Subject Code: KME301

PAPER ID-311225

Roll No:

**B TECH**
**(SEM-III) THEORY EXAMINATION 2020-21**
**THERMODYNAMICS**

***Time: 3 Hours*** ***Total Marks: 100***

**Note: 1.** Attempt all Sections. If require any missing data; then choose suitably.

## SECTION A

**1. Attempt *all* questions in brief. 2 x 10 = 20**

| Q no. | Question | Marks | CO |
|---|---|---|---|
| a. | Differentiate between MACROSCOPIC & MICROSCOPIC Viewpoint? | 2 | CO1 |
| b. | What do you mean by reversible process? What are the conditions which must be satisfied by the process during reversible process? | 2 | CO1 |
| c. | Write down the Statement of third law of thermodynamics. | 2 | CO2 |
| d. | Define principle of entropy increase. | 2 | CO2 |
| e. | What do you understand by Effectiveness and Irreversibility? | 2 | CO3 |
| f. | Explain Adiabatic and Isothermal compressibility. | 2 | CO3 |
| g. | What do you understand by Sensible heat and Latent heat of vaporization? | 2 | CO4 |
| h. | Determine the dryness fraction of steam of 1 kg of water is in suspension with 39kg of dry steam. | 2 | CO4 |
| i. | Write down the properties of refrigerant. | 2 | CO5 |
| j. | What is Bell Coleman cycle? | 2 | CO5 |

## SECTION B

**2. Attempt any *three* of the following:**

| Q no. | Question | Marks | CO |
|---|---|---|---|
| a. | A mass of 8 kg gas expands within a flexible container so that the *p–v* relationship is of the from $pv^{1.2}$ = constant. The initial pressure is 1000 kPa and the initial volume is 1 m3. The final pressure is 5 kPa. If specific internal energy of the gas decreases by 40 kJ/kg, find the heat transfer in magnitude and direction. | 10 | CO1 |
| b. | Derive an expression for thermal efficiency of Carnot Engine | 10 | CO2 |
| c. | In a steam generator, water is evaporated at 260°C, while the combustion gas (*cp* = 1.08 kJ/kg K) is cooled from 1300°C to 320°C. The surroundings are at 30°C. Determine the loss in available energy due to the above heat transfer per kg of water evaporated (Latent heat of vaporization of water at 260°C = 1662.5 kJ/kg). | 10 | CO3 |
| d. | A steam plant working on a simple Rankine cycle operated between the temperature of 260°c and 95°c. The steam is dry and saturated when it enters the turbine and expanded isentropically. Find Rankine efficiency. | 10 | CO4 |
| e. | Determine the ideal COP of an absorption refrigerating system in which the heating, cooling, and refrigeration take place at 197°C, 17°C, and –3°C respectively. | 10 | |

## SECTION C

**3. Attempt any *one* part of the following:**

| Q no. | Question | Marks | CO |
|---|---|---|---|
| a. | A turbo compressor delivers 2.33 m3/s at 0.276 MPa, 43°C which is heated at this pressure to 430°C and finally expanded in a turbine which delivers 1860 kW. During the expansion, there is a heat transfer of 0.09 MJ/s to the surroundings. Calculate the turbine exhaust temperature if changes in kinetic and potential energy are negligible. | 10 | CO1 |
| b. | One kg of air at 1 bar and 300K is compressed adiabatically till its pressure becomes 5 times the original pressure. Subsequently it is expanded at constant pressure and finally cooled at constant volume to return to its original state. Calculate the heat and work interactions, and change in internal energy for each process and for the cycle | 10 | CO1 |

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**4. Attempt any *one* part of the following:**

| Q no. | Question | Marks | CO |
|---|---|---|---|
| a. | 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. | 10 | CO2 |
| b. | To check the validity of the second law, $m_1$ kg of water at absolute temperature $T_1$ is isobarically mixed and adiabatically mixed with $m_2$ kg of water at absolute temperature $T_2$. Find the change in entropy of the Universe. Deduce the expression if the masses of water mixed are equal to m and show that the mixing process is irreversible. Specific heat of water is $S_w$. Assume, $T_1 > T_2$ | 10 | CO2 |

**5. Attempt any *one* part of the following:**

| Q no. | Question | Marks | CO |
|---|---|---|---|
| a. | Air flows through an adiabatic compressor at 2 kg/s. The inlet conditions are 1 bar and 310 K and the exit conditions are 7 bar and 560 K. Compute the net rate of availability transfer and the irreversibility. Take $T0 = 298$ K. | 10 | CO3 |
| b. | Derive Clausius – Clapeyron equation | 10 | CO3 |

**6. Attempt any *one* part of the following:**

| Q no. | Question | Marks | CO |
|---|---|---|---|
| a. | Steam at 20 bar and 360° C is expanded in a steam turbine to 0.08 bar. It then enters a condenser, where is condensed to saturated liquid water. The pump feeds back the water into the boiler. i) Assuming ideal processes, find per kg of steam, the network, and the cycle efficiency. ii) If the turbine and the pump have each 80% efficiency, find the percentage reduction in the network and cycle efficiency. | 10 | CO4 |
| b. | Explain the components and working of steam power plant with help of schematic diagram. | 10 | CO4 |

**7. Attempt any *one* part of the following:**

| Q no. | Question | Marks | CO |
|---|---|---|---|
| a. | Define all the processes happening in basic vapour compression refrigeration cycle with the help of p-v and T-S diagram. | 10 | CO5 |
| b. | A standard vapour compression refrigerator using F-12 as the refrigerant operates between the condenser pressure of 10 bar and the evaporator pressure of 1.5 bar. The evaporator absorbs 75 KJ/min of energy as heat and the vapour is Dry saturated at exit from the compressor. Represent the cycle on T-S plane and calculate: - (i) flow rate of refrigerant, (ii) Power consumed.<br>(iii) COP of the cycle. | 10 | CO5 |