Con. 6491–13. **LJ–10277**

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

N.B. 1) Question No. 1 is compulsory.

2) Attempt any four questions out of reaming six questions.

3) Assume suitable data, if required.

4) Use of steam table, moillier diagram are permitted.

Q. 1. Answer any five of the following:- **20**

a) Differentiate between point function and path function

b) Show that internal energy is property of system

c) What are assumptions of air standard cycle?

d) State the zeroth law of thermodynamics. What is its significance?

e) What do you mean by Available and Unavailable energy?

f) Difference between heat engine, refrigerator, heat pump

g) What are the limitations of first law of thermodynamics?

Q.2. a) Develop the following expression for the heat transfer from a mass of gas undergoing reversible expansion process obeying the polytrophic law $PV^n = C$

$$Q_{1-2} = \frac{\gamma - \eta}{\gamma - 1} \text{ X Polytropic work done}$$ **6**

b) What is Joule –Thomson coefficient? Explain inversion point and inversion curve. **4**

c) A quantity of gas occupies a volume of 0.28 m^3 at a pressure of 1.03 bar and temperature of 21°C.The gas is compressed isothermally to a pressure of 5.15 bar and than expanded adiabatically to its initial volume. Determine for this quantity of gas. a) Heat received or rejected during compression in KJ. b) Change of internal energy of gas during expansion in KJ. c) The mass of gas in kg.Take C_P= 0.921 KJ/kg-K C_V = 0.5678 KJ/kg-K . Draw P-V diagram. **10**

Q.3. a) State the second law of thermodynamics, and establish the equivalence between them. 10

c) A reversible heat engine operates between two reservoirs at temperatures of 875 K and 310 K the engine drives the reversible refrigerator which operates between the reservoirs at temperature of 310 K and 255 K. The heat transfer to the engine is 2000 KJ and the net work output of the combined engine and refrigerator plant is 350 KJ. Make calculation for cooling effect. **10**

Q.4. a) Derive the Steady flow energy equation. Apply it to compressor. **8**

b) In a steady flow process, the fluid flows through a machine at the rate of 15 kg/min. Between the entrance and exit of machine, the inlet velocity 5 m/s, pressure 100 KPa and specific volume 0.45 m^3/kg and outlet velocity 8 m/s, 700 KPa pressure , 0.125m^3/kg .The working fluid leaves the machine with internal energy 160 kJ/kg greater than that at entrance and during the process 7200 kJ/min of heat is lost to the surrounding . Assuming entrance and exit pipe to be at same level, calculate the shaft work and the ratio of inlet and outlet pipe diameter. **12**

Q.5. a) Define a) Wet steam b) Superheated steam c) Dryness fraction d) Saturation temperature. **8**

b) In a thermal power plant operating on an ideal Rankin cycle, superheated steam produced at 1.5 MPa and 300°C is feed to a turbine where it expands to the condenser pressure of 80 KPa. The saturated liquid coming out of the condenser is pumped back to the boiler by a feed pump. Assuming ideal Processes, determine a) The condition of steam after isentropic expansion, b) Rankine cycle efficiency, c) The mean effective pressure, d) The ideal steam consumption per kW hour e) The actual steam consumption per kW hour. Take relative efficiency = 60% and neglect pump work. **12**

Q 6. a) Derive an expression for the air standard efficiency and mean effective pressure of an Otto cycle. **10**

b) In an air standard diesel cycle air a 0.1 MPa and 300 K is compressed adiabatically until the pressure rise to 5 MPa . If 700 kJ/kg of energy in the form of heat is supplied at constant pressure, determine the compression ratio, cut off ratio,thermal efficiency and Mean effective pressure. **10**

Q.7. a) Define 1) Mach No., 2) Stagnation temperature ,3) Stagnation Pressure 4) Sonic flow. Explain the effect of variation in back pressure on C-D nozzle performance. **10**

b) A supersonic nozzle is to be designed for air flow with Mach number 3 at the exit section which is 250 mm in diameter. The pressure and temperature of air at the nozzle exit are 8.5 kN/m^2 and 215 K. Make calculation for a) reservoir pressure and temperature b) throat area. **10**