CSM : 14

MECHANICAL ENGINEERING
PAPER - II

Time Allowed : 3 hours | Full Marks : 100

Marks for each question is indicated against it.

Attempt any 5 (five) questions taking not more than 3 (three) questions from each Part.

PART A

1. (a) Explain the first law of thermodynamics as referred to closed systems undergoing a process. What is perpetual motion machine of first kind (PMM-I)? Is it possible? Justify your answer. **(4+3+1+2=10)**

(b) A cylinder contains $1m^3$ of gas at 100kPa and 100ºC. The gas is compressed to a volume of $0.3m^3$ polytropically. The final pressure of the gas is 600kPa. Find (i) the mass of the gas, (ii) the work transfer, (iii) the heat transfer and (iv) the change in internal energy. **(2+2+3+3=10)**

2. (a) Clsssify and explain diffferent fluids on the basis of viscosity. Illustrate with related graphs. **(3+3=6)**

(b) Derive the steady flow energy equation for steady incompressible flow. Also write its practical application. **(3+3=6)**

(c) Write the definition and mathematical expression of (i) Mach number and (ii) surface tension. **(4+4=8)**

3. (a) Air enters at 1 bar and 15ºC into the compressor of a constant pressure open cycle gas turbine plant and leaves the compressor at 6 bar. Using the following data:

Temperature of gases entering the turbine = 700ºC

Pressure loss in the combustion chamber = 0.1 bar

Isentropic efficiency of compressor = 80%

Efficiency of combustion = 90%

Take g = 1.4, C_p = 1kJ/kgK for air and gases

Find

(i) The quality of air circulated in the system if the plant develops 940kW.

(ii) Heat supplied per kg of air circulation.

(iii) The thermal efficiency of the cycle.

Neglect the mass of fuel **(4+4+4=12)**

(b) A single stage single acting compressor delivers $15m^3$ of free air per minute from 1 bar to 8 bar. The speed of the compressor is 300rpm. Assuming that the compression and expansion follow the law $pv^{1.3 = constant}$ and clearance is $1/16^{th}$ of swept volume, find the diameter and stroke of the compressor. Take L/D = 1.5. The temperature and pressure of air at the suction are same as atmospheric air. **(4+4=8)**

4. (a) Explain briefly the mechanism of convective heat transfer. **(10)**

(b) A radiation shield having same emissivity on both sides is placed between two parallel plates. One of the parallel plates having the emissivity 0.8 and that of the other plate is 0.5. Calculate the emissivity of the shield in order to reduce the radiation losses from the system to one-tenth of that of without shield. **(10)**

PART B

5. (a) What is knocking in SI engine? Explain the phenomenon of knock in SI engine. What are its effects? **(2+6+2=10)**

(b) Explain the various stages of combustion in a diesel engine. **(10)**

6. (a) What are the different forms of steam nozzle? Explain why nozzles are made convergent-divergent. **(6+4=10)**

(b) Derive the expression for the velocity and flow through the nozzle in terms of initial pressure, initial specific volume, area of cross-section, final pressure and index *n* of friction adiabatic expansion. **(10)**

7. A Pelton wheel works under a net head of 310m at a speed of 560rpm developing 5890kW. The overall efficiency of the turbine is 80%. The ratio of jet diameter to the mean bucket circle diameter is 1/10. Find: (i) the number of jets, (ii) the diameter of each jet, (iii) the diameter of the turbine and (iv) the quantity of water supplied to the turbine. Take $C_v = 0.97$ and bucket speed = 0.47 × jet speed. **(5+5+5+5=20)**

8. (a) Explain in brief different ways of producing refrigeration. **(5)**

(b) Explain with suitable sketch the working of absorption refrigeration system and vapour compression system. **(10)**

(c) What is refrigerant? Give the name of some important refrigerants stating their properties. **(2+3=5)**

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