(03 Hours)   Total Marks: 80

N.B.: 1. Question No. **1** is **compulsory**.

      2. Attempt **any three** questions out of remaining **five** questions.

      3. Assume suitable data wherever required.

      4. Assumptions made should be stated clearly.

Q.1   **a)** Explain path function and point function.   05

      b) State and explain second law of thermodynamics.   05

      c) Explain modified Rankine cycle.   05

      d) Derive expression for air standard efficiency of Brayton cycle.   05

Q.2   **a)** 3 kg of air is kept at an absolute pressure of 100 kPa and temperature of 300 K is compressed polytropically until the pressure and temperature become 1500 kPa and 500K respectively. Evaluate the polytropic exponent, the final volume, the work of compression and the heat interaction.   10

      b) Air at 1 bar pressure, 290 K temperature flows steadily at the rate of 120 m³/hr into a compressor where its pressure and temperature are respectively raised to 15 bar and 390 K . During the compression process, the heat transfer from the compressor is 10 percent of work transfer. Neglecting changes in kinetic energy and potential energy, evaluate the work and heat interactions. Presume that air behaves as a perfect gas.   10

Q.3   **a)** State the first law of thermodynamics applied to closed system undergoing i) cycle and ii) process. Also prove internal energy is property of system.   10

      b) Three real heat engines have the same thermal efficiency and are connected in series. The first engine absorbs 2400kJ of heat from a thermal reservoir at 1250 K and the third engine rejects its waste of 300 kJ to a sink at 150 K. Determine the work output from each engine.   10

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Q.4 **a)** i) Define COP of heat pump and refrigerator and derive the relationship between the two.

ii) Define availability, dead state and irreversibility. 10

b) i) Write and explain the steady flow energy equation, also apply it to boiler and nozzle.

ii) State and explain principle of increase of entropy. 10

Q.5 **a)** i) Write short note on Mollier chart.

ii) What is cut-off ratio? How does it affect the efficiency of Diesel cycle? 10

b) In a certain heat exchanger, 50 kg of water is heated per minute from 50°C to110°C by hot gases which enter heat exchanger at 250°C. If the flow rate of gases is 100 kg/min, estimate the net change of entropy. Cp (water) = 4.186 kJ/kgK, Cp (gas) =1 kJ/kgK.

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Q.6 **a)** i) Explain reheat Rankine cycle.

ii) Explain sensible heat of water, latent heat of steam and dryness fraction. 10

b) In a diesel cycle, air at 0.1MPa and 300K is compressed adiabatically until the pressure rises 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.

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