CBCS SCHEME

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

17AE/AS33

Third Semester B.E. Degree Examination, Aug./Sept. 2020
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 thermodynamics data handbook is permitted.***

Module-1

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

b. State zeroth law of thermodynamics and extract the concept of temperature from it. **(05 Marks)**

c. In 1709, Sir Issac Newton proposed a new temperature scale. 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 Celsius 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 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 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 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 2 kg of this fluid expands in an irreversible adiabatic process related by $PV^{1.2}$=C. The initial conditions are 1 MPa and 200°C and final pressure is 100 KPa. 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 1.5 kW, 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 273 K is heated to 373 K by first bringing it in contact with reservoir at 323 K and then reservoir at 373 K. 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 0.3 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 = 135.8 $kNm^4/(kgmol)^2$, b = 0.0365 $m^3/kg.mol$ **(08 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 for 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. **(08 Marks)**

Module-5

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

b. Compare Otto and Diesel cycles with the help of PV and TS 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 120 KJ. 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 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. **(06 Marks)**

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

* * * * *