CBCS SCHEME

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

15AE33

Third Semester B.E. Degree Examination, Dec.2018/Jan.2019
Aero Thermodynamics

Time: 3 hrs. Max. Marks: 80

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

Module-1

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

b. Distinguish between:
(i) Thermal equilibrium and mechanical equilibrium.
(ii) Path and process.
(iii) Diathermic wall and adiabatic wall. **(06 Marks)**

c. In testing an electrical apparatus, the average temperature of a coil of wire is often obtained by measuring the electrical resistance of the wire. The resistance of a certain magnetic coil at room temperature (303 K) is 1240 ohms. After a certain testing operation, the coil resistance is 1435 ohms. The resistance R in ohms, of the copper wire used in the coil is related to the temperature t, in degree Celsius, by $R = R_0[1 + 0.00395(t - 20)]$, where R_0 is a constant. Find the average temperature of the coil at the end of the test. **(06 Marks)**

OR

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

b. What is meant by polytropic process? Derive an expression for displacement work for a polytropic process. **(04 Marks)**

c. A gaseous system undergoes three quasistatic processes in sequence. The gas initially at 5 bar, 0.01 m^3 is expanded at constant pressure. It is then further expanded according to the relation, $PV^{1.4}$ = constant to 2 bar, 0.025 m^3. The gas is then returned to its initial state during which process PV = constant. Calculate the work interaction in each of the three processes and the network for the system. **(08 Marks)**

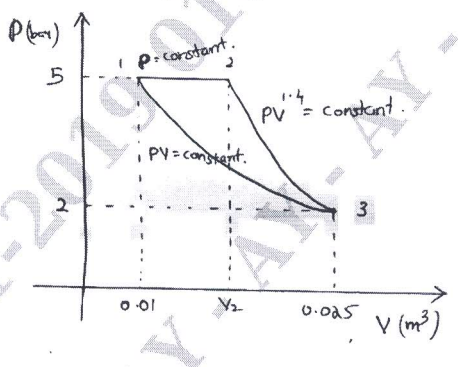

Fig. Q2 (c)

Module-2

3 a. State and explain the 1st law of thermodynamics for cyclic and non-cyclic processes. **(04 Marks)**

b. Show that the change in energy between two states is independent of the path. **(04 Marks)**

c. A fluid is contained in a cylinder by spring loaded, frictionless piston so that the pressure in fluid is linear function of the volume (P = a + bV). The internal energy of the fluid is given by the following equation :
where U is in kJ, P is in kPa and V is in m^3. If the fluid changes from an initial state of 170 kPa, 0.02 m^3 to a final state of 400 kPa, 0.06 m^3. Find the magnitude and direction of the work and heat transfer. **(08 Marks)**

OR

4 a. Explain pure substance with examples and two property rule for pure substance. **(05 Marks)**

b. Write the steady flow energy equation and explain all the terms. **(05 Marks)**

c. In a steady flow device, 135 kJ of work is done by each kg of fluid for the fluid the specific volume, pressure and velocity at the inlet are 0.37 m^3/kg, 600 kPa and 16 m/s respectively. The corresponding properties of the fluid at the exit are 0.62 m^3/kg, 100 kPa and 270 m/s. The inlet is 32 m above the floor level and the discharge pipe is at the floor level. The heat transfer from the device is 9 kJ/kg of fluid. What is the change in specific internal energy of the fluid as it passes through the device? **(06 Marks)**

Module-3

5 a. Describe Clausius & Kelvin-Plank statements of the second law of thermodynamics. **(04 Marks)**

b. What do you understand by a reversible and an irreversible process? What are the causes of irreversibility of a process. **(04 Marks)**

c. The COP of heat pump is 5 when the power supplied to drive it is 35 kW. Evaluate the heat transfers from and to the working fluid. The heat transfer from the heat pump is used to heat water flowing through the radiators of a building. Evaluate the flow rate of radiator water in kg/s, given that its temperature increases by 20°C. Neglect the change in velocity of water as it flows through the condenser. **(08 Marks)**

OR

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

b. Prove that entropy is a property of a system. **(04 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? **(04 Marks)**

Module-4

7 a. Draw a neat P-T phase diagram for water and mark the following on it. (i) Solid region (ii) Liquid region (iii) Vapour phase (iv) Triple point and (v) Critical point. **(06 Marks)**

b. 0.1 kg saturated steam expands reversibly from 10 to 1 bar in a piston-cylinder device according to $PV^{1.3}$ = constant. Find the work and heat interactions during the expansion process. **(10 Marks)**

OR

8 a. Define the following terms with reference to the pure substance (i) Latent heat (ii) Tripple point (iii) Enthalpy and (iv) Dryness fraction. **(04 Marks)**

b. 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) The work transfer (ii) Heat transfer and (iii) The change in entropy assuming that air behaves as an ideal gas with R = 287 J/kgK. **(08 Marks)**

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

Module-5

9 a. Derive an expression for the air standard efficiency of an otto cycle. **(06 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 120 kJ. Determine (i) The maximum working temperature of the engine and (ii) The Heat added in kJ. **(04 Marks)**

OR

10 a. Explain with T-S diagrams, limitations of carnot cycle and how we can overcome the same in Rankine cycle. **(08 Marks)**

b. A simple Rankine cycle works between the boiler pressure of 3 MPa and condenser pressure of 4 kPa. The steam is dry saturated before expanding in the turbine. Determine (i) Rankine cycle efficiency and (ii) Work ratio. **(08 Marks)**

* * * * *