CBCS SCHEME

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15ME43

Fourth Semester B.E. Degree Examination, Jan./Feb. 2023
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 Thermodynamic data hand book and steam tables is permitted.

Module-1

1 a. With the help of P-V and T-S diagrams, derive an expression for the air standard efficiency of a Diesel cycle. **(08 Marks)**

b. An engine of 250mm bore and 375mm stroke works on constant volume cycle. The clearance volume is $0.00263m^3$. The initial pressure and temperature are 1 bar and 50°C if maximum pressure is 25 bar. Find the following:
i) Air standard efficiency of the cycle
ii) Mean effective pressure. **(08 Marks)**

OR

2 a. What are the methods of improving the efficiency of open cycle gas turbines? **(02 Marks)**

b. Explain with a neat sketch the working of Turbo-propeller. **(06 Marks)**

c. A gas turbine unit has a pressure ratio of 6:1 and maximum cycle temperature of 610°C. The isentropic efficiency of compressor and turbine are 0.80 and 0.82 respectively. Calculate the power output in KW of an electric generator geared to the turbine when the air enters the compressor at 15°C at the rate of 16kg/s. **(08 Marks)**

Module-2

3 a. Discuss with the help of T-S diagram, the effect of boiler pressure and super heat on the performance of a Rankine cycle. **(06 Marks)**

b. In ideal Rankine cycle the steam at inlet to turbine is dry saturated at a pressure of 35 bar and the exhaust pressure is 0.2 bar. Calculate: i) The pump work ii) Turbine work iii) Rankine efficiency vi) Condenser heat flow v) Dryness fraction at the end of expansion. **(10 Marks)**

OR

4 a. With the help of T-S diagram, explain the working of Rankine cycle with regeneration using open feed water system. **(08 Marks)**

b. A steam power plant uses the following cycle steam at boiler outlet 150 bar. 550°C reheat at 40 bar, 550°C, condenser at 0.1 bar using Mollier chart. Find quality of turbine exhaust, cycle efficiency, steam rate. **(08 Marks)**

Module-3

5 a. Define the following: i) Stoichometric air ii) Calorific value iii) Adiabatic flame temperature iv) Enthalpy of combustion. **(08 Marks)**

b. Methane [CH_4] is burned with atmospheric air the analysis of the products on a dry basis is as follows: $CO_2 = 10\%$, $O_2 = 2.37\%$, $CO = 0.53\%$, $N_2 = 87.1\%$.
i) Determine the combustion equation.
ii) Calculate the air fuel ratio.
iii) Percent theoretical air. **(08 Marks)**

OR

6 a. Describe the following as applied to IC engine: i) Morse test ii) Heat balance sheet. **(06 Marks)**

b. A single cylinder four stroke diesel engine works on the following data. Cylinder bore = 15cm stroke = 25cm, speed 250rpm, area of indicator diagram = $6cm^2$. Length of the indicator diagram = 9cm, spring constant = 7.5 bar/cm, brake specific fuel consumption = 0.24kg/kW hr, calorific value = 42,000kJ/kg, diameter of brake wheel = 10cm, rope diameter = 3.5cm, brake load = 40kg. Calculate: i) Brake power ii) Indicated mean effective pressure iii) Indicated power iv) Mechanical efficiency v) Indicated thermal efficiency. **(10 Marks)**

Module-4

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

b. A refrigeration machine of 6 Tonnes capacity working on Bell-Coleman cycle has an upper most pressure of 5.2 bar the pressure and temperature at the start of compression are 1 bar and 18°C. The cooled compressed air enters the expander at 41°C. Assuming both compression and expansion to be adiabatic with an index of 1.4. Calculated: i) COP ii) Quantity of air circulated per minute iii) Power required. **(08 Marks)**

OR

8 a. Define:
- i) Relative humidity
- ii) Dew point temperature
- iii) Specific humidity
- iv) Degree of saturation. **(08 Marks)**

b. It is required to design an air-conditioning plant for a small office room for following winter conditions: out door conditions = 14°C DBT and 10°C WBT, required conditions = 20°C DBT and 60% RH, Amount of air circulation = $0.30m^3$/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 by-pass factor of coil is 0.4.
- ii) The capacity of the humidifier. **(08 Marks)**

Module-5

9 a. Discuss application of compressed air and derive an expression for the volumetric efficiency of reciprocating air compressor. **(08 Marks)**

b. A single acting air compressor has a bore of 15cm and a stroke of 25cm. The crank speed is 600rpm. Air taken from atmosphere (1 bar, 27°C) is delivered at 11 bar. Assuming that compression and expansion follow the law $PV^{1.25} = C$ and the clearance is 5%. Determine: i) Power required to drive the compressor. Assuming the mechanical efficiency to be 80% ii) Volumetric efficiency. **(08 Marks)**

OR

10 a. Define Nozzle. What are the types of nozzles? Explain with neat diagram. **(05 Marks)**

b. What are the effects of super saturation flow? **(03 Marks)**

c. Dry saturated steam at a pressure of 11 bar enters a convergent-divergent nozzle and leaves at a pressure of 2 bar. If the flow is adiabatic and friction less determine:
- i) The exit velocity of steam.
- ii) Ration of cross section at exit and that at throat. Assume the index of adiabatic expansion to be 1.135. **(08 Marks)**

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