

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:
- Enthalpy of formation
 - Enthalpy of combustion
 - Stoichiometric air
 - Excess air
 - 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. $\text{CO}_2 = 8.0\%$, $\text{CO} = 0.9\%$, $\text{O}_2 = 8.8\%$, $\text{N}_2 = 82.3\%$. 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 $1/8^{\text{th}}$ of stroke and 14 bar at $7/8^{\text{th}}$ of stroke. The cut-off occurs at $1/15^{\text{th}}$ 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:
- 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°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 $C_p = 1.1\text{kJ/kgK}$, $\gamma = 1.32$ 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°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:
- 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°C DBT and 28°C WBT. Find the following:
- Specific humidity
 - Relative humidity
 - Dew point temperature
 - Vapour density
 - Enthalpy of moist air. (10 Marks)

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