CBCS SCHEME

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17ME43

Fourth Semester B.E. Degree Examination, June/July 2023
Applied Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note:* 1. *Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of steam table and thermodynamic data handbook is permitted.

Module-1

1 a. What is an air standard efficiency? Derive an expression for air standard efficiency of an Otto cycle. **(07 Marks)**

b. In an air standard diesel cycle, the compression ratio is 16, and at the beginning of isentropic compression, the temperature is 15°C and the pressure is 0.1 MPa. Heat is added until the temperature at the end of the constant pressure process is 1480°C. Calculate:
(i) Cut-off ratio
(ii) The heat supplied per kg of air
(iii) The cycle efficiency
(iv) M.E.P. **(13 Marks)**

OR

2 a. With the help of line diagram and T-S diagram, explain inter cooling and reheating in gas turbine cycle. **(10 Marks)**

b. Air enters the compressor of an ideal air standard Brayton cycle at 100 kPa, 300 K with a volumetric flow rate of 6 m^3/s. The compressor pressure ratio is 10. The turbine inlet temperature is 1500 K. Determine:
(i) The thermal efficiency
(ii) The power output. **(10 Marks)**

Module-2

3 a. Discuss with help of T-S diagram the effect of boiler pressure condenser pressure on the performance of a Rankine cycle with P-V and T-S diagram. **(08 Marks)**

b. Steam at 20 bar, 360°C is expanded in a steam turbine to 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler.
(i) Assuming ideal process, find per kg of steam the net work and the cycle efficiency.
(ii) If the turbine and the pump have each 80% efficiency, find the percentage reduction in the net work and cycle efficiency. **(12 Marks)**

OR

4 a. With the help of schematic diagram and T-S diagram, explain reheat Rankine cycle and derive an expression for its thermal efficiency. **(08 Marks)**

b. A 40 MW steam power plant working on Rankine cycle operates between boiler pressure of 4 MPa and condenser pressure of 10 kPa. The steam leaves the boiler and enters the steam turbine at 400°C, the isentropic efficiency of the steam turbine is 85%. Determine:
(i) The cycle efficiency
(ii) The quality of exhaust steam from the turbine
(iii) The steam flow rate in kg per hour, consider pump work. **(12 Marks)**

Module-3

5 a. Explain the following terms with reference to a combustion process:
(i) Stoichiometric air
(ii) Enthalpy of formation
(iii) Enthalpy of combustion
(iv) Combustion efficiency **(08 Marks)**

b. The product of combustion of an unknown hydrocarbon C_XH_Y have the following composition as measured by an Orsat apparatus CO_2 = 8%, O_2 = 8.8%, CO = 0.9%, N_2 = 82.3%. Determine:
(i) Composition of the fuel
(ii) Air/fuel ratio
(iii) Percentage of excess air used **(12 Marks)**

OR

6 a. Explain the phenomenon of knocking in SI engine. What are the different factors which influence the knocking? **(10 Marks)**

b. The following particulars refers to a 2-stroke diesel engine:
Bore = 10 cm, Stroke = 15 cm, Piston speed = 300 m/min, torque developed = 58 Nm, mechanical efficiency = 80%, indicated thermal efficiency = 40%, calorific value of fuel = 44 MJ/kg. Determine:
(i) Indicated power
(ii) Indicated mean effective pressure
(iii) Fuel consumption per kWh on brake power output. **(10 Marks)**

Module-4

7 a. With neat sketch, explain the working of a vapour absorption refrigeration system. **(08 Marks)**

b. A vapour 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 in kg/min (ii) Power input (iii) COP. Take C_{PV} = 0.72 kJ/kgK. **(12 Marks)**

OR

8 a. Define the following:
(i) Dry bulb temperature
(ii) Dew point temperature
(iii) Relative humidity
(iv) Degree of saturation **(08 Marks)**

b. It is required to design an air conditioning plant for a office room with the following conditions: outdoor conditions 14°C DBT and 10°C WBT; required conditions 20°C DBT and 60% R.H.; amount of air circulation 0.30 m^3/min/person. Seating capacity of office 60. The required condition is achieved first by heating and then by adiabatic humidifying. Determine the following:
(i) Heating capacity of the coil in KW and the surface temperature required if the bypass factor of coil is 0.4.
(ii) The capacity of the humidifier. **(12 Marks)**

Module-5

9 a. Define the following with respect to compressor:
(i) Isothermal efficiency
(ii) Adiabatic efficiency
(iii) Mechanical efficiency
(iv) Volumetric efficiency **(08 Marks)**

b. A single acting reciprocating compressor with cylinder of 15 cm diameter and 18 cm stroke has a clearance volume of 4% of swept volume. It takes in air at 1 bar 25°C and delivers at 8 bar while running at 1200 rpm. The actual power input is 18 KW. Estimate:
(i) The power required to drive the unit
(ii) The isothermal efficiency
(iii) The mechanical efficiency when the mass flow rate is 4 kg/min. **(12 Marks)**

OR

10 a. Discuss the different shapes of nozzle. **(04 Marks)**

b. Discuss the following:
(i) Effect of friction in nozzle flow
(ii) Supersaturated flow through nozzle **(06 Marks)**

c. What is critical pressure ratio? Derive an expression for pressure ratio which gives maximum discharge through the nozzle. **(10 Marks)**

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