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06ME33

Third Semester B.E. Degree Examination, June 2012
Basic Thermodynamics

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Explain macroscopic and microscopic points of view in the study of thermodynamics. **(04 Marks)**

b. Differentiate between the following with suitable examples :
i) Intensive an extensive property.
ii) Point function and path function.
iii) Steady state and equilibrium.
iv) Reversible and irreversible process.
v) Thermal and thermodynamic equilibrium. **(10 Marks)**

c. The mercury column of a mercury glass thermometer reads 50 mm when the thermometer is at the ice point and 250 mm when thermometer is at steam point. The length of the mercury column and the temperature scale are related as $t = ax^2 + b$ where t = 0 at ice point and t = 100 at steam point. Compare this scale with Celsius scale where 't' is linearly defined in terms of 'x' with the same values of 't' at the ice and steam points. **(06 Marks)**

2 a. State the thermodynamic definition of work. What is the advantage of thermodynamic definition over the mechanics definition of work? **(04 Marks)**

b. Show that work and heat are path functions. **(06 Marks)**

c. Show that the work done in polytropic process is given by $W_{1-2} = \frac{m\ R(T_2 - T_1)}{1-n}$. **(04 Marks)**

d. A gas undergoes the following reversible non flow process during its change from initial state, pressure p_1 = 15 bar v_1 = 1 m^3/kg to a final state having pressure p_2 = 6 bar and specific volume $2m^3/kg$. Sketch the process on p – v diagram and find the work done in each case.
i) Polytropic process
ii) Constant volume followed by constant pressure
iii) Constant pressure followed by constant volume. **(06 Marks)**

3 a. State first law of thermodynamics as applied to a cycle and as applied to a process. **(04 Marks)**

b. Show that the heat transfer during a polytropic process is $\left(\frac{\gamma - n}{\gamma - 1}\right)$ times the work transfer. **(08 Marks)**

c. 1 kg of ethane (perfect gas) is compressed from 1.1 bar 27°C according to the law $pv^{1.3}$ = constant until the pressure is 6.6 bar. Calculate the flow from the cylinder wall. Given molecular weight of ethane = 30 and R_o = 8.314 kJ/kg K. **(08 Marks)**

4 a. Define :
i) Thermal efficiency
ii) Coefficient of performance
iii) Thermal reservoir. **(06 Marks)**

b. State the Kelvin-Planck and Clausius statements of the second law of thermodynamics and prove their equivalence. **(08 Marks)**

c. A heat engine with an efficiency of 40% drives a refrigerator with a C.O.P. of 4. Determine the ratio of total heat rejected to the atmosphere to the heat absorbed by refrigerator. **(06 Marks)**

PART – B

5 a. State and prove clausius inequality. **(06 Marks)**

b. Show that entropy is a property of the system. **(06 Marks)**

c. A mass m of a fluid at a temperature of T_1 is mixed with an equal mass of the same fluid at T_2. Prove that the resultant change of entropy of the universe is given by 2 mc ln $\frac{\left(\frac{T_1 + T_2}{2}\right)}{\sqrt{T_1 T_2}}$ where 'C' is specific heat. **(08 Marks)**

6 a. Explain the concept of available and unavailable energy. When does the system become dead? **(06 Marks)**

b. What is irreversibility? Derive general expression for irreversibility for
i) non flow process ; ii) steady flow process. **(08 Marks)**

c. 15 kg of water is heated in an insulated tank by churning process from 300 K to 340 K. If the surrounding temperature is 300 K, find the loss in availability for the process. **(06 Marks)**

7 a. Draw a neat sketch of throttling calorimeter and explain how dryness fraction of steam is determined. Clearly explain its limitations. **(08 Marks)**

b. A vessel having a capacity of 0.39 m^3 contains saturated water and saturated steam at a temperature of 245°C. The mass of the liquid present is 10 kg. Find the following :
i) The mass
ii) The specific volume
iii) The specific enthalpy
iv) The specific entropy
v) The specific internal energy.
Use the following properties. P_{sat} = 36.5 bar, v_f = 0.001239 m^3/kg, v_g = 0.0546 m^3/kg, h_f = 1061.4 kJ/kg K, h_{f_g} = 1740.2 kJ/kg, s_f = 2.7474 kJ/kg K, s_{f_g} = 3.3585 kJ/kg K. **(12 Marks)**

8 a. Write a note on Vander Waall's equation. **(04 Marks)**

b. Show that the entropy change of an ideal gas is given by the equation of the form.
$s_2 - s_1 = c_p \ln \frac{v_2}{v_1} + c_v \ln \frac{p_2}{p_1}$. **(06 Marks)**

c. A tank having a volume of 4.5 m^3 contains 6 kg of nitrogen the temperature is 27°C. What is the pressure of the gas according to i) ideal gas and ii) Vander-walls equation. **(10 Marks)**

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