10. a) An engine working on Otto cycle has temperature and pressure, at the beginning of isentropic compression at 25°C and 1.5 bar. Find the compression ratio if Y = 1.4 and thermal efficiency of the engine = 48%. Also find temperature and pressure at the end of compression.

b) Show that the efficiency of Otto cycle is a function of compression ratio only.

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Roll No .....

AU/IP/IEM/ME - 304

B.E. III Semester

Examination, December 2013

Thermodynamics

Time : Three Hours

Maximum Marks : 70

Note: Solve five questions.

1. a) Define the steady flow process. Explain steady flow energy equation.

b) In a gas turbine, the gas enters at the rate of 5kg/sec with a velocity of 50m/s and enthalpy of 900kJ/kg and leaves the turbine with a velocity of 150m/s and enthalpy of 400 kJ/kg. The loss of heat from the gases to the surroundings is 25 kJ/kg. Assume for gas R = 0.285 kJ/kg K and C_p = 1.004 kJ/kg K and the inlet conditions to be at 100 kPa and 27°C. Determine the power output of the turbine and diameter of inlet pipe.

OR

2. a) What is thermodynamic equilibrium? Explain mechanical, chemical and thermal equilibrium.

b) A perfect gas flows through a nozzle where it expends in a reversible adiabatic manner. The inlet conditions are 20 bar, 500°C, 38m/sec. At exit, the pressure is 2 bar. Determine the exit velocity and exit area if the flow rate is 5Kg/s. Take R = 190 J/Kg K and Y = 1.35.

3. a) Prove that the efficiency of reversible engine is maximum.

   b) State the Kelvin-Planck and clausius statements of the second law of thermodynamics and establish the equivalence between them.

OR

4. a) What is a heat pump? How does it differ from a refrigeration? Explain

   b) An inventor claims to have developed an engine that takes in 105MJ at a temperature of 400K and rejects 42MJ at a temperature of 200K and delivers 15 kWh of mechanical work. Would you advise money to put this engine in the market?

5. a) Develop expressions for isothermal changes in internal energy, enthalpy and entropy for a gas obeying van der Waal's equation of state.

   b) One kg of CO_2 has a volume of $1m^3$ at 100°C compute the pressure by

      i) Van der Waal's equation.

      ii) Perfect gas equation.

      The values of *a* and *b* of CO_2 are as given:

      $a = 362850\ Nm^4/(Kg\ mol.)^2$

      $b = 0.0423\ m^3/Kg\ mol.$

      $R_o = 8314\ Nm/Kg\ mol\ k$

OR

6. a) What do you understand by compressibility factor?

   b) Write down the first and second T.dS equations and derive the expression for the difference in heat capacities C_p and C_v. What does the expression signify?

7. a) Explain formation of steam with help of Temperature-Heat Graph.

   b) In a laboratory experiment, the following observations were recorded to find the dryness fraction of steam by combined separating and throttling calorimeter. Total quantity of steam passed = 36kg.

      Water drained from separator = 1.8kg

      Steam pressure before throttling = 12 bar

      Temperature of steam after throttling = 110°C

      Pressure of steam after throttling = 1.013 bar

      Specific heat of steam = 2.1 kJ/kg K

      Determine the dryness fraction of steam before inlet to the calorimeter.

OR

8. a) What is the main feature of triple point? State the values of pressure and temperature at the triple point of water.

   b) Draw a phase equilibrium diagram for a pure substance on H-S plot with relevant constant property lines.

9. a) Derive an expression for the efficiency of the carnot engine.

   b) For a given compression ratio; the air standard Diesel cycle is less efficient than air standard Otto cycle explain.

OR