

**Con. 3032-10.****AN-2432**

(3 Hours)

[ Total Marks : 100

**N.B.** (1) Question No. 1 is **compulsory**.(2) Attempt any **four** questions out of the remaining **six** questions.(3) Use of steam table, gas table and Mollier chart are **permitted**.(4) Assume **suitable** data if **required**.

1. (a) Explain intensive and extensive properties with examples. 4
- (b) Give reasons why the Carnot cycle can not be considered as the practical power plant cycle even-though it's efficiency is maximum. 4
- (c) An inventor claims that a new heat cycle will develop 400 W for a heat supply of 35.5 kJ/min. Is his claim possible? Given that source is at 200 K and sink is at 850 K. 4
- (d) 2 kg of steam is at 8 bar and 0.8 dry. Determine it's enthalpy and volume. 4
- (e) What is Cut-off ratio? How does it affect the thermal efficiency of Diesel cycle? 4
2. (a) Air at a temperature of 20 °C passes through a heat exchanger at a velocity of 40 m/s where it's temperature is raised to 820 °C. It then enters a turbine with same velocity of 40 m/s and expands till the temperature falls to 620 °C. On leaving the turbine, the air is taken at a velocity of 55 m/s to a nozzle where it expands until the temperature has fallen to 510 °C. If the air flow rate is 2.5 kg/s, calculate : 10
  - (i) rate of heat transfer to the air in the heat exchanger.
  - (ii) the power output from the turbine assuming no heat loss.
  - (iii) the velocity at exit from the nozzle, assuming no heat loss.
- (b) Define : 6
  - (i) Availability
  - (ii) Dead state
  - (iii) Irreversibility
  - (iv) Effectiveness.
- (c) For the same compression ratio and heat supplied compare Otto, Diesel and Dual cycle with the help of P-V and T-S diagram. 4
3. (a) State and prove Carnot theorem. 7
- (b) A Rankine cycle operates between the pressure 15 bar and 0.01 bar. The initial degree of superheat is 100 °C. Assuming isentropic efficiency of expansion 85%, calculate : 9
  - (i) Pump work
  - (ii) Actual turbine work
  - (iii) Thermal efficiency.
- (c) What is Joule-Thompson coefficient? What conclusions can be drawn from a given values of this coefficient? 4

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4. (a) A reversible power cycle is used to drive a reversible heat pump cycle. The power cycle takes in  $Q_1$  heat units at temperature  $T_1$  and rejects  $Q_2$  heat units at temperature  $T_2$ . The heat pump abstracts  $Q_4$  heat units from the sink at  $T_4$  and discharges  $Q_3$  heat units at temperature  $T_3$ . Develop an expression for the ratio  $\frac{Q_4}{Q_1}$  in terms of four temperatures. 8
- (b) A fluid flows under steady state through a C-D nozzle, prove that :— 8
- $$\frac{dA}{A} = \frac{dV}{V} (M^2 - 1)$$
- (c) Define : 4
- |                       |                               |
|-----------------------|-------------------------------|
| (i) Wet steam         | (iii) Subcooled liquid        |
| (ii) Quality of steam | (iv) Tripplle point of water. |
5. (a) Air at 20 °C and 1.05 bar occupies 0.025 m<sup>3</sup>. The air is heated at constant volume untill the pressure is 4.5 bar and then cooled at constant pressure back to original temperature. Sketch the processes on T-S and P-V diagram and calculate : 7
- (i) The heat flow from air
  - (ii) The net entropy change.
- (b) A rigid cylinder of voume 0.028 m<sup>3</sup> contains steam at 80 bar and 350 °C. The cylinder is cooled until the pressure is 50 bar. Calculate : 8
- (i) The state of steam after cooling.
  - (ii) The amount of heat rejected by the steam.
- (c) Discuss the effect of variation of back pressure on C-D nozzle performance. 5
6. (a) In an engine working on Dual cycle, the temperaure and pressure at the beginning of the cycle are 90 °C and 1 bar respectively. The compression ratio is 9. The maximum pressure is limited to 68 bar and total heat supplied per kg of air is 1750 KJ. 10
- Determne :
- (i) Pressure and temperature at all salient points.
  - (ii) Air standard efficiency
  - (iii) Work done per cycle.
- (b) A normal shock wave is standing in a C-D nozzle where Mach number is 2. If the pressure and density before shock are 26.5 KN/m<sup>2</sup> and 0.413 kg/m<sup>3</sup> respectively, determine : 10
- (i) Pressure, temperature and density after shock.
  - (ii) Velocity before and after shock
  - (iii) Stagnation pressure before and after shock.
  - (iv) Strength of shock.
7. Write short notes on any **four** of the following :— 20
- (a) Absolute thermodynamic temperature scale
  - (b) Principle of increase of entropy
  - (c) Rayleigh and Fanno flow
  - (d) Calusius Inequality
  - (e) Brayton cycle.