Answer All Questions

PART-A (5 x 2 = 10 marks)

i. State zeroth law of thermodynamics.
ii. Write first law of thermodynamics for a closed system undergoing a process.
iii. Emphasize the significance of the term entropy in thermodynamics.
iv. List the assumptions made in analysis of air standard cycle.
v. Record the advantages of vapour compression refrigeration in comparison with gas refrigeration.

PART-B (5 x 8 = 40 marks)

1. (a) With suitable diagram, explain the process of energy conversion in nuclear power plants. (4)
   (b) Determine the absolute pressure exerted on an object submerged 1000 m below the surface of the sea. The density of the sea water is 1020 kg/m³ and the acceleration due to gravity is 9.7 m/s². The local atmospheric pressure is 0.98 bar. (4)
   (OR)

2. (a) Explain the phase diagram of water - steam, in P-v, coordinates. (4)
   (b) Find the enthalpy and entropy of steam when the pressure is 2 MPa and the specific volume is 0.09 m³/kg. (4)

3. (a) Derive an expression for work done during a polytropic process with polytropic index ‘n’. (4)
   (b) Two kg of a gas at 17°C is heated to a temperature of 89°C. The specific heats at constant pressure and constant volume are 1.002kJ/kgK and 0.716 kJ/kgK respectively. Find the heat absorbed by the gas for each of the two methods of heating.
      (a) Constant Pressure Heating
      (b) Constant Volume Heating (4)
   (OR)

4. (a) Obtain an expression for general form of Steady Flow Energy Equation (SFEE). (4)
   (b) A blower handles 1 kg/s of air at 20°C and consumes a power of 15 kW. The inlet and outlet velocities of air are 100 m/s and 150 m/s respectively. Find the exit air temperature, assuming adiabatic conditions. Take c_p of air as 1.005 kJ/kgK. (4)

5. (a) Derive the expression for efficiency of a Carnot heat engine. (4)
   (b) A reversible power cycle produces 40 kW of power while rejecting 1000 kJ/min of energy to a cold reservoir which is at 200 K. Determine the temperature of the reservoir which supplies heat to this power cycle. (4)
   (OR)

6. (a) State and prove the equivalence of two statements of second law of thermodynamics. (4)
   (b) Calculate the entropy change of the universe, when a copper block at 600 g mass and with Cp of 150 J/K at 100°C is placed in a lake at 8°C. (4)
7. (a) Show the diesel cycle on a $Pv$ and $Ts$ coordinates and explain various processes involved. (4)  
(b) An engine equipped with a cylinder having a bore 15 cm and a stroke of 45 cm operates on an Otto cycle. If the clearance volume is 2000 cm$^3$, compute the air standard efficiency. (4)  

(OR)

8. (a) Show the Brayton cycle on a $Pv$ and $Ts$ coordinates and explain various processes involved. (4)  
(b) A gas turbine plant operates on the Brayton cycle between the temperature 27$^\circ$C and 800$^\circ$C. Find the pressure ratio at which the cycle efficiency approaches the Carnot efficiency. (4)

9. (a) With the help block diagram and P-h diagram, explain the principles of vapour compression refrigeration system. (4)  
(b) With the help of T-s and h-s diagram, explain the reversed Carnot cycle with a phase changing working fluid. (4)  

(OR)

10. (a) With suitable diagram explain vapour absorption refrigeration system. (4)  
(b) Write notes on liquefaction and solidification. (4)

PART-C (1 x 10 = 10 marks)

11. At the inlet to a nozzle, the enthalpy of fluid passing is 3000 kJ/kg and the velocity is 60 m/s. At the discharge end, the enthalpy is 2762 kJ/kg. The nozzle is horizontal and there is a negligible heat loss from it. (a) Find the velocity at exit from the nozzle (b) If the inlet area is 0.1 m$^2$ and the specific volume at inlet is 0.187 m$^3$/kg, find the exit mass flow rate (c) If the specific volume at the nozzle exit is 0.498 m$^3$/kg, find the exit area of the nozzle. (10)  

(OR)

12. Two reversible heat engines, A and B are arranged in series. A rejecting heat directly to B. Engine A receives 200 kJ at a temperature of 421$^\circ$C from a hot source, while engine B is in communication with a cold sink at a temperature of 4.4$^\circ$C. If the work output of A is twice that of B, find (a) the intermediate temperature between A and B (b) the efficiency of each engine (c) the heat rejected to the cold sink. (10)