Final Assessment Test – April 2019

VIT
Vellore Institute of Technology

Course: MEE1003 - Engineering Thermodynamics

Class NBR(s): 1357 / 2096 / 2099 / 2101 / 2191 / 2668 / 2690 / 2920 / 2924

Slot: A1+TA1+V1

Time: Three Hours

Max. Marks: 100

General Instructions: i) Assume suitable data if required
ii) Steam table and compressibility chart are permitted

Answer any FIVE Questions
(5 X 20 = 100 Marks)

1. A closed system of constant volume experiences a temperature rise of 25°C when a certain process occurs. The heat transferred in the process is 30 kJ. The specific heat at constant volume for the pure substance comprising the system is 1.2 kJ/kg°C and the system contains 2.5 kg of this substance. Determine

   I. The change in internal energy

   II. The work done

   Also, during the flight test it is noticed that, the air speed of a turbojet engine is 250 m/s. Ambient air temperature is -14°C. Gas temperature at outlet of nozzle is 610°C. Corresponding enthalpy values for air and gas are 250 and 900 kJ/kg respectively. Fuel air ratio is 0.0180. Chemical energy of fuel is 45 MJ/kg. Owing to incomplete combustion 6% of chemical energy is not released in the reaction. Heat loss from the engine is 21 kJ/kg of air. Calculate

   III. The velocity of the exhaust jet

2. Consider hot gases flowing through a pipeline as shown in Fig.1. Due to heat loss to the surroundings, the temperature of the gas decreases continuously from the inlet at state 'm' to the exit at sate 'n'. Assume a reversible isobaric path between the inlet and exit states of the gas. Find the available energy at the two sections (Infinitesimal). Comment on your results.

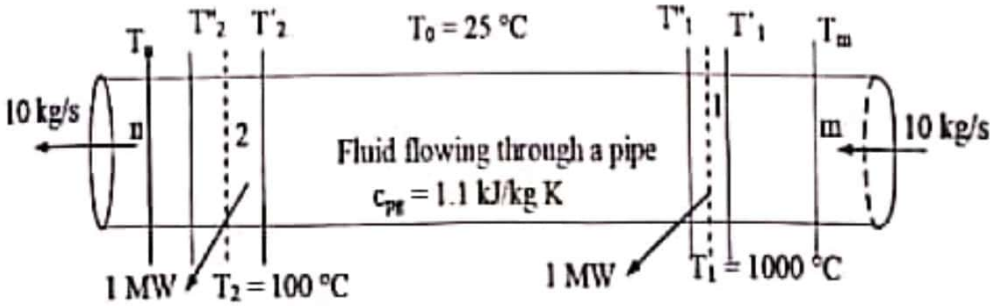

Fig.1 Heat loss through a pipe

3. A reheat steam Rankine cycle is shown in Fig.2. Take the properties from the steam table and find the specific power, thermal efficiency, heat rate and steam rate of the power plant. Also find the irreversibility of the condenser with the water inlet temperature of 25°C with 8°C rise in temperature

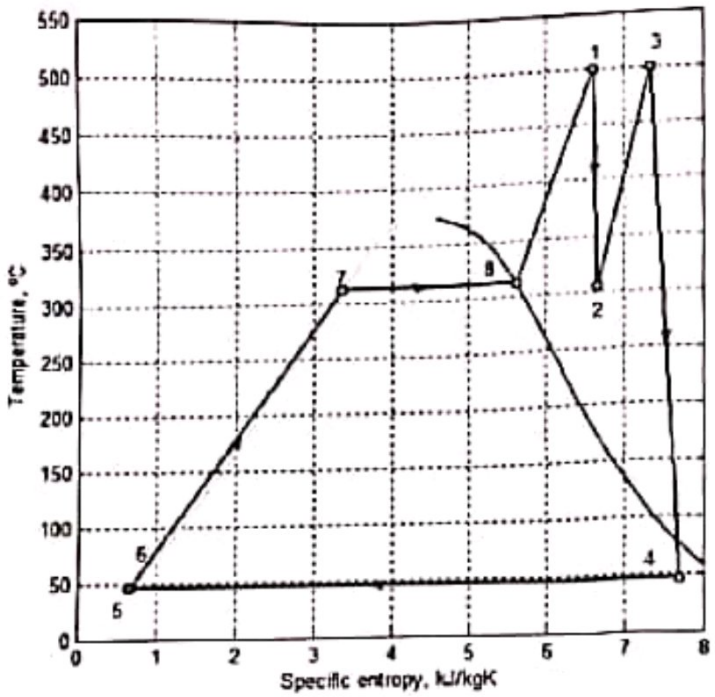

Fig.2 Reheat Rankine Cycle

4. A twin cylinder CI engine with a compression ratio of 13:1 and cylinder dimensions of 200 mm x 250 mm works on two stroke cycle and consumes 14 kg/h of fuel while running at 300 rpm. The relative and mechanical efficiencies are 65% and 76% respectively. The fuel injection is effected up to 5% of stroke. If the calorific value of the fuel used is given as 41000 kJ/kg, calculate

   I. The cut-off ratio
   II. Air standard efficiency
   III. Indicated and Brake power
   IV. Mean effective pressure

5. 4 kg of carbon dioxide at 40°C and 1.4 bar are mixed with 8 kg of nitrogen at 160°C and 1 bar to form a mixture at a final pressure of 0.7 bar and it occupies 3 m^3 of volume. The process occurs adiabatically in a steady flow apparatus. Take value of Cp = for CO_2 = 0.85 kJ/kg K and N_2 = 1.04 kJ/kg K. Calculate

   I. The final temperature of the mixture
   II. The mole fraction of each component
   III. The average molecular weight
   IV. The specific gas constant
   V. Specific volume of CO_2 and N_2

6. Derive the Clausius-Claperyons equation and explain their importance in thermodynamics. Also, using this equation, estimate the enthalpy of vapourisation with the following data. At 200°C, vg = 0.1274 m^3/kg, vf = 0.001157 m^3/kg, (dp/dT) = 32 kPa/K.