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18AE/AS32

Third Semester B.E. Degree Examination, July/August 2021
Aero Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note: ***1. Answer any FIVE full questions.***
2. Use of Thermodynamics Data Hand Book is permitted.

1 a. Differentiate between with schematics.
i) Microscopic and Macroscopic view points
ii) Cyclic and Non cyclic process
iii) Intensive and extensive properties
iv) Path and point functions. **(10 Marks)**

b. Define a temperature scale. A new temperature scale t′ is to be constructed and compared with an ordinary centigrade scale, defined by the expression, $t' = ax^2 + b$, where x (in cm) is the length as a property. For this t′ scale. Take the length of the mercury column for ice and steam points as 50mm and 250mm, respectively. Also t′ = 0 at ice point and t′ = 100 at steam point. Compare this t′ scale with the centigrade scale, where temperature t linearly varies with x, but with same values at t′ at the ice-point and at the steam point. **(10 Marks)**

2 a. With suitable diagram define work and heat and discuss any two similarities and dissimilarities between them. Also write the sign conventions followed in them. **(10 Marks)**

b. A piston cylinder engine has a stroke length of 300mm and area of $0.12m^2$, containing gas at an initial pressure of 2MPa. The gas expands according to a process which is represented by a straight line on the p-v plot, to one tenth of the initial pressure. Represent this process on a p-v diagram and find the magnitude and direction of heat transfer. **(10 Marks)**

3 a. With a neat diagram, explain Joules experiment and establish the equivalence of heat and work. **(06 Marks)**

b. From the first law of thermodynamics develop the concept of energy and further show that energy is a property. **(06 Marks)**

c. Twenty five persons attend a book release ceremony arranged in a small hall measuring 10m × 8m × 3m. Due to power failure A/C goes off and each person gives up about 32kJ of heat per hour. Assuming the room is completely sealed off and insulated, calculate the air temperature rise occurring in 10 minutes, if the initial temperature was 25°C and each person occupies a volume of $0.071m^3$. Take $C_V = 0.718$ for air (kJ/kg K). **(08 Marks)**

4 a. Derive an expression for steady flow energy equation stating the assumptions made and further deduce/modify it for an evaporator of a refrigerating system. **(10 Marks)**

b. A rigid insulated tank evacuated initially is connected through a valve to a supply line that carries steam at 1MPa and 300°C. The valve is opened now and the steam is allowed to flow slowly into a tank until the pressure reaches 1K/Pa, at which point the value is closed. Determine the final temperature of steam in the tank. If the final temperature is more or less than the initial temperature and discuss why? **(10 Marks)**

5 a. Discuss about a Perpetual Motion Machine of second kind (PMMII) and show how it violates, Kelvin-Planck statement of second law of thermodynamics. **(08 Marks)**

b. A reversible heat engine is supplied with heat from two constant temperature sources at 1000K and 800K and rejects energy to a constant temperature sink at 380K. The engine executes a number of complete cycles developing 90kW and rejects 4200kJ of heat per minute. Calculate heat supplied by each source and engine efficiency. **(12 Marks)**

6 a. Define entropy and deduce an expression for principle of increase of entropy, $ds \geq \frac{\delta Q}{T}$. **(10 Marks)**

b. A heat reservoir at 1000K is brought in thermal contact with a heat reservoir at 500K. 1000kJ of heat is transferred from the high temperature reservoir to the low temperature reservoir. Calculate the change in entropy of the universe. **(10 Marks)**

7 a. Define critical point and triple point of water and show them on a P-T diagram. Also identify the fusion line and vapourization lines on it. **(10 Marks)**

b. A tank contains 2kg of water consisting of liquid and vapour in equilibrium at 20 bar. If the liquid and vapour each occupy half the volume of the tank, what is the enthalpy of contents of the tank? **(10 Marks)**

8 a. Using the relation $C_p - C_v = T\left(\frac{\partial v}{\partial T}\right)_p\left(\frac{\partial P}{\partial T}\right)_v$ for an ideal gas show that $C_p - C_v = R$. **(08 Marks)**

b. Determine the specific volume of nitrogen gas at 10MPa and 150K based on i) Ideal gas equation ii) Vander Waal's equation. **(08 Marks)**

c. Define: i) Dryness fraction ii) Enthalpy of vaporization. **(04 Marks)**

9 a. Derive an expression for air standard efficiency of an Otto cycle, representing all the processes on a P-V and T-S diagram. **(10 Marks)**

b. The pressure and temperature at the beginning of compression in a Diesel cycle are respectively 1 bar and 350K. If the compression ratio is 14, $\gamma = 1.4$, determine:

i) The maximum cycle pressure

ii) The percentage of working stroke at which the heat supply is cut-off

iii) Heat supplied/kg of air.

Take $P_4 = 27$ bar. **(10 Marks)**

10 a. With the help of a block diagram, explain the working of a reheat Rankine cycle and show all the processes on a T-S or h-s diagram. **(10 Marks)**

b. In a power plant working on a reheat cycle the turbine develops 650kJ/kg of work between the inlet and reheater and 760kJ/kg of work between the reheater and condenser. After Pre-heating steam enters LP turbine at a pressure of 2MPa and 500°C and expands down to condenser pressure at 8kPa. Determine cycle efficiency ignoring pump work. **(10 Marks)**

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