

Thermodynamics

S.E. : Sem. III [MECH/AUTO]

Time : 3 Hrs.]

Mumbai University Examination Paper : Dec. '18

[Marks : 80

- N.B.:** (1) Question No. 1 is compulsory.
(2) Attempt any THREE questions from question number 2 to 6.
(3) Assume suitable data if required and state it clearly.
(4) Use of Steam Table and Mollier chart is permitted.

1. Solve the following (any Four) [20]
- (a) State first law of thermodynamics for closed system. State its limitations.
 - (b) Explain heat engine, heat pump and refrigerator with the help of neat sketch.
 - (c) Explain free air delivered and volumetric efficiency. Write their equations also.
 - (d) Define: available energy, dead state and irreversibility.
 - (e) Explain working of Otto cycle with the help of PV and TS diagram. Write the equation for efficiency of the cycle.
 - (f) Define types of steam and represent it on p-v diagram for water.
2. (a) 3 kg of air at a pressure of 150 kPa and temperature 360 K is compressed polytropically to 750 kPa according to law $PV^{1.25} = C$. The gas is then cooled to initial temperature at constant pressure. The air is then expanded at constant temperature till it reaches original pressure of 150 kPa. Draw the cycle on p-V diagram and determine net work and heat transfer. [12]
- (b) Prove that energy is property of the system. [8]
3. (a) In a steady flow device, the inlet and outlet conditions are given below. Determine the heat loss or gain by the system in kW. Fluid flow rate through the device is 2.1 kg/s and work output of the device is 750 kW. [8]
- | Property | Inlet | Outlet |
|---------------------------|-------|--------|
| Pressure (bar) | 10 | 8.93 |
| Specific enthalpy (kJ/kg) | 2827 | 2341 |
| Velocity (m/s) | 20 | 120 |
| Elevation (m) | 3.2 | 0.5 |
- (b) Explain Kelvin-Planck & Clausius statement with the help of sketch. [6]
- (c) A heat engine receives 1000 kW of heat at constant temperature of 280°C. The heat is rejected at 5°C. The possible heats rejected are 840 kW, 492 kW and 300 kW. Classify the cycle into reversible, irreversible and impossible using Clausius Inequality theorem. [6]
4. (a) Define Critical Point and Triple point. Draw p-T diagram for water and show these points on it. [6]
- (b) Write four Maxwell relations. [4]
- (c) A house is maintained at a temperature of 20°C by means of a heat pump in winter by pumping heat from the atmosphere. Heat losses through the walls of the house are estimated at 0.65 kJ/K temperature different between inside of the house and outside atmosphere. [10]

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