CBCS SCHEME

USN | | | | | | | | | | | **18ME42**

Fourth Semester B.E. Degree Examination, June/July 2024
Applied Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Derive an expression for thermal efficiency of Otto cycle. **(08 Marks)**

b. Calculate the percentage loss in the ideal efficiency of a diesel engine with compression ratio 14, if the fuel cut-off is delayed from 5% to 8%. **(08 Marks)**

c. Describe the phenomenon of detonation in SI engine. Mention any four important effects of detonation. **(04 Marks)**

OR

2 a. Classify the IC Engines. **(06 Marks)**

b. In a test of a 4-stroke, 4-cylinders engine 75 mm bore, and 100 mm stroke, the following results were obtained at full throttle at a constant speed and constant fuel supply 6 kg/h. BP when all cylinders are working is 15.6 kW and when cylinder No. 1 cut-out is 11.1 kW, cylinder no.2 cut-out is 11.03 kW, cylinder no.3 cut-out is 10.88 kW, cylinder no.4 cut-out is 10.66 kW. If the calorific value of fuel is 83600 kJ/kg and clearance volume is 0.001 m^3, Calculate (i) Mechanical efficiency (ii) Indicated thermal efficiency (iii) Air standard efficiency. **(08 Marks)**

c. Compare Otto and Diesel cycles for constant maximum pressure and heat supplied with P-V and T-S diagrams. **(06 Marks)**

Module-2

3 a. Explain how the reheating will improve the specific output of the Brayton cycle, with T-S diagram and also give reason for reduction in thermal efficiency. **(10 Marks)**

b. A Gas turbine unit has a pressure ratio 6:1 and maximum cycle temperature of 610°C. The isentropic efficiencies of the compressor and turbine are 0.80 and 0.82 respectively. Calculate the power output. The air enters the compressor at 15°C at the rate of 16 kg/s. Take C_P = 1.006 kJ/kg, γ = 1.4 for compression process and C_P = 1.11 kJ/kg, γ = 1.333 for expansion process. **(10 Marks)**

OR

4 a. With neat sketch explaining the working of Ram-Jet and write the advantages. **(08 Marks)**

b. In a gas turbine the compressor takes in air at a temperature of 15°C and compresses it to four times the initial pressure with an isentropic efficiency of 82%. The air is then passed through a heat exchanger heated by the turbine exhaust before reaching combustion chamber. The effectiveness of heat exchanger is 0.78. The maximum temperature after constant pressure combustion is 600°C and the efficiency of the turbine is 70%. Neglect all losses and working fluid throughout the cycle having characteristic of air. Find the efficiency of the cycle. Take C_P = 1.0045 kJ/kgK, γ = 1.4. **(12 Marks)**

Module-3

5 a. What are the drawbacks of Carnot cycle as a reference cycle? **(04 Marks)**

b. Explain with T-S diagram the effects of pressure and temperature on the Rankine cycle. **(06 Marks)**

c. A steam power plant operating on Rankine cycle gets steam at 40 bar and dry saturated. After doing work steam is exhausted at 0.30 bar. If the steam flow rate is 60 kg/s determine
(i) Pump work (ii) Turbine work
(iii) Cycle efficiency (iv) Heat flow in the condenser. **(10 Marks)**

OR

6 a. With a schematic and T-S diagram, explain the working of reheat vapour power cycle and deduce an expression for cycle efficiency. **(10 Marks)**

b. A simple Rankine cycle works between pressures 28 bar and 0.06 bar, the initial condition of steam being dry saturated. Calculate the cycle efficiency, work ratio and specific steam consumption. **(10 Marks)**

Module-4

7 a. Derive an expression for C.O.P of an air refrigeration system working on Reversed Carnot cycle. **(10 Marks)**

b. A Bell-Coleman Refrigerator operates between pressure limits of 1 bar and 8 bar. Air is drawn from the cold chamber at 9 °C, compressed and then it is cooled to 29 °C, before entering the expansion cylinder. Expansion and compression follow the law $PV^{1.35} = C$. Calculate the theoretical C.O.P of the system. Take C_P = 1.003 KJ/kg K, $C_V = 0.716$ KJ/kgK, R = 0.287 KJ/kgK. **(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. An air conditioning system is designed under the following conditions :
Outdoor conditions = 30 °C DBT and 75% RH
Required indoor conditions = 22 °C DBT and 70% RH
Amount of free air circulated = 3 m^3/sec.
Coil dew point temperature = 14 °C
The required condition is achieved first by cooling and dehumidifier and then by heating.
Calculate : (i) The capacity of the cooling coil in tones
(ii) The capacity of the heating coil in kW.
(iii) The amount of water vapour removed in kg/s. **(10 Marks)**

Module-5

9 a. Explain the operation of single stage, single acting reciprocating compressor with P-V diagram. Assume no clearance. **(08 Marks)**

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

c. A multistage compressor is to be designed to elevate the pressure from 1 bar to 120 bar such that the stage pressure ratio will not exceed 4. Determine
(i) Number of stages (ii) Exact pressure ratio (iii) Intermediate pressures
(iv) The minimum power required to compress 15 m^3/min of free air. Take n = 1.2. **(08 Marks)**

OR

10 a. Derive an expression for pressure ratio which gives maximum discharge through the nozzle. **(10 Marks)**

b. Explain different types of steam nozzles. **(04 Marks)**

c. In a steam nozzle, the steam expands from 4 bar to 1 bar. The initial velocity is 60 m/s and the initial temperature is 200 °C. Determine the exit velocity of the nozzle efficiency is 92%. **(06 Marks)**

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