Subject Code: BME301

PAPER ID-311980

Roll No:

# BTECH
## (SEM III) THEORY EXAMINATION 2024-25
## THERMODYNAMICS

**TIME: 3 HRS** **M.MARKS: 70**

**Note:** Attempt all Sections. In case of any missing data; choose suitably.

## SECTION A

**1. Attempt *all* questions in brief.** **2 x 07 = 14**

| Q no. | Question | CO | Level |
|---|---|---|---|
| a. | Differentiate between open and closed system. | 1 | K 2 |
| b. | Define intensive and extensive properties. | 1 | K 2 |
| c. | Define specific heat at constant volume. | 2 | K 2 |
| d. | What are the limitations of the First law of Thermodynamics? | 3 | K 3 |
| e. | What is entropy generation? | 3 | K 3 |
| f. | Define Joule – Thomson Coefficient | 4 | K 3 |
| g. | Define saturation pressure and saturation temperature. | 5 | K 3 |

## SECTION B

**2. Attempt any *three* of the following:** **07 x 3 = 21**

| | | | |
|---|---|---|---|
| a. | Explain reversible and irreversible process in detail. Also discuss the thermodynamic state, process, cycle and internal energy. | 1 | K 2 |
| b. | A nozzle is a device for increasing the velocity of a steady flowing steam. At inlet to a certain nozzle, the fluid parameters are: Enthalpy =2850kJ/kg; velocity=50m/sec, area=0.1m$^2$ and specific volume=0.18 m$^3$/kg. At the discharge end the enthalpy is 2650kJ/kg and the specific volume is 0.49 m$^3$/kg. Make the calculations for the velocity of fluid at exit from the nozzle, mass flow rate of the fluid and exit area of the nozzle. The nozzle is horizontal and there is negligible heat loss from it. | 2 | K 3 |
| c. | State the Kelvin Planck and Clausius statements of 2nd law of thermodynamics and also show the equivalence between these two statements. | 3 | K 2 |
| d. | Discuss Availability and Irreversibility in detail with suitable examples. | 4 | K 2 |
| e. | A steam turbine working on Rankine cycle is supplied with dry saturated steam at 25bar and exhaust takes place at 0.2bar. For a steam flow rate of 10 kg/s, determine: (a) quality of steam at the end of expansion, (b) turbine shaft work, (c) power required to drive the pump (d) work ratio (e) Rankine efficiency and (f) heat flow in the condenser. | 5 | K 3 |

## SECTION C

**3. Attempt any *one* part of the following:** **07 x 1 = 07**

| | | | |
|---|---|---|---|
| a. | Discuss Zeroth Law of Thermodynamics. Derive an expression for work done in adiabatic process for an ideal gas. | 1 | K 2 |
| b. | A spherical balloon of 1m diameter contains a gas at 200kPa and 300K. The gas inside the balloon is heated until the pressure reaches 500kPa. During the process of heating, the pressure of gas inside the balloon is proportional to diameter of the balloon. Find the Work Done by the gas inside the balloon. | 1 | K 2 |

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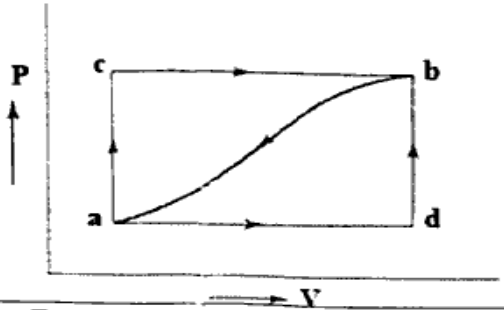
| | | | |
|---|---|---|---|
| **4.** | **Attempt any *one* part of the following:** | **07 x 1 = 07** | |
| a. | When a system is taken from state a to state b, in Fig. along a path acb, 84 kJ of heat flow into the system, and the system does 32 kJ of work. (a) How much will the heat that flows into the system along path adb, if the work done is 10.5 kJ? (b) When the system is returned from 'b' to 'a' along the curved path, the work done on the system is 21 kJ. Does the system absorb or liberate heat, and how much of the heat is absorbed or liberated? (c) If Ua = 0 and Ud = 42 kJ, find the heat absorbed in the processes ad and db.   | 2 | K 2 |
| b. | Derive Steady Flow Energy Equation (S.F.E.E.). By considering suitable assumptions write the steady flow energy equation for nozzle and compressor. | 2 | K 2 |
| **5.** | **Attempt any *one* part of the following:** | **07 x 1 = 07** | |
| a. | Which is the more effective way to increase the thermal efficiency of a Carnot engine: To increase the temperature of source ($T_H$) while the sink temperature ($T_L$) is held constant or to decrease the sink temperature by the same amount while the source temperature is held constant. How the result would be affected in case of a Carnot heat pump? | 3 | K 3 |
| b. | A heat engine is used to drive a heat pump. The heat transfers from the heat engine and from the heat pump are used to heat the water circulating through the radiators of a building. The efficiency of the heat engine is 27% and the COP of the heat pump is 4. Evaluate the ratio of the heat transfer to the circulating water to the heat transfer to the heat engine. | 3 | K 3 |
| **6.** | **Attempt any *one* part of the following:** | **07 x 1 = 07** | |
| a. | Derive Maxwells equations. | 4 | K 2 |
| b. | Discuss in detail available and unavailable energy. What is the available energy referred to a cycle? | 4 | K 2 |
| **7.** | **Attempt any *one* part of the following:** | **07 x 1 = 07** | |
| a. | Explain working of Rankine cycle with T-s diagram and also derive the thermal efficiency of the cycle. | 5 | K 3 |
| b. | Steam at 1000 kPa and 300 °C enters an engine and expands to 20 kPa. If the exhaust steam has a dryness fraction of 0.9, make calculations for the drop in enthalpy and change in entropy. | 5 | K 3 |