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B. E. (Fourth Semester) Examination, ~~2020~~

APR-MAY2022

(New Scheme)

(Mechanical & Automobile Branch)

APPLIED THERMODYNAMICS

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : *Attempt all questions. Part (a) of each question is compulsory. Answer any two parts out of three parts (b), (c) and (d). Steam table and Mollier can be used.*

Unit-I

1. (a) Draw Erricson and Atkinson cycle on p-v and T-s diagram. 2

(b) Draw the compression ignition cycle on P-v and T-s diagram. Derive the thermal efficiency of the cycle. 7

(c) An engine working on the Otto cycle is supplied with air at 0·1 MPa, 35°C. The compression ratio is 8. Heat supplied is 2100 kJ/kg. Calculate the maximum pressure and temperature of the cycle, the cycle efficiency and the mean effective pressure. (For Air $C_p = 1{\cdot}005$, $C_v = 0{\cdot}718$ and $R = 0{\cdot}287$ kJ/kgK) 7

(d) An oil engine working on Diesel cycle has cylinder bore of 190 mm and piston stroke of 230 mm. The clearance volume is 290 cm^3. The fuel injection takes place at constant pressure of 6% of the stroke. Determine the air standard efficiency. Also calculate the percentage of loss of efficiency if fuel cut-off is delayed from 6% to 11% of the stroke with same compression ratio. 7

Unit-II

2. (a) Define volumetric efficiency. 2

(b) A single stage double-acting air compressor is required to deliver 14 m^3 of air per minute measured at 1·013 bar and 15°C. The delivery pressure is 7 bar and the speed 300 rpm. Take the clearance volume as 5% of the swept volume with the compression and expansion of $n = 1{\cdot}3$, Calculate : 7

(i) Swept volume of the cylinder

(ii) The delivery temperature

(iii) Indicated power

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

(d) Two stage Compressor, compresses air from 1 bar and 20°C to 42 bar. If $pv^{1\cdot3} = C$ and inter-cooling is complete to 20°C. Find per kg of air (i) Work done (ii) Mass of water necessary for abstracting rise of cooling water is 25°C. Take $R = 287$ J/kg-K, $C_p = 1$ kJ/kg K for air. 7

Unit-III

3. (a) Define : 2

(i) Work ratio

(ii) Specific steam consumption

(b) Explain methods of improving efficiency of Rankine cycle with neat schematic diagrams. 7

(c) A steam is supplied to steam turbine at pressure 20 bar and degree of superheat to be 137·6°C. The exhaust pressure is 0·08 bar and the expansion of steam takes place isentropically. Determine the following : 7

(i) Heat supplied, (Assuming that the feed pump supplies water to the boiler at 20 bar),

(ii) Heat rejected,

(iii) Net work done

(iv) Work done by turbine

(v) Thermal efficiency

(d) Steam at 15 bar and 250°C is expanded through a turbine at first to 4 bar and isobarically reheated to initial temperature of 250°C and finally expanded to 0·1 bar. Using Mollier chart find : 7

(i) Work done per kg of steam

(ii) Amount of heat suppled during the process of reheat

(iii) Thermal efficiency

Unit-IV

4. (a) Write the sources of air leakage in the condenser. 2

(b) Write the difference between jet condenser and surface condenser. 7

(c) Explain the working principle of : 7

(i) Natural draught cooling tower

(ii) Forced draught cooling tower

(d) In a condenser, vacuum gauge reads 715 mm of Hg while barometer reads 755 mm. The temperature of condensate be 25°C. Determine the pressure of steam and air, mass of air per kg of steam. Also, determine the vacuum efficiency. 7

Unit-V

5. (a) Define stagnation enthalpy. 2

(b) Show that for one dimensional steady isentropic flow through a duct :

$$\frac{dA}{A} = \left(M^2 - 1\right)\frac{dV}{V}$$ 7

Where, M = Mach No., A = Area, V = velocity.

(c) Explain the occurrence of choking for adibatic flow with friction and adiabatic flow without friction. 7

(d) A steam of air flows in a duct of 100 mm diameter at a rate of 1 kg/s. The stagnation temperature is 37°C at one section of the duct the static pressure is 40 kPa. Calculate the Mach Number, Velocity and stagnation pressure at this section. 7