CBCS SCHEME

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18AE/AS32

Third Semester B.E. Degree Examination, July/August 2022
Aerothermodynamics

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. State Zeroth Law of thermodynamics and extract the concept of temperature from it. **(05 Marks)**

b. What is thermodynamic system? Explain the types of thermodynamic system. **(05 Marks)**

c. A new temperature scale is proposed by Sir Issac Newton. On this scale, the 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 the Cesium scale. **(10 Marks)**

OR

2 a. Distinguish between Heat and Work. **(04 Marks)**

b. Derive an expression for displacement work in a polytropic process PV^n = constant. Show on a P-V diagram, four expansion process for n = 0, n = 1, n = 1.4 and n = ∞. Name each of the process. **(08 Marks)**

c. A spherical balloon has an initial diameter of 25cm and contains air at 1.2 bars. When heated the diameter increases 30cm. During heating the pressure is found to be proportional to diameter. Calculate the workdone. **(08 Marks)**

Module-2

3 a. Write the first law of thermodynamics for any process in i) Closed system ii) Open system. **(04 Marks)**

b. Explain Joules experiment with a neat sketch. **(08 Marks)**

c. Prove that internal energy is a property of the system. **(08 Marks)**

OR

4 a. Write the steady flow energy equation for an open system and explain the terms involved in it. Simplify SFEE (Steady Flow Energy Equation) for the following systems. i) Steam Turbine ii) Nozzle. **(10 Marks)**

b. The properties of a certain fluid are related as follows : U = 196 + 0.718T and PV = 0.287 (T + 273) U is specific internal energy in kJ/Kg, P is pressure in kN/m^2, V is specific volume in m^3/Kg. A closed system consisting of 2Kg, of this fluid expands in an irreversible adiabatic process related by $PV^{1.2}$ = C. The initial conditions are 1MPa and 200°C and final pressure is 100KPa. Determine the work transfer and change in internal energy for the process. **(10 Marks)**

Module-3

5 a. Represent schematically and give performance equation for
i) Heat engine ii) Refrigerator iii) Heat pump.
Prove that $(COP)_{HP} = (COP)_{refrigerator} + 1$. **(04 Marks)**

b. State Kelvin Plank and Clausius statements of second law of thermodynamics and show that they are equivalent. **(08 Marks)**

c. A reversible refrigerator operates between 35°C and -15°C. If heat rejected to 35°C is 1.5kW, determine the rate at which heat is leaking into refrigerator. **(08 Marks)**

OR

6 a. Prove that entropy is a property of a system. **(05 Marks)**

b. Define Clausius inequality and entropy of a system. Show that for an irreversible process, $ds \geq \frac{\delta Q}{T}$. **(10 Marks)**

c. One Kg of water at 273K is heated to 373K by first brining it in contact with reservoir at 323K and then reservoir at 373K. What is the change in entropy of the universe? **(05 Marks)**

Module-4

7 a. Define : i) Critical Point ii) Tripple point iii) Dryness fraction iv) Pure substance v) Compressibility factor . **(10 Marks)**

b. Derive Vander Waal's constants in terms of critical properties. **(10 Marks)**

OR

8 a. Write the Maxwell relation and explain the terms involved. **(04 Marks)**

b. A rigid Vessel of volume $0.3m^3$ contains 10Kg of air at 300K. Determine the pressure that would be excreted by air on the vessel, using i) Perfect gas equation ii) Vander Waal's equation. Take for air, R = 287.1J/Kg K, Molecular weight = 28.96, Vander Waal's constants, a =135.8kN $m^4(Kg.mol)^2$, b = 0.0365 m^3/Kg.mol. **(08 Marks)**

c. $0.1m^3$ of air at 5MPa, 356°C contained in a cylinder expands reversibly and isothermally to 0.25MPa. Calculate for air i) Work Transfer ii) Heat Transfer iii) Change in entropy, assuming that air behaves as an ideal gas with R = 287J/Kg.K. **(08 Marks)**

Module-5

9 a. With the help of T-S and P-V diagram, evaluate an expression for the air standard efficiency of a Diesel cycle. **(10 Marks)**

b. Compare Otto and Diesel cycles with the help of P-V and T-S diagram. **(06 Marks)**

c. A Carnot engine rejects heat to the sink at 32°C and has a thermal efficiency of 52.3%. The work output from the engine is 120kJ. Determine: i) The maximum working temperature of the engine and ii) The heat added in kJ. **(04 Marks)**

OR

10 a. What are the methods of increasing the efficiency of Rankine cycle? **(04Marks)**

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

c. Explain with T-S diagram, limitation of Carnot cycle how we can overcome the same in Rankine cycle. **(10 Marks)**

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