CBCS SCHEME

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17ME43

Fourth Semester B.E. Degree Examination, Jan./Feb. 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 Thermodynamics data hand book and Mollier chart is permitted.***

Module-1

1 a. State the assumptions made in the air standard cycles. Derive the expression for the air standard efficiency of Otto cycle. **(10 Marks)**

b. The compression ratio of a Diesel cycle is 14 and the cut-off ratio is 2.2. At the beginning of cycle, air is at 0.98 bar and 100°C. Find the temperature and pressure at all salient points and also Air Standard efficiency. **(10 Marks)**

OR

2 a. Explain briefly with T-S diagram for the following Gas Turbine cycle :
(i) Regeneration (ii) Intercooling (iii) Reheating. **(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) Thermal efficiency (ii) Work ratio (iii) Power developed. **(10 Marks)**

Module-2

3 a. With T-S diagram and schematic diagram explain the working of ideal regenerative Rankine cycle. **(10 Marks)**

b. In a Rankine cycle, the steam at inlet to turbine is saturated at a pressure of 35 bar and the exhaust pressure is 0.2 bar. Calculate :
(i) Pump work (ii) Turbine work (iii) Rankine efficiency (iv) Condenser heat flow. Assume mass flow rate = 9.5 kg/s. **(10 Marks)**

OR

4 a. Sketch the flow diagram and T-S diagram of a reheat Rankine cycle. Briefly explain the working principle and derive the cycle efficiency for reheat Rankine cycle. **(10 Marks)**

b. Steam enters the turbine of a steam power plant operating an Rankine cycle at 10 bar and 300°C. The condenser pressure is 0.1 bar. Steam leaving the turbine is 90% dry. Calculate the adiabatic efficiency of the turbine and also cycle efficiency. Neglecting pump work. **(10 Marks)**

Module-3

5 a. Explain the following with reference to combustion process:
(i) Percent excess air (ii) Enthalpy of formation
(iii) Enthalpy of combustion (iv) Internal energy of combustion. **(10 Marks)**

b. Calculate the air-fuel ratio for burning of propane (C_3H_8) with 130% theoretical air. **(10 Marks)**

OR

6 a. Explain briefly the combustion process in spart ingnition (SI) and Compression Ignition (CI) engines. **(10 Marks)**

b. The following observations are taken during a trial on four stroke Diesel Engine :

Cylinder diameter = 25 cm, Stroke = 40 cm
Speed = 250 rpm, Brake load = 70 kg,
Brake drum diameter = 2 m, Mean effective pressure = 6 bar,
Diesel oil consumption = 0.1 m^3/min, Specific gravity of fuel = 0.78,
Calorific value of fuel = 43900 kJ/kg

Determine :

(i) IP (ii) BP (iii) FP
(iv) Mechanical efficiency (v) Brake thermal efficiency. **(10 Marks)**

Module-4

7 a. Derive an expression for COP of an air refrigeration system working on Bell-Coleman cycle. **(10 Marks)**

b. A vapour compression plant uses R-12 and is to develop 5 tonnes of refrigeration. The condenser and evaporator temperature are to be 40°C and −10°C respectively.

Determine : (i) The refrigerant flow rate in kg/s
(ii) The volume flow rate handled by the compressor in m^3/s
(iii) The compressor discharge temperature
(iv) Pressure ratio. **(10 Marks)**

OR

8 a. Define the following :

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

b. A sling psychrometer reads 40°C DBT and 28°C WBT, Calculate the following :

(i) Specific humidity (ii) Relative humidity
(iii) Dew point temperature (iv) Enthalpy of mixture / kg of dry air. **(10 Marks)**

Module-5

9 a. Show that for perfect intercooling, stage pressure ratio remains the same in multistage air compressor and hence prove that $Z = \left[\frac{P_{X-1}}{P_1}\right]^{\frac{1}{X}}$. where Z = stage pressure ratio, P_1 = Initial pressure, X = Number of stages. **(10 Marks)**

b. In a two-stage reciprocating air compressor 1.5 kg/min of air is compressed from 1 bar to 25 bar and the index of compression is 1.2. If the work of compression is minimum and the air is cooled in the intercooler so that its temperature is brought back to initial temperature of 15°C. Determine :

(i) Heat rejected during compression. (ii) Heat rejected in the intercooler.
(iii) Power.
Take for air C_P = 1 KJ/kgK and C_V = 0.714 KJ/KgK **(10 Marks)**

OR

10 a. Define critical pressure ratio for the nozzle of the steam turbine. Obtain analytically its value in terms of the index of expansion. **(10 Marks)**

b. Steam is allowed to expand in a set of nozzles from 10 bar and 200°C to final pressure of 5 bar what type of nozzle is it. Neglecting the initial velocity of steam, calculate the minimum area of the nozzle required to allow a flow of 3 kg/s under the given conditions. Assume that expansion of steam to be Isentropic. **(10 Marks)**

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