Duration: 3hrs **[Max Marks: 80]**

N.B.: (1) Question No 1 is Compulsory.
(2) Attempt any three questions out of the remaining five.
(3) All questions carry equal marks.
(4) Assume suitable data, if required and state it clearly.
(5) Use of steam table and Mollier Diagram is permitted.

1 Solve **any four** **20**

a State the second law of thermodynamics with the block diagram.

b Classify types of systems with the suitable example.

c Define the following,

(i) Dryness fraction (ii) Latent heat of vaporization

(iii) Critical point (iv) Triple point

d Draw P-V and T-S diagram of Diesel and Dual cycle.

e Define the following,

(i) Sonic Velocity (ii) Stagnation temperature

(iii) Stagnation Pressure (iv) Mach number

2 a Steam is supplied to a fully loaded 1100 kW turbine at 15 bar with an internal energy of 2395 kJ/kg, specific volume of 0.16 m^3/kg and velocity of 1100 m/s. Exhaust takes place at 0.05 bar with internal energy of 1885 kJ/kg, specific volume of 0.26 m^3/kg and velocity of 300 m/sec. Heat loss from the steam turbine is 21 kJ/kg. Potential energy change is negligible. Determine: **10**

(i) Shaft work output per kg, and

(ii) Steam flow rate in kg/hr.

b Derive the Steady Flow Energy Equation (SFEE) and apply it to Turbine and Nozzle. **10**

3 a Three Carnot heat engines are connected in series. The first engine receives 4000 kJ of heat from a source of at 2000 K and delivers 1800 kJ of work, the second and third engine delivers 1200 kJ and 500 kJ of work respectively. Determine the exhaust temperature of second and third Carnot engines. **10**

	b	Describe the Phase conversion of water with the help of Temperature vs Enthalpy (T-h) curve. State the Maxwell's relation.	5
	c	Explain the Rankine Reheat cycle with the help of T-S diagram.	5
4	a	Derive the Clausius Inequality.	**8**
	b	Explain various components of a simple steam power plant with sketch	**6**
	c	A certain gas occupies a space of 0.3 m^3 at a pressure of 2 bar and temperature of $77°C$. It is heated at a constant volume, until the pressure is 7 bar. Determine change in internal energy and enthalpy. Take C_p = 1.005 kJ/kgK, C_v = 0.716 kJ/kgK, and R = 0.287 kJ/kgK.	**6**
5	a	Derive the expression of efficiency of Otto cycle and state the assumptions.	**10**
	b	In an air standard diesel cycle with the compression ratio of 14, the condition of air at the start of compression stroke are 1 bar and 300 K. The temperature rises to 2775 K at the end of heat addition process. Determine the thermal efficiency of the cycle and net work done per kg of air.	**10**
6	a	Derive an expression for the area velocity relationship for a compressible fluid flow in the form $\frac{dA}{A} = -\frac{dV}{V}(1-M)^2$	**10**
	b	A steam turbine working on a Rankine cycle is supplied with dry saturated steam at 20 bar and exhaust pressure is 0.3 bar. Determine the work done and Rankine efficiency.	**10**