CBCS SCHEME

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

21AU34

Third Semester B.E. Degree Examination, Jan./Feb. 2023
Engineering Thermodynamics

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Classify the following properties as intensive or extensive with suitable reasons:
(i) Refractive index of glass slab
(ii) Velocity of a bullet
(iii) Energy required to lift a bucket of water **(06 Marks)**

b. Describe the following terms with respect to thermodynamics:
(i) State (ii) Path (iii) Process (iv) Thermometric property **(04 Marks)**

c. Define a new temperature scale 'N' which freezing and boiling points of water are 150°N and 350°N respectively. Correlate this temperature scale with centigrade scale for which freezing and boiling points are 0°C and 100°C respectively. What kind of observation made on its correlations? **(10 Marks)**

OR

2 a. Starting from a convenient state point on a P-V diagram, show the four expansion process for n = 0, 1, γ, ∞ (where γ is ratio of specific heat). What are each of these process called? Illustrate the expression for the expansion work of an isothermal process. **(10 Marks)**

b. Considering gas contained in a cylinder as a system the initial pressure and volume being 210 kPa and 0.04 m^3 respectively. Estimate the work done when the volume of gas increases to 0.15 m^3 for the following process :
(i) Pressure varies inversely with volume (ii) Constant pressure heating **(10 Marks)**

Module-2

3 a. Write the steady flow energy equation and modify the SFEE for the following cases:
(i) Adiabatic expansion of steam in turbine
(ii) Horizontal steam nozzle with negligible entrance velocity **(06 Marks)**

b. What is perpetual motion machine of first kind? Why it is impossible? **(04 Marks)**

c. A closed rigid vessel containing 10 kg of oxygen at 290 K is supplied with heat until its pressure becomes two fold that of initial value. Identify the process and find the final temperature, change in internal energy, and enthalpy and heat interaction across the system boundary. Take C_V = 0.65 kJ/kgK and R = 259.8 kJ/kgK. **(10 Marks)**

OR

4 a. Define the two statement of second law of thermodynamics. Show that the violation of clausius statement of second law of thermodynamic violates Kelvin Planck's law of thermodynamic. **(10 Marks)**

b. A reversible heat engine operating between two thermal reservoirs at 800°C and 30°C respectively. It drives a reversible refrigerator between −15°C and 30°C. The heat input to the heat engine is 1900 kJ and the network output from the combined plant (engine & refrigerator both) is 290 kJ. Determine the heat absorbed by the refrigerant and the total heat transferred to 30°C reservoir. **(10 Marks)**

Module-3

5 a. Define entropy. Prove that entropy is a property of the system. **(06 Marks)**

b. What do you understand by the entropy principle? **(04 Marks)**

c. A lump of steel of mass 8 kg at 1000 K is dropped in 80 kg of oil at 300 K. Find out entropy change of steel, the oil and the universe. Take specific heats of steel and oil as 0.4 kJ/kg.K and 3.5 kJ/kgK respectively. **(10 Marks)**

OR

6 a. Define the following with respect to pure substance with necessary expressions:
(i) Sensible heat (ii) Latent heat (iii) Dryness fraction
(iv) Enthalpy of superheated steam (v) Enthalpy of dry saturated steam **(10 Marks)**

b. Steam initially at 15 bar and 250°C expands isentropically to 1.5 bar. Determine:
(i) The condition of steam (ii) Change in specific enthalpy
(iii) Change in specific entropy (iv) Change in internal energy
(v) Work done, if the mass of the steam is 0.9 kg. **(10 Marks)**

Module-4

7 a. With the help of T-S and h-s diagram, explain the working principle of vapour compression refrigeration plant. What is the effect of superheating and sub-cooling on the vapour compression refrigeration cycle? **(10 Marks)**

b. In an air refrigeration plant working on a reversed bryton cycle, air enters into the compressor at 1 bar, −15°C, where it is compressed to a pressure of 5.5 bar. Air enters the expander at 15°C. Determine: (i) COP of the cycle (ii) Mass flow rate of air into the compressor per minute for 1 ton of refrigeration. Assume both compression and expansion process are isentropic. **(10 Marks)**

OR

8 a. Describe the following terms with respect to psychrometry:
(i) Relative humidity (ii) Absolute humidity (iii) Dry bulb temperature
(iv) Wet bulb temperature (v) Specific humidity **(10 Marks)**

b. The dry and wet temperature of atmospheric air at 101.325 kPa pressure are measured with sling psychrometry and determined to be 25°C and 15°C respectively. Solve the following by the use of tables only: (i) Dew point temperature (ii) Specific humidity
(iii) Relative humidity (iv) Enthalpy of moist air **(10 Marks)**

Module-5

9 a. Derive an expression for efficiency of diesel cycle interms of compression ratio, cut off ratio and specific heat ratio with the assumptions involved. **(10 Marks)**

b. An engine of 250 mm bore 375 mm stroke works on constant volume cycle. The clearance volume is 0.00263 m^3. The initial pressure and temperature are 1 bar and 50°C. If maximum pressure is 25 bar, find: (i) Air standard efficiency (ii) Mean effective pressure **(10 Marks)**

OR

10 a. List out the methods that are employed to determine the frictional power. Explain with necessary sketches and equation about (i) Willian's line method (ii) Morse test **(10 Marks)**

b. The following data refer to the test conducted on a two stroke diesel engine run for 20 minutes at full load. MEP = 3 bar, speed = 350 rpm, Net brake load = 0.65 kN, fuel consumption = 1.52 kg, cooling water = 160 kg, water inlet temperature = 30°C, water outlet temperature = 52°C, A/F ratio = 32, room temperature = 25°C, exhaust temperature = 300°C, cylinder bore = 20 cm, stroke = 28 cm, brake drum diameter = 100 cm, calorific value of fuel = 44000 kJ/kg, steam formed per kg of fuel in the exhaust = 1.4 kg, specific heat of steam in exhaust = 2.09 kJ/kgK, specific heat of dry exhaust gas = 1 kJ/kgK. Construct the heat balance sheet on minute basis. **(10 Marks)**