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15ME43

Fourth Semester B.E. Degree Examination, July/August 2022
Applied Thermodynamics

Time: 3 hrs. Max. Marks: 80

Note: ***1. Answer any FIVE full questions, choosing ONE full question from each module.***
2. Use of thermodynamics data hand book allowed.

Module-1

1 a. Derive an expression for the air standard efficiency of a diesel cycle with the help of P-V and T-S diagrams. **(08 Marks)**

b. Air enters the compressor of a gas turbine plant at 20°C and compressed with pressure ratio 3.5. The isentropic efficiency of the compressor is 80%. The air is then heated in a heat exchanger having 70% effectiveness. The maximum cycle temperature is 650°C. The isentropic efficiency of the turbine is 75%. Neglecting the losses find thermal efficiency of the cycle. Take R = 287J/kgK and $\gamma = 1.4$. **(08 Marks)**

OR

2 a. Derive an expression for optimum pressure ratio for maximum specific power output in terms of maximum and minimum temperatures of the brayton cycle. **(08 Marks)**

b. An engine working on ideal otto cycle has a swept volume of $0.12m^3$ and clearance volume of $0.03m^3$. The pressure and temperature at the beginning of compression are 1 bar and 100°C. If the pressure at the end of constant volume heat addition is 25 bar, calculate : i) air standard efficiency ii) temperature and pressure at all salient points. **(08 Marks)**

Module-2

3 a. What are the drawbacks of Carnot cycle as a reference cycle? **(02 Marks)**

b. Explain with T – S diagrams the effect of pressure and temperature on the Rankine cycle. **(06 Marks)**

c. A Rankine cycle using water as the working fluid operates between the pressure limits of 10KPa and 15000KPa. The maximum temperature of the cycle is 600°C. Determine the cycle efficiency and the steam flow rate. **(08 Marks)**

OR

4 a. With neat sketch and T–S diagram, derive an expression for the thermal efficiency of a Rankine cycle with Reheat. **(08 Marks)**

b. Steam from a boiler enters a turbine at 25 bar and expands to condenser pressure of 0.2 bar. Determine the Rankine cycle efficiency neglecting pump work when, i) steam is 80% dry at turbine inlet ii) steam is saturated at turbine inlet. Inlet by 76.1°C. Take : T_S at 25 bar = 223.9°C, h_{sup} at 25 bar, 300°C = 3008.8 kJ/kg ; s_{sup} = 6.644kJ/kgK. **(08 Marks)**

Module-3

5 a. Define the terms : i) Stoichiometric air ii) Enthalpy of formation iii) Combustion efficiency. **(06 Marks)**

b. During a test on single – cylinder, four stroke oil engine, the following results were obtained.
Cylinder bars = 20cm, Stroke = 40cm, mean effective pressure = 6bar, Torque = 407 Nm, Speed = 250rpm, fuel consumption = 4 kg/h, C.V. of fuel = 43MJ/kg, Cooling water flow rate = 4.5 kg/min, air used = 30 kg/kg of fuel, Rise in temperature of cooling water = 45°C, Temperature of exhaust gases = 420°C, Room temperature = 20°C CP of exhaust gases = 1 kJ/kgK, CP of water = 4.18 kJ/kgK. Find IP, BP and draw heat balance sheet on hour basis. **(10 Marks)**

OR

6 a. Explain the factors affecting detonation. **(06 Marks)**

b. Methane is burned with atmospheric air. The analysis of the products of combustion on a dry basis is as follows :
CO_2 = 10%, O_2 = 2.37%, CO = 0.53% and N_2 = 87.1%. Calculate the air fuel ratio and the percent theoretical air and determine the combustion equation. **(10 Marks)**

Module-4

7 a. Determine the terms :
i) C.O.P ii) T.O.R iii) Dew point temperature iv) Relative humidity. **(04 Marks)**

b. With a neat sketch explain vapour absorption refrigeration system. **(06 Marks)**

c. A vapor compression refrigerator of 10 tonnes capacity using Freon – 12 as the refrigerant has an evaporator temperature of 10°C and a condenser temperature of 30°C. Assuming simple saturation cycle, determine : i) mass flow rate of refrigerant ii) C.O.P. Take CPV = 0.72 kJ/kgK. **(06 Marks)**

OR

8 a. Mention any 4 properties of a good refrigerant. **(04 Marks)**

b. With the help of psychrometric chart explain i) Sensible heating ii) cooling and dehumidifying. **(04 Marks)**

c. Atmospheric air at 101.325 KPa has 30°C DBT and 15°C DPT. Without using psychrometric chart, using the property values from the tables, calculate :
i) Partial pressures of air and water vapour ii) Specific humidity iii) Relative humidity iv) Vapour density iv) Enthalpy of moist air. **(08 Marks)**

Module-5

9 a. What are the advantages of multi-stage compression? **(04 Marks)**

b. Derive an expression for the optimum pressure ratio to get minimum work in case of a 2 stage reciprocating air compressor. **(06 Marks)**

c. A single –stage double – acting air compressor is required to deliver 14m^3 of air per minute measured at 1.013 bar and 15°C. The delivery pressure is 7 bars. Take clearance volume as 5% of the swept volume and index of compression and expansion as n = 1.3. Calculate :
i) Volumetric efficiency ii) Delivery temperature iii) Indicated power. **(06 Marks)**

OR

10 a. What are steam nozzles? How they are classified? **(04 Marks)**

b. What are the effects of super saturation in a nozzle? **(04 Marks)**

c. A single cylinder, double acting air compressor is required to deliver 100m^3/min of air at a mean piston speed of 500m/min measured at 1 bar and 15°C. The air is delivered at 7 bar. Assume a clearance volume of $1/15$th of swept volume per stroke. Find volumetric efficiency, speed, bore, stroke for the following two cases.
i) If ambient and suction conditions are same.
ii) If ambient and suction conditions are different.

Take : Ambient pressure	= 1 bar	
Ambient temp	= 15°C	
Suction pr	= 0.98 bar	
Suction temp	= 30°C	
L/D	= 1.25.	**(08 Marks)**

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