Condition of vapour at entrance to evaporator
iii) C.O.P.
iv) Power required, in kW

Neglect valve throttling and clearance effect. **(12 Marks)**

8 a. Define the following:

i) Wet bulb temperature
ii) Dew point temperature
iii) Relative humidity
iv) Specific humidity
v) Degree of saturation. **(10 Marks)**

b. A sting thermometer reads 40°C DBT and 28°C WBT. Find the following:

i) Specific humidity
ii) Relative humidity
iii) Dew point temperature
iv) Vapour density
v) Enthalpy of moist air. **(10 Marks)**

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