SE(ME) III (old) ✓

—TDY—

26/11/2014

(OLD COURSE) **QP Code :12231**

NOTE: **(3 Hours)** **[Total Marks : 100**

- Question No 1 is **COMPULSORY**.
- Attempt any **FOUR** questions out of remaining **SIX** questions.
- Assume suitable data wherever required.
- Illustrate answers with sketches wherever required.
- Use of steam table, Gas table and Mollier chart is permitted.

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1. Solve the following **(any FIVE)** **20**
   (a) State the statements of second law of thermodynamics. What are limitations of first law of thermodynamics?
   (b) Differentiate between Intensive and extensive properties with example.
   (c) Define Dryness fraction, Degree of superheat, critical point, triple point and subcooled liquid.
   (d) Explain Brayton cycle with help of P-V and T-S diagram.
   (e) What is Joule-Thomson coefficient? State its significance.
   (f) Explain Mach No, stagnation properties and critical properties.

2. (a) Define availability. Derive an expression for availability of closed system. **08**
   (b) A certain mass of air initially at pressure of 480 kPa and at a temperature of 190 °C is expanded adiabatically to a pressure of 94 kPa. It is then heated at constant volume until it attains its initial temperature when the pressure is found to be 150 kPa. State the type of compression necessary to bring the system back to its original pressure and volume and determine: (i) index of adiabatic expansion (ii) work done per kg of air. Take R = 0.29 kJ/kg.K **12**

3. (a) Explain Closed, Open and Isolated system. **08**
   (b) A reversible heat engine operates between two reservoirs at 600 °C and 40 °C. The engine drives a reversible refrigerator which operates between the same 40 °C reservoir and a reservoir at – 18 °C. The heat transfer to the heat engine is 2100 kJ and there is a net work output of 370 kJ from the combined plant. Calculate heat transfer to the refrigerator and net heat transfer to the 40 °C reservoir. **12**

4. (a) Helium gas is expanded polytropically in a turbine from 4 bar, 300 °C to 1 bar such that the final volume is 2.5 times the initial volume. The velocity of the gas at the exit is 50 m/s. Calculate (i) mass flow rate of gas required to produce 1 MW turbine output. (ii) Heat transfer during the process (iii) Exit area of the turbine. Assume Cp for helium = 5.193 kJ/kg & R = 2.0785 kJ/kgK **12**
   (b) A heat engine is supplied with 278 kJ/s of heat at a constant fixed temperature of 283 °C and the heat rejection takes place at 5 °C. The following results were reported (i) 208 kJ/s is rejected (ii) 139 kJ/s is rejected (iii) 70 kJ/s is rejected. Classify which of the results report a reversible cycle or irreversible cycle or impossible results. **08**

5. (a) Explain Rankine cycle. Derive the expression for thermal efficiency of the cycle. **08**
   (b) In an air standard dual cycle, the pressure and temperature at the beginning of compression are 1 bar and 57 °C respectively. The heat supplied in cycle is 1250 kJ/kg. Two third of this heat being added at constant volume and rest at constant pressure. If compression ratio is 16. Determine the maximum pressure, temperature in the cycle, thermal efficiency and mean effective pressure. **12**

6. (a) 2 kg of steam at a pressure of 20 bar exist in following conditions: (i) Wet Steam with x = 0.9 (ii) Dry & saturated steam. (iii) Superheated steam with temp of 250 °C. Calculate: Total Enthalpy, Volume, Entropy & Internal Energy. Take $Cp_{superheated\ steam}$ = 2.302 kJ/kgK. **12**
   (b) For the same compression ratio and heat input, compare Otto, Diesel and Dual cycle with help of P-V and T-S diagram. **08**

7. (a) Air enters a converging diverging nozzle at 1 MPa and 800 K with a negligible velocity. The flow is steady, one dimensional and isentropic with $\gamma = 1.4$. For an exit Mach number of 2 and a throat area of 20 cm^2, determine (i) throat conditions (ii) exit plane conditions including exit area and (iii) mass flow rate through the nozzle. **10**
   (b) Derive the relation $\frac{dA}{A} = \frac{dV}{V}[M^2 - 1]$ for the isentropic flow of a fluid through C-D nozzle **10**