CBCS SCHEME

USN | | | | | | | | | | |

15AE33

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

Time: 3 hrs. Max. Marks: 80

Note:* 1. *Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of thermodynamics data handbook is permitted.

Module-1

1 a. What is thermodynamic system? Explain the types of thermodynamic system. **(04 Marks)**

b. State zeroth law of thermodynamics and extract the concept of temperature from it. **(04 Marks)**

c. On a new temperature 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) is 0°N and 12°N respectively. Obtain the relation between the New Scale and the Celsius scale. **(08 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. **(06 Marks)**

c. A spherical balloon has an initial diameter of 25 cm and contains air at 1.2 bar. When heated, the diameter increases to 30 cm. During heating the pressure is found to be proportional to diameter. Calculate the work done. **(06 Marks)**

Module-2

3 a. Prove that internal energy is a property of the system. **(06 Marks)**

b. Explain Joules experiment with a neat sketch. **(06 Marks)**

c. Write the first law of thermodynamics for any process in (i) closed system (ii) open system. **(04 Marks)**

OR

4 a. Write the steady flow energy equation for an open system and explain the terms involved in it. Simplify SFEE for the following systems: (i) Steam turbine (ii) Nozzle **(08 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 2 kg 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 100 kPa. Determine the work transfer and change in internal energy for the process. **(08 Marks)**

Module-3

5 a. Represent schematically and give performance equation for (i) Heat engine, (ii) Refrigerator (iii) Heat pump. **(04 Marks)**

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

c. A reversible refrigerator operates between 35°C and –15°C. If heat rejected to 35°C is 1.5 KW, determine the rate at which heat is leaking into refrigerator. **(06 Marks)**

OR

6 a. Prove that entropy is a property of the system. **(04 Marks)**

b. Define Clausius inequality and entropy of a system. Show that for an irreversible process, $ds \geq \frac{\delta Q}{T}$. **(08 Marks)**

c. One kg of water at 273 K is heated to 373 K by first bringing it in contact with reservoir at 323 K and then reservoir at 373K. What is the change in entropy of the universe? **(04 Marks)**

Module-4

7 a. Define: (i) Critical Point (ii) Triple point (iii) Dryness fraction (iv) Pure substance **(08 Marks)**

b. Derive Vander Waal's constants in terms of critical properties. **(08 Marks)**

OR

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

b. A rigid vessel of volume 0.3 m^3 contains 10 kg of air at 300 K. Determine the pressure that would be exerted by air on the vessel, using (i) Perfect gas equation (ii) Vander Waal's equation. Take for air, R = 287.1 J/kg.K, Molecular weight = 28.96, Vander Waal's constants a = 1.35.8 $Nm^4/(kg.mol)^2$, b = 0.0365 m^3/kg.mol. **(06 Marks)**

c. 0.1 m^3 of air at 5 MPa, 356°C contained in a cylinder expands reversibly and isothermally to 0.25 MPa. Calculate the air, (i) Work transfer, (ii) heat transfer, (iii) Change in entropy, assuming that air behaves as an ideal gas with R = 287 J/kg.K. **(06 Marks)**

Module-5

9 a. Compare Otto and Diesel cycles with the help of P-V and T-S diagram. **(04 Marks)**

b. With the help of T-S and P-V diagram, evaluate an expression for the air standard efficiency of a Diesel cycle. **(08 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 120 kJ. Determine:
(i) The maximum working temperature of the engine and
(ii) Heat added in kJ. **(04 Marks)**

OR

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

b. Consider a steam power plant operating on a simple Rankine cycle. Steam enters the turbine at 3 MPa and 350°C and is condensed in the condenser at a pressure of 75 kPa. Determine the thermal efficiency of the cycle. **(04 Marks)**

c. Explain with T-S diagram, limitations of Carnot cycle and how we can overcome the same in Rankine cycle. **(08 Marks)**

* * * * *