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337453(37)

B. E. (Fourth Semester) Examination, 2021

(New Scheme)

(Mechanical & Automobile Branch)

APPLIED THERMODYNAMICS

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : *All questions are compulsory. Attempt any two part from (b), (c) & (d) of 7 marks each part (a) will carry 2 marks.*

Unit-I

1. (a) What do you mean by mean effective pressure (map).

(b) Derive an expression for work ouput and efficiency of otto cycle.

(c) Compare otto, Diesel and dual cycles on the basis of :

(i) Same compression ratio

(ii) Same maximum pressure and temperature

(d) In an air standard Diesel cycle, the compression ratio is 16 and at the begining of isentropic compression the temperature is 15°C and the pressure is 0·1 MPa. Heat is added until the temperature at the end of the constant pressure process is 1480°C. Calculate :

(i) the cut off ratio

(ii) the heat supplied per kg of air

(iii) the cycle efficiency

(iv) the mean effective pressure

Unit-II

2. (a) Write effect of clearance volume in reciprocating compressor.

(b) A single stage acting reciprocating air compressor takes in air at 1 bar 27°C and delivers at 7 bar, volume of air entering the compressor is 5 m^3/min. Air is compressed according to $PV^{1.3} = C$. Calculate isothermal efficiency and power required to drive compressor neglecting clearance volume.

(c) A single acting reciprocating air compressor has a bore of 15 cm and stroke of 25 cm. The crank rotates at 600 rpm. Air is taken in at 1·013 bar and 27°C and delivered at 11 bar. Assuming index of compression as 1·25, find the power required to drive the compressor. If the clearance volume is 5% of stroke volume, find its volumetric efficiency.

(d) A two stage single acting reciprocating air compressor compresses air from 1 bar 20°C to 40 bar following the law $PV^{1.33}$ = constant. For perfect intercolling. Find per kg of air, work done, mass of cooling water to be circulated in the intercooler if the maximum rise in cooling water temperature is limited to 22°C. If the above compression is done by a single stage, what will be the work done and estimate the % of work sayed in multistage.

Unit-III

3. (a) Why is the rankine cycle rather than carnot cycle is used as a standard reference cycle for steam power plant?

(b) Steam at 20 bar and 360°C expands in a steam turbine to 0.08 bar. It is then condensed in a condenser to saturated water. The pump feed back the water to boiler. Assume ideal rankine cycle and determine :

(i) Net work done /kg of steam

(ii) Rankine efficiency

(c) Steam power plant uses the following cycle :

Steam at boiler = 150 bar, 550°C

Reheat at 40 bar to 550°C

Condenser pressure = 0·1 bar

Using Mollier's chart and assuming ideal processes.

Find :

(i) Quality of steam at turbine exhaust

(ii) Cycle efficiency

(iii) Steam rate

(d) In a single heater regenerative cycle, steam inlet to turbine is 30 bar, 400°C exhaust pressure is 0·1 bar. Feed water heater works at 5 bar. Find the cycle efficiency, steam rate and increase in mean temperature of heat addition.

Unit-IV

4. (a) State the advantages of using a condenser in a steam power plant.

(b) Explain low level counter flow jet condenser with neat & clean diagramme.

(c) The following observations were made during a test on surface condenser :

Barometer reading = 760 mm of Hg

Condenser vacuum = 705 mm of Hg

Mean temp of condensate = 35°C

Condensate collected = 2000 kg/hr

Quantity of cooling water circulated = 60000 kg/hr.

Rise in temp of cooling water = 16°C

Hot well temp = 28°C

Determine :

(i) Vacuum efficiency

(ii) Condenser efficiency

(iii) Quality of steam entering the condenser and

(iv) Mass of air present per m^3 of condenser volume

Assume inlet temperature of water 20°C.

(d) A vacuume 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 vacuum efficiency.

Unit-V

5. (a) Define mach number.

(b) A stream 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.

(c) What is stagnation state? What do you mean by stagnation properties?

(d) Static gas at 10 bar 800 k flows in a duct under reversible adiabatic conditions. Determine the static temperature, velocity and mach number at points where the pressure are 5 bar and 1 bar respectively. Cp = 1·05 kJ/kgK and y = 1·4.