CBCS SCHEME

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18AE/AS32

Third Semester B.E. Degree Examination, Feb./Mar. 2022
Aero Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of Thermodynamic Data Hand Book and steam tables are permitted.

Module-1

1 a. Define the following and explain:
i) Thermodynamic process
ii) Control volume
iii) Point function
iv) Isolated system (10 Marks)

b. Design a temperature scale to measure a temperature T in terms of property P according to the relation T = a *l*n p + b, where a and b are constants. It is found that the ice and steam points are 0°C and 100°C respectively with the instrument showing the values of P as 1.86 and 6.81, respectively. Evaluate the temperature corresponding to value of P = 2.8. (10 Marks)

OR

2 a. Define work and heat and explain the sign conventions followed. For the following cases identify heat and work interactions with proper sign conventions. The system is underlined.
i) Glowing of an incandescent lamp.
ii) A gas being compressed by a compressor
iii) A dentist grinding a teeth. (10 Marks)

b. A gas has an initial volume of $0.4m^3$ and expands to $0.8m^3$. The initial temperature and pressure of the gas are respectively 0.1MPa and 27°C. Find the workdone by assuming the pressure between the initial and final states of the system i) Constant ii) Inversely proportional to volume iii) Given by the ideal gas relation, PV = MRT. (10 Marks)

Module-2

3 a. Define first law of Thermodynamics. Prove that energy is a property. Mention the limitations of the first law. (10 Marks)

b. Ten kg of gas is compressed from an initial volume of $1.5m^3$ to $0.3m^3$ at a constant pressure of 10 bar. During this process temperature rises from 20°C to 130°C and increase in internal energy is found to be 3000kJ. Calculate the workdone, heat interaction, change in enthalpy and average value of specific heat at constant pressure. (10 Marks)

OR

4 a. Derive from the fundamentals, steady flow energy equation for an open system. (10 Marks)

b. A nozzle supplies air at 2.7MPa, 923 kJ/kg enthalpy and at 30 m/s to a turbine wheel. The corresponding exit pressure and enthalpy are 700kPa and 660kJ/kg.
i) If the heat loss is 0.96kJ/kg and mass flow rate is 0.2kg/s find the exit velocity.
ii) Find the exit velocity for adiabatic conditions. (10 Marks)

Module-3

5 a. What do you understand by perpetual motion machines PMM-I and PMM-II? With a block diagram represent the same and prove that both of them violate the laws of thermodynamics. **(10 Marks)**

b. A reversible heat engine works between two reservoirs at 1400K and 350K respectively. A reversible heat pump receives heat from reservoir at 250K and rejects it to the reservoir at 350K, to which the heat engine also rejects heat. The workout put from the engine is used to drive the heat pump. If the total heat supplied to the reservoir at 350K is 100kW, find the heat to be received by the heat engine. **(10 Marks)**

OR

6 a. Define entropy. Explain the principle of increase of entropy and show that in differential form $ds \geq \delta Q/T$. **(08 Marks)**

b. Define available and unavailable energy represent them on a T-S diagram citing any thermodynamic process of your choice. **(06 Marks)**

c. A rigid tank contains air at 35°C and is stirred by a paddle wheel which docs 500kJ of work on air. During the stirring process, temperature of air remains constant. If the surroundings is at 15°C, estimate the change in entropy of air and change in entropy of the surroundings. **(06 Marks)**

Module-4

7 a. For ideal gas mixtures define:
i) Mass fraction ii) Mole fraction iii) Molecular weight. **(09 Marks)**

b. Write Vander Waal's equation of state for real gases and explain all the components. **(04 Marks)**

c. A vessel having a volume of $0.3m^3$ is filled with a mixture of 3kg CO_2 and 2.5kg N_2 at 30°C. Determine:
i) Mole fraction of each component
ii) Molecular weight of the mixture
iii) Pressure of the mixture if R for the mixture is 0.238kJ/kg K mol. **(07 Marks)**

OR

8 a. Define a pure substance. Define and represent the following on a T-S or P-H diagram.
i) Sensible heat ii) Latent heat iii) Degree of superheat iv) Critical point. **(12 Marks)**

b. Using Maxwell relation $(\partial s/\partial v)_T = (\partial p/\partial T)_V$ and noting $Td_5 = du + pdv$, show that internal energy of a perfect gas is a function of temperature only. **(08 Marks)**

Module-5

9 a. With the help of p-v and T-s diagrams make the thermodynamic analysis of an Otto cycle and derive an expression for its air-standard efficiency. **(10 Marks)**

b. The temperature and pressure at the beginning of compression in a petrol engine cycle is 300K and 102kPa respectively. The maximum cycle temperature is 1900K and the compression ratio is 8. If r = 1.4 determine per kg of air i) the heat supplied ii) the net workdone iii) the thermal efficiency. Take $C_v = 0.7168$ kJ/kg K. **(10 Marks)**

OR

10 a. Make the thermodynamic analysis of a simple Rankine cycle, showing all the processed on the T-s diagram. Arrive at an equation/expression to find the thermal efficiency of the cycle. Considering and neglecting pump work. **(10 Marks)**

b. A power plant supplies steam, to a turbine using a steam generator which subsequently condenses in a condenser. If the generator and condenser pressures are respectively 30bar and 4kPa, and the steam is dry saturated at the turbine inlet determine i) The cycle efficiency ii) work ratio iii) specific steam consumption iv) pump work in kg/kwh. **(10 Marks)**

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