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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  $27^\circ C$ . 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 =  $22^\circ C$   
 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,  $550^\circ C$ , Reheat pressure = 40bar, reheat temperature =  $550^\circ C$ , 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)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
 2. Any revealing of identification, appeal to evaluator and /or equations written eg,  $42+8=50$ , will be treated as malpractice.

**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  $14\text{m}^3$  air per minute measured at 1.013 bar and  $150^\circ\text{C}$ . 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:
- Swept volume of cylinder
  - Delivery temperature
  - 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,  $15^\circ\text{C}$ , pressure ratio 6. The isentropic efficiency of compressor and turbines are 0.8 and 0.85 respectively. The maximum temperature in the cycle is  $800^\circ\text{C}$ . The regenerative efficiency is 0.78. Assume  $C_p = 1.1\text{kJ/kgK}$ ,  $\gamma = 1.32$  for the combustion products. Find the cycle efficiency. (10 Marks)
- 7 a. Define the following:
- Refrigerating effect
  - Ton of refrigeration
  - Ice making capacity
  - 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  $-12^\circ\text{C}$  and a condenser temperature of  $27^\circ\text{C}$  is needed in a food storage locker. The refrigerant ammonia is sub-cooled by  $6^\circ\text{C}$  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:
- Condition of volume of outlet of the compressor
  - Condition of vapour at entrance to evaporator
  - C.O.P.
  - Power required, in kW
- Neglect valve throttling and clearance effect. (12 Marks)
- 8 a. Define the following:
- Wet bulb temperature
  - Dew point temperature
  - Relative humidity
  - Specific humidity
  - Degree of saturation. (10 Marks)
- b. A sting thermometer reads  $40^\circ\text{C}$  DBT and  $28^\circ\text{C}$  WBT. Find the following:
- Specific humidity
  - Relative humidity
  - Dew point temperature
  - Vapour density
  - Enthalpy of moist air. (10 Marks)

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