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B037411(037)

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

(Mechanical Engg. Branch)

APPLIED THERMODYNAMICS

Time Allowed : Three hours

Maximum Marks : 100

Minimum Pass Marks : 35

Note : *Attempt all questions. Part (a) from each question is compulsory. Attempt any two parts from part (b), (c) and (d) of each question. Steam table and mollier chart in permitted.*

Unit-I

1. (a) Define compression ratio. How does it affect the air standard efficiency of an Otto cycle? 4

(b) A diesel cycle engine takes in air at pressure 1 bar and temperature 30°C. The pressure at the end of compression is 30 bar and the cut-off is 6% of the stroke. 8

Calculate :

(i) the compression ratio

(ii) the percentage clearance

(iii) the heat supplied

(iv) the thermal efficiency

(v) the mean effective pressure

(c) An air standard limited pressure cycle gas a compression ratio of 15 and compression login at 0.1 MPa, 40°C. The maximum pressure is limited to 6 MPa and the heat added is 1.675 MJ/kg. 8

Compute :

(i) the heat supplied at constant volume per kg of air

(ii) the heat supplied at constant pressure per kg of air

(iii) the cycle efficiency

(iv) the m.e.p. of the cycle

(d) Deduce an expression for the air standard efficiency of an engine working on dual combustion cycle in terms of compression ratio, cut-off ratio, pressure ratio and adiabatic index. 8

Unit-II

2. (a) Define the term isothermal efficiency and volumetric efficiency in relation to reciprocating air compressor. 4

(b) Prove that the minimum work required per cycle with perfect intercooling is given by : 8

$$W = \frac{xG}{n-1} P_1 V_1 \left[\left(\frac{P_{x+1}}{P_1} \right)^{\frac{n-1}{x^n}} - 1 \right]$$

(c) A two stage single acting air compressor draws in air at 1 bar and 17°C and compresses it to a pressure of 60 bar. After compression in the L.P. cylinder, the air is cooled at constant pressure of 8 bar to a temperature of 37°C. The low pressure cylinder has

a diameter of 150 mm and both the cylinders having 200 mm stroke. If the law of compression is $pv^{1.35} = C$. Find the power of the compressor, when it runs at 200 rpm.

Take R = 287 J/kg K. 8

(d) The following data refer to the performance test of single acting reciprocating compressor with bore = 0·15 cm and stroke 12 cm.

Suction pressure and temperature = 1 bar and 20°C

Discharge pressure and temperature = 6 bar and 177 °C

Speed of the machine = 800 rev/min

Mass of air delivered = 1.6 kg/min

Make calculation for the volumetric efficiency and indicated power. 8

Unit-III

3. (a) Give reasons why the cannot cycle cannot be considered as the theoretical cycle for steam power plant. 4

(b) What is a Rankine cycle? Draw it on p-v and T-S diagram and describe its different processes.

What are the properties of working fluid for Rankine cycle? 8

(c) What do you understand by ideal regenerative cycle? why is it not possible in practice? Also explain actual regenerative cycle. 8

(d) A steam power plant uses steam as working fluid and operated at a boiler pressure of 5 MPa, dry saturated and a condenser pressure of 5 kPa. Determine the cycle efficiency for 8

(i) Carnot cycle

(ii) Rankine cycle

Also show the T-S representation for both cycles.

Unit-IV

4. (a) Define function of steam condenser. State the advantage of using a condenser in a steam power plant. 4

(b) Explain the working principle of : 8

(i) Natural draught cooling tower

(ii) Forced draught cooling tower

(c) State the difference between Jet and surface condensers. 8

(d) State the source of air leakage into the condenser and its effect on performance of condenser. 8

Unit-V

5. (a) Differentiate between the compressible and incompressible flow. 4

(b) Derive the following relation for one dimensional compressible flow through ducts of varying area. 8

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

(c) A stream of air flow 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. 8

(d) Explain the effect of area change in subsonic and supersonic flows. 8