

- N. B. :**
- (1) Question No. 1 is compulsory
 - (2) Solve any **three** questions from remaining **five** questions
 - (3) Assume suitable data
 - (4) Use of Mollier Chart and Steam Table is permitted

Q1) Answer any **Four** of the following :

- a) Prove that Energy is a property of the system.
- b) What is cut-off ratio. Discuss its effect on the thermal efficiency of diesel engine.
- c) Define Joule- Thompson coefficient and Explain its significance.
- d) State and Explain Maxwell Equations.
- e) Define COP for refrigerator and heat pump. Derive relation between them.

[20]

Q2) a) State and derive Steady flow energy equation and apply it to a boiler, condenser.

[08]

b) Steam flows into a turbine, at a flow rate of 5000 kg/hr. The turbine develops a power of 550KW. The heat loss from the casing of the turbine and bearings is negligible.

- (i) Find the change in enthalpy across the turbine, if the inlet velocity is negligible and exit velocity is 360 m/s and the change in potential energy is negligible.
- (ii) Find the change in enthalpy across the turbine, if the velocity at entry is 66m/s and inlet pipe is 3m above the exit pipe

[12]

Q3) a) State and prove Carnot theorem.

[08]

b) A reversible heat engine operates with two environments. In the first, it draws 12000 kW from a source at 400°C and in the second, it draws 25000 kW from a source at 100°C. In both the operations, the engine rejects heat to a thermal sink at 20°C. Determine the operation in which the engine delivers more power

[12]

Q4) a) Derive an expression for efficiency of Dual cycle.

[08]

b) In an air standard Diesel cycle, the conditions at the beginning of the compression stroke are 300K and 1 bar. The air is compressed to a pressure of 50 bar and then fuel is injected such that 20kJ of energy is added per mole of air. Determine the compression ratio, the cut-off ratio and thermal efficiency of the cycle, if c_p of air is 3.5 times the gas constant R.

[12]

Q5) a) Explain equivalency of Kelvin-Planck and Clausius Statement

[08]

b) 1.5 kg of gas flows through gas turbine unit from its initial pressure and temperature 600 kN/m² and 1300 K respectively and exhausts at a pressure of 102 kN/m² and a temperature of 600 K to the atmosphere. The atmospheric pressure and temperature are 100 kN/m² and 298K. Calculate availability at the entrance to the gas turbine and exhaust of the gas turbine.

[12]

Q6) a) Explain

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|-------------------------------|-----------------------------|
| (i) Dry Saturated Steam | (ii) Sensible heat of water |
| (iii) Total Enthalpy of Steam | (iv) Dryness Fraction |

[08]

b) In a Rankine cycle, the maximum pressure of steam supplied is 6 bar. The dryness fraction is 0.9. The exhaust pressure is 0.7 bar. Find the theoretical work done and Rankine efficiency.

[12]