CBCS SCHEME

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15ME43

Fourth Semester B.E. Degree Examination, Feb./Mar. 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 thermodynamic data book is permitted.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Define: (i) Compression ratio (ii) Cut-off ratio (iii) Explosion ratio (iv) Expansion ratio **(08 Marks)**

b. An engine working on dual combustion cycle takes in air at 1 bar and 30°C. The clearance is 8% of the stroke and cut-off takes place at 10% of the stroke. The maximum pressure in the cycle is limited to 70 bar. Find : (i) Temperatures and pressures at the salient points (ii) Air standard efficiency. **(08 Marks)**

OR

2 a. With a schematic diagram, explain how inter-cooling improves the thermal efficiency of open cycle gas turbine plant. **(04 Marks)**

b. With a neat sketch, explain the working of turbo jet. Show the processes on T-S diagram. **(04 Marks)**

c. In a regenerative gas turbine cycle, air enters the compressor at 1 bar, 15°C, pressure ratio is 6. The isentropic efficiency of compressor and turbine are 0.8 and 0.85 respectively. The maximum temperature in the cycle is 800°C. The regenerator efficiency is 0.78. Assume for air C_p = 1.005 kJ/kgK, γ = 1.4, for hot gases C_p = 1.1 kJ/kgK, γ = 1.32. Find cycle efficiency. **(08 Marks)**

Module-2

3 a. Why is ideal regenerative cycle impracticable? **(03 Marks)**

b. Write a note on feed water heaters. **(04 Marks)**

c. A simple Rankine cycle works between pressures of 30 bar and 0.04 bar. The initial condition of steam being dry saturated. Calculate the cycle efficiency, work ratio and specific steam consumption. **(09 Marks)**

OR

4 a. With a neat sketch, explain the working of binary vapour cycle. Show the processes on T-S diagram. **(08 Marks)**

b. In a reheat cycle, the initial steal pressure and the maximum temperature are 150 bar and 550°C. If the condenser pressure is 0.1 bar and moisture at condenser inlet is 5% and assuming ideal processes, determine: (i) Reheat pressure (ii) Cycle efficiency (iii) Steam rate. Assume reheat temperature as 550°C. **(08 Marks)**

Module-3

5 a. Define the following:
(i) Stoichiometric air (ii) Excess air
(iii) Percent excess air (iv) Combustion efficiency **(08 Marks)**

b. The gravimetric analysis of a sample of coal is given by as follows: C = 82%, H_2 = 10%, ash = 8%. Calculate: (i) Stoichiometric A/F ratio (ii) The analysis of products by volume. **(08 Marks)**

OR

6 a. Describe the phenomena of detonation in SI engine. Mention the parameters affecting detonation. **(08 Marks)**

b. A four cylinder petrol engine has a bore of 60 mm and a stroke of 90 mm. Its rated speed is 2800 rpm and it is tested at this speed against brake which has a torque arm 0.37 m. The net brake load is 160 N and the fuel consumption is 8.986 lit/h. the specific gravity of petrol is 0.74 and it has LCV of 44100 kJ/kg. A Morse test was carried out and cylinders are cut-out in the order 1, 2, 3 4 with corresponding brake loads of 110, 107, 104 and 110N. Calculate:
(i) Brake thermal efficiency (ii) Mechanical efficiency
(iii) Brake specific fuel consumption (iv) Indicated mean effective pressure. **(08 Marks)**

Module-4

7 a. For a Bell-Coleman refrigeration cycle. Show that $COP = \frac{T_1}{T_2 - T_1}$ where T_1 and T_2 are temperature of air before and after compression. **(08 Marks)**

b. 28 tonnes of ice at 0°C is produced per day in an ammonia refrigerator. The temperature range in the compressor is from 25°C to −15°C, The vapour is dry saturated at the end of compression. Assuming a COP of 62% of theoretical, calculate the power required to drive the compressor. Take latent heat of ice as 335 kJ/kg. **(08 Marks)**

OR

8 a. Derive the relation between specific humidity and relative humidity. **(03 Marks)**

b. Explain the following by showing the process on psychrometric chart:
(i) Cooling with dehumidification of air
(ii) Heating and humidification of air **(05 Marks)**

c. With a schematic diagram, explain the working of winder air conditioning system. Show the processes on psychrometric chart. **(08 Marks)**

Module-5

9 a. What are the applications of compressed air? **(04 Marks)**

b. Define volumetric efficiency of an air compressor. Derive the expression for volumetric efficiency in terms of clearance and pressure ratios. **(06 Marks)**

c. Atmospheric air at 1 bar and 27°C taken into a single stage reciprocating compressor. It is compressed according to the law $PV^{1.3} = C$ to the delivery pressure of 6 bar. The compressor takes 1 m^3 of air per min. The speed of the compressor is 300 rpm. Stroke to diameter ratio is equal to 1.5:1, mechanical efficiency of the compressor is 0.85. Calculate:
(i) Indicated power and isothermal efficiency
(ii) The cylinder dimensions and power of motor required to drive the compressor.
Neglect clearance. **(06 Marks)**

OR

10 a. For a steam nozzle show that critical pressure ratio $\frac{p_2}{p_1} = \left(\frac{2}{n+1}\right)^{\frac{n}{n-1}}$. **(08 Marks)**

b. Steam is supplied at a pressure of 11 bar and 0.97 dry to a convergent divergent nozzle and expands down to a back pressure of 0.3 bar. The throat area is 5 cm^2 and 12% of the total enthalpy drop is lost in the divergent part. Determine:
(i) Steam flow rate (ii) Nozzle outlet area
Assume maximum discharge condition. **(08 Marks)**

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