CBCS Scheme

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15AE33

Third Semester B.E. Degree Examination, June/July 2017
Aerothermodynamics

Time: 3 hrs. Max. Marks: 80

Note: 1. Answer any FIVE full questions, choosing one full question from each module.
2. Use of Thermodynamic Data Handbook/Charts/Tables is permitted.

Module-1

1 a. With suitable sketches/examples distinguish between :
i) Closed and open systems ii) path and point functions iii) Thermal and mechanical equilibrium. **(06 Marks)**

b. State zeroth law of thermodynamics and extract the concept of temperature from it. Name any four types of thermometers and their corresponding thermometric property. **(05 Marks)**

c. Sir Isaac Newton proposed a temperature scale in 1709. On this scale, temperature was a linear function of Celsius scale. The reading on this at Ice point (0°C) and normal human body temperature (37°C) were 0°N and 12°N respectively. Obtain the relation between the Newton scale and Celsius scale. **(05 Marks)**

OR

2 a. Derive an expression for : i) Shaft work ii) Spring work. **(05 Marks)**

b. Air in a cylinder at an initial volume of $0.01m^3$ and the initial pressure 6MP expands following a quasi-static process given by $PV^{1.4}$ = constant. If the final volume of the gas is $0.025m^3$. Determine the work done by gas. **(05 Marks)**

c. Show that work is a path function and not a property. **(03 Marks)**

d. Write down two similarities and two dissimilarities between heat and work. **(03 Marks)**

Module-2

3 a. Write the first law of thermodynamics for a closed system undergoing
i) a cycle ii) a process. **(04 Marks)**

b. A stationary mass of gas is compressed from an initial state of $0.3m^3$ and 0.105MPa to a final state of $0.15m^3$ and 0.105 MPa, the pressure remaining constant during the process. There is a transfer of 37.6kJ of heat from the gas during the process. How much does the internal energy of the gas change? **(05 Marks)**

c. A mass of 0.5kg of pure substance at pressure P = 1bar and T = 323K, Occupies volume $V = 0.15m^3$. Given internal energy = 31.5kJ, evaluate specific enthalpy. **(04 Marks)**

d. Define specific heat at i) Constant pressure and ii) Constant volume. **(03 Marks)**

OR

4 a. Write down Steady Flow Energy Equation and explain all the terms involved. **(04 Marks)**

b. How do you apply SFEE for : i) Steam Nozzle ii) Steam turbine? **(05 Marks)**

c. A turbine operates under steady flow conditions receiving steam at the following state: pressure 1.2MPa, temperature 188°C, enthalpy 2785 kJ/kg, velocity 34m/s and elevation 3m. The steam leaves the turbine in the following state: pressure 20KPa, enthalpy 2512 kJ/kg, velocity 100m/s and elevation 0m. Heat is lost to the surroundings at the rate of 0.29 kJ/s. If the steam flow rate is 0.42 kg/s. determine the power output from the turbine. **(07 Marks)**

Module-3

5 a. State Kelvin Plank and Clausius statements of second law of thermodynamics and show that they are equivalent. **(06 Marks)**

b. Represent schematically and explain: i) heat engine ii) refrigerator. Prove that: $(COP)_{HP} = (COP)_R + 1$. **(05 Marks)**

c. A reversible refrigerator operates between 35°c and −12°C. If heat rejected to 35°C is 1.3 kW determine the rate at which heat is leaking into the refrigerator. **(05 Marks)**

OR

6 a. State and prove Clausius inequality. **(04 Marks)**

b. Describe the working of Carnot engine and show that $\eta = 1 - \frac{T_2}{T_1}$. Represent Carnot cycle in P-V and T-S diagram. **(04 Marks)**

c. Define entropy and prove that it is a property of the system. **(03 Marks)**

d. For an ideal gas undergoing finite change of state from 1 to 2 derive an expression for change in entropy. **(05 Marks)**

Module-4

7 a. Define the following : i) Pure substance ii) Saturation pressure iii) Triple point iv) Critical point. **(04 Marks)**

b. Sketch and explain P-T diagram of water. **(06 Marks)**

c. Find the enthalpy and entropy of steam when the pressure is 2MPa and the specific volume is 0.09 m^3/kg. **(06 Marks)**

OR

8 a. Derive and explain Maxwell's equations. **(08 Marks)**

b. Show that for an ideal gas, $C_p - C_v = R$. **(04 Marks)**

c. 1 kg of air at a pressure of 8 bar and temperature 100°C undergoes a reversible polytropic process following the law $PV^{1.2}$ = constant. If the final pressure is 1.8 bar determine final specific volume, temperature and increase in entropy. Assume R = 0.287 kJ/kg K and $\gamma = 1.4$. **(04 Marks)**

Module-5

9 a. Explain Air standard cycle. **(04 Marks)**

b. Explain working of diesel cycle with the help of P-V and T-S diagrams. Derive an expression for the efficiency of diesel cycle in terms of its compression and cut-off ratios. **(08 Marks)**

c. A diesel engine has a compression ratio of 14 and cut off takes place at 6% of stroke. Find its Air-standard efficiency. **(04 Marks)**

OR

10 a. Explain Rankine cycle with the help of a sketch and T-S diagram. Derive an expression for thermal efficiency of Rankine cycle. **(06 Marks)**

b. Consider a steam power plant operating on a sample Rankine cycle. Steam enters the turbine at 3MPa and 350°C and is condensed in the condenser at a pressure of 75 KPa. Determine the thermal efficiency of the cycle. **(06 Marks)**

c. How can we increase the efficiency of the Rankine cycle? **(04 Marks)**

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