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10ME/AU33

Third Semester B.E. Degree Examination, June/July 2018
Basic Thermodynamics

Time: 3 hrs. Max. Marks:100

Note: *1. Answer FIVE full questions, selecting at least TWO full questions from each part.*
2. Use of Thermodynamic data hand book is permitted.

PART – A

1 a. Differentiate between the following with suitable examples:
i) Intensive and extensive properties.
ii) Path and point functions. **(06 Marks)**

b. Explain the concept of temperature measurement using thermocouple. **(04 Marks)**

c. State the Zeroth law of thermodynamics and briefly explain its significance. **(04 Marks)**

d. A temperature scale is being developed using the following relation $t = a\ln(P) + \left(\frac{b}{2}\right)$ where 'P' is the thermometric property and 'a' and 'b' are constants. Determine Celsius temperature corresponding to thermometric property of 6.5, if ice point and steam point give thermometric property value of 3 and 8. **(06 Marks)**

2 a. Define heat and thermodynamic definition of work. Calculate the work done by the system when the gas expands reversibly to a volume V_2 m^3 during the following processes:
i) Isothermal process ii) Polytropic process. The initial pressure and volume of a mass of gas in a cylinder fitted with a movable piston are P_1 bar and V_1 m^3 respectively. **(12 Marks)**

b. A cylinder contains one kg of fluid at an initial pressure of 20bar. The fluid is allowed to expand reversible behind a piston according to law $PV^2 = C$ until the volume is doubled. The fluid is then cooled reversibly at constant pressure until the piston regains its original position, heat is then supplied reversibly with the piston firmly locked in this position until the pressure rises to the original value of 20bar. Calculate the net work done by the fluid for an initial volume of $0.05m^3$. **(08 Marks)**

3 a. State first law of thermodynamics for a closed system undergoing a cycle process. Show that internal energy is the property of the system. **(06 Marks)**

b. Derive steady flow energy equation for a single stream of fluid entering and learning the control volume. **(06 Marks)**

c. Air enters a gas turbine with velocity 105 m/s, specific volume $0.8m^3/kg$ and leaves at 135m/s and $1.5m^3/kg$. The inlet area of the gas turbine is $0.05m^2$. As air passes through the turbine, the specific enthalpy decreases by 145 kJ/kg and air loses 27 kJ/kg of heat. Determine: i) Mass flow rate of air ii) Exit area of the turbine iii) Power developed by the turbine. **(08 Marks)**

4 a. Write two statements of second law of thermodynamics and show their equivalence. **(08 Marks)**

b. Explain the various causes of irreversibility. **(04 Marks)**

c. A reversible heat engine extracts heat from three reservoirs at 1000K, 810K and 595K. The engine delivers 10×10^3 J/S of network and rejects 400 kJ/min of heat to a sink at 298K. If the heat supplied to the reservoir at 1000K is 55% of the heat supplied by the reservoir at 595K. Determine quantity of heat absorbed by each reservoir. **(08 Marks)**

PART – B

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

b. Show that entropy is a property. **(04 Marks)**

c. Define available and unavailable energy. **(04 Marks)**

d. A reversible engine extracts 75kW of energy from a reservoir at 750K and produces 15kW of work. The engine rejects heat to two reservoirs at 650K and 58 K respectively. Determin quantity of heat rejected to each sink. **(06 Marks)**

6 a. Draw a P-T diagram for pure substance and indicate all necessary points and differe regions on it. **(06 Marks)**

b. Define dryness fraction. With a neat sketch, explain the measurement of dryness fraction steam by using separating and throttling calorimeter. **(08 Marks)**

c. A rigid vessel contains liquid-vapour mixture in the ratio of 3:2 by volume. Determi quality of water vapour mixture and total mass of fluid in vessel, if the volume of vessel $2m^3$ and initial temperature is 150°C. **(06 Marks)**

7 a. Write down the Td_s equations and derive the expression for the difference in heat capaciti C_p and C_v. **(10 Marks)**

b. $1.2m^3$ of air is heated reversibly at constant pressure from 300K to 600K and is then cool reversibly at constant volume back to initial temperature. If the initial pressure is 1 b calculate:

i) The net heat flow

ii) The overall change in entropy.

Represent the processor T-S plot. Take $C_p = 1.005$ kJ/kg K and R = 0.287 kJ/kg K. **(10 Marks)**

8 a. Show that the entropy change of an ideal gas is given by the equation of the for

$$S_2 - S_1 = C_p \ln\frac{V_2}{V_1} + C_v \ln\frac{P_2}{P_1}.$$ **(08 Marks)**

b. State and explain Dalton's law of partial pressures and Amagat's law of additive volum **(08 Marks)**

c. One kg of CO_2 has a volume of $1m^3$ at 100°C. Compute the pressure by i) Vander Wa equation ii) Perfect gas equation. **(04 Marks)**

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