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337413(37)

B. E. (Fourth Semester) Examination, April-May 2021

(Old Scheme)

(Mech. Engg. Branch)

APPLIED THERMODYNAMICS

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : *Part (a) of each unit is compulsory and solve any two from (b), (c) and (d). Use of Steam table and Mollier diagram is printed.*

Unit-I

1. (a) Define Entropy principle? 2

(b) Explain the equivalence of Kelvin planck and clausius statement. 7

(c) A heat engine produces work equivalent to 80 kW with an efficiency of 40%. Determine the heat transfer rate to and from the working fluid. 7

(d) A heat engine develops 10 kW power when receiving heat at the rate of 2250 kJ/min. Evaluate the corresponding rate of heat rejection from the engine and its thermal efficiency. 7

Unit-II

2. (a) Define law of corresponding state. 2

(b) Derive first T-ds equation. 7

(c) Setup the Tds relation. 7

$$Tds = c_p dt - \beta v T d\rho$$

Where symbols have their usual meaning.

(d) Derive the following reduced equation of state. 7

$$\left(P_r + \frac{3}{v_r^2}\right)(3v_r - 1) = 8T_r$$

Unit-III

3. (a) Define pure substances. 2

(b) Steam at 10 bar pressure and 0.9 deryness fraction is cooled at constant volume at 160°C. What will be the final condition. 7

(c) Find the enthalpy , entropy and volume of steam at 1.4 MPa, 380°C. 7

(d) A vaccum of 710 mm was obtained in a condenser when the barometer reads 755 mm. The temperature of condensate was 25°C. Determine the pressure of air and steam in the condenser and the mass of air per kg of steam. Also determine the volume efficiency. 7

Unit-IV

4. (a) Draw P-V and T-S diagram for reversed Carnot cycle. 2

(b) Explain the simple vapour compression refrigeration cycle. 7

(c) Derive the equation for volumetric efficiency of air compressor. 7

(d) A single acting two stage air compressor deals with

4 m^3/min of air at 1.013 bar and 15°C with a speed of 250 rpm. The delivery pressure is 80 bar. Assuming complete intercooling, find the minimum power required by the compressor and the bore and stroke of the compressor. Assume a piston speed of 3 m/s. Mechanical efficiency of 75% and volumetric efficiency of 80% per stage. Assume polytropic index of compression in both the stages to be n = 1·25 and neglect clearance. 7

Unit-V

5. (a) Define Mach number. 2

(b) Derive the following equation. 7

$$\frac{dA}{A} = \left(M^2 - 1\right)\frac{dV}{V}$$

(c) Derive the following equation. 7

$$\frac{dA}{A} = \frac{\left(M^2 - 1\right)dm}{m\left(1 + \frac{Y-1}{2}M^2\right)}$$

(d) Derive the given equation. 7

$$\frac{T_o}{T} = 1 + \frac{Y-1}{2}M^2$$