



USN

--	--	--	--	--	--	--	--	--	--

10ME/AU33

Third Semester B.E. Degree Examination, Aug./Sept.2020**Basic Thermodynamics**

Time: 3 hrs.

Max. Marks: 100

- Note: 1. Answer any FIVE full questions, selecting at least TWO questions from each part.**
2. Use of steam tables is permitted.

PART - A

- 1 a. Define the following :
(i) Open system (ii) Closed system (iii) Isolated system
(iv) Point function (v) Path function (10 Marks)
- b. State the zeroth law of thermodynamics and briefly explain its significance. (04 Marks)
- c. The resistance of the winding of a motor at room temperature 28°C and at full load under steady state conditions is given as 75 Ω and 90 Ω respectively. The windings are made of copper with temperature t°C is given by $R_{tp} = R_0[1 + 0.004t]$. If R_0 is the resistance at 0°C, find the temperature of the coil at full load. (06 Marks)
- 2 a. State and explain thermodynamic definition of work. (04 Marks)
- b. Derive an expression for displacement of the system follows the law $PV^n = \text{constant}$. (06 Marks)
- c. A system of volume V contains a mass m of gas at a pressure of P and the temperature T, these properties are related by $\left(P + \frac{a}{V^2}\right)(V - b) = mRT$, where a, b, R are constants, obtain an expression for the displacement work done when the system undergoes an isothermal process from volume 'V₁' to a final volume 'V₂'. Calculate the work for the system which contain 10 kg of gas expanding from 1m³ to 10m³ at a constant temperature of 293 K. Assume a = 15.7 × 10⁴ Nm⁴, b = 1.07 × 10⁻² m³ and R = 0.278 kJ/kg-K. (10 Marks)
- 3 a. Give the precise statement of first law of thermodynamics as applied to a closed system undergoing a process and hence prove that internal energy is a property. (08 Marks)
- b. A nozzle is a device for increasing the velocity of a steadily flowing stream. At the inlet to a certain nozzle, the enthalpy of the fluid passing is 3000 kJ/kg and the velocity is 60 m/s. At the discharge end, the enthalpy is 2762 kJ/kg. The nozzle is horizontal and there is a negligible heat loss from it.
(i) Find the velocity at the exit of nozzle
(ii) If the inlet area 0.1 m² and specific volume at inlet is 0.187 m³/kg, find the mass flow rate
(iii) If the specific volume at the exit of the nozzle is 0.498 m³/kg, find the diameter at the exit section of the nozzle. (12 Marks)
- 4 a. State the Kelvin-Planck and Clausius statements of the second law of thermodynamics and show that the violation of the former results in the violation of the latter. (08 Marks)
- b. A direct heat engine operating between two reservoirs at 327°C and 27°C drives a refrigerator operating between 27°C and 13°C. The efficiency of the heat engine and the refrigerator are each 70% of their maximum values. The heat transferred to the heat engine is 500 kJ. The net heat rejected by the engine and the refrigerator to the reservoir at 27°C is 400 kJ. Find the net work output of the engine refrigerator combination. Draw the schematic representation. (12 Marks)



10ME/AU33

PART – B

- 5 a. Prove that entropy is a property of a system from Clausius inequality. (10 Marks)
b. 0.5 kg of ice block at -10°C is brought into contact with 5 kg copper block at 80°C in an insulated container. Determine the change in entropy of (i) ice block (ii) copper block (iii) the universe. Given specific heat of ice = 2 kJ/kgK, specific heat of water = 4.2 kJ/kgK, specific heat of copper = 0.5 kJ/kgK, enthalpy of fusion of water at 0°C = 334 kJ/kg. (10 Marks)
- 6 a. Sketch the temperature-pressure phase diagram for water mark on it the following regions of solid, liquid and vapour phase triple point and critical point. (05 Marks)
b. Sketch and explain Separating Calorimeter. (05 Marks)
c. Determine the dryness fraction of the steam sample is tested in a separating and throttling calorimeter and the following data were obtained:
(i) Pressure of steam sample = 15 bar
(ii) Pressure of steam at exit = 1 bar
(iii) Temperature of steam at exit = 150°C
(iv) Water collected from the separating calorimeter = 0.2 kg/min
(v) Discharge collected at the exit = 10 kg/min (10 Marks)
- 7 a. Derive Clausius Clapyerson's equation of liquid and explain the significance. (06 Marks)
b. Distinguish between:
(i) Ideal gas and real gas
(ii) Perfect gas and semi perfect gas (04 Marks)
c. 2 kg air ($C_p = 1.005$ kJ/kgK and $C_v = 0.718$ kJ/kgK) is compressed reversibly according to $PV^{1.3} = \text{constant}$ from 1 bar, 37°C to 5 bar:
(i) Find the increase in internal energy
(ii) Use the relation $\phi = [(n - \gamma)/(n - 1)] C_v (T_2 - T_1)$. Calculate the magnitude and direction of work.
(iii) Show the initial and final states and the process path on T-S diagram. (10 Marks)
- 8 a. Define mass fractions and mole fractions of the constituents of an ideal gas mixture. (04 Marks)
b. Find the gas constant and apparent molar mass of a mixture of 2 kg O_2 and 3 kg of N_2 , given the inversed gas constant is 8314.2 J/KmolK, molar masses of O_2 and N_2 are respectively 32 and 28. (04 Marks)
c. Write short notes on:
(i) Vander Waal's equation of states
(ii) Reduced properties
(iii) Compressibility charts (12 Marks)

* * * * *