Printed Pages – 6 Roll No. :

337453(37)

B. E. (Fourth Semester) Examination Nov.-Dec. 2019

(New Scheme)

(Mech. 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 (2 marks each). Answer any two parts (2 × 7 = 14 marks each) out of three from (b), (c) and (d).*

Unit - I

1. (a) Define compression ratio. How does it affect the air standard efficiency of an otto cycle?

(b) In a diesel cycle, air at 0·1 MPa and 300 K is compressed adiabatically until the pressure rises to 5 MPa. If 700 kJ/kg of energy in the form of heat is supplied at constant pressure, determine the compression ratio, thermal efficiency and mean effective pressure.

(c) For the same maximum pressure and heat input, which cycle is more efficient? Explain with P-v and T-s diagram.

(d) Derive an expression for the air standard efficiency and mean effective pressure of dual cycle.

Unit - II

2. (a) Define volumetric efficiency.

(b) Why is multi-staging essential for high compression ratio? Derive an expression for minimum work input in a multistage compressor.

(c) A compressor delivers air at 7·5 bar gauge having 70 cm stroke. The atmospheric conditions are 20°C and 1 bar. Clearance volume is 4% of the stroke volume. After overhauling the compressor, a distance piece 1 cm thick which was inserted

between the cylinder head and the cylinder was accidentally omitted while assembling.

Calculate :

The percentage change in volume of free air delivered.

Assume $n = 1{\cdot}25$

(d) Calculate the size of the cylinder for a double acting air compressor taking air at 1 bar and 15°C and compressing to 6·5 bar with law of compression $pv^{1{\cdot}25} = c$. The indicated power of the compressor is 40 kW and it runs at 120 rpm. The average piston speed is 150 m/min. Clearance may be neglected.

Unit - III

3. (a) Give reasons why the Carnot cycle cannot be considered as the theoretical cycle for steam power plant?

(b) What do you mean by binary vapour cycle? What are the advantages and disadvantages of mercury as a working fluid.

(c) A steam turbine receives steam at pressure 20 bar

and superheated to 88·6°C. The exhaust pressure if 0·07 bar and expansion of steam takes place isentropically.

Calculate :

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

(ii) Heat rejected

(iii) Net work done

(iv) Thermal efficiency

(v) Theoretical steam consumption

(vi) If the actual steam consumption is 5 kg/kWh, what is the efficiency ratio of the turbine.

(d) Steam enters a turbine at 60 bar and 600°C. Steam is bled off at 7 bar for regenerative feed heating and the remaining steam is condensed in condenser to condenser temperature 30°C. Calculate :

(i) The amount of bled steam

(ii) The ideal thermal efficiency of cycle

(iii) Steam rate kg/kWh.

Unit - IV

1. (a) Define condenser efficiency.

(b) In a condenser test following observations were made :

Vacuum = 70 cm of Hg,

Barometer = 76 cm of Hg

Mean temperature of condensation = 35°C,

Hot well temperature = 29°C,

Mass of cooling water = 45500 kg/hr

Inlet water temperature = 16.5°C,

Outlet water temperature = 31°C,

Mass of condensate = 1200 kg/hr

Calculate

(i) The mass of air present per unit condenser volume

(ii) The state of steam entering the condenser

(iii) The vacuum efficiency

(iv) The condenser efficiency

(c) Describe the principle of working of cooling towers with neat sketches.

(d) What do you mean by the term vacuum efficiency of a condenser? What are the factors that affect vacuum efficiency?

Unit - V

5. (a) Differentiate between the compressible and incompressible flow.

(b) Derive the following relation for one-dimensional compressible flow through ducts of varying area

$$\frac{dA}{A} = \frac{1}{r}\frac{dp}{p}\left(\frac{1 - M^2}{M^2}\right)$$

(c) Gas turbine gases leave the nozzle with a stagnation pressure of 6 bar and stagnation temperature of 1200 K. If the static pressure is 1 bar, determine the static temperature and velocity of the jet. Consider the flow process to be reversible adiabatic.

(d) Explain Fanno line and Rayleigh line.