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Roll No. (m)

National Institute of Technology Hamirpur (H.P.)

B.Tech. End-Semester Examination, December, 2022

Branch	:	ME	**Course Code**	:	ME-212
Semester	:	3rd	**Time**	:	3 Hrs
Course Name	:	Engineering Thermodynamics	**Max. Marks**	:	50

NOTE: Attempt all questions which carry marks as indicated in the [ ]. Assume suitable data if missing.

Q-1. Write down the expression for Enthalpy and Entropy for **(i)** Point A (subcooled region), **(ii)** Point B (saturated liquid line), **(iii)** Point C (wet region), **(iv)** Point D (saturated vapor line), **(v)** Point E (superheated region) inside T-S curve. **[5×1]**

Q-2. Derive the following first and second TdS equations. **[2×4]**

(a) $TdS = C_v\ dT + T\left(\frac{\partial P}{\partial T}\right)_V dV$, (b) $TdS = C_p\ dT - T\left(\frac{\partial V}{\partial T}\right)_P dP$

Q-3. Prove the following expression: **[2×3]**

(a) $\Delta s = C_v ln\left(\frac{T_2}{T_1}\right) + R\ ln\left(\frac{v_2}{v_1}\right)$,

(b) A liquid of mass m at a temperature T_1 is mixed with equal amount of same liquid at temperature T_2. The specific heat of liquid is C. Then drive the following expression for the total entropy change.

$$\Delta s = 2 \times m \times C \times ln\left(\frac{{}^{T_1+T_2}/_2}{\sqrt{T_1 T_2}}\right)$$

Q-4. Write down the statement and expression for Clausius Clapeyron equation. Derive the expression for efficiency of dual cycle. **[2+5]**

Q-5. An engine with 200 mm cylinder diameter and 300 mm stroke works on diesel cycle. The initial pressure and temperature of air used are 1 bar and 27 °C. The cut off is 8% of stroke and compression ratio is 15. Determine **(i)** Pressure and Temperature at all salient points in the cycle. **(ii)** Cycle Efficiency, **(iii)** Mean Effective Pressure **[4+2+2]**

Q-6. In a steam turbine steam at 20 bar, 360 °C is expanded to 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. Determine **(i)** the net work done per kg of steam, **(ii)** Cycle efficiency. Consider pump work in calculation and exit of turbine in wet region. Refer the steam table for calculate the enthalpy and entropy at required points. **[2×4]**

Q-7. One kg of air is contained in a piston cylinder assembly at 10 bar pressure and 500 K temperature. The piston moves outwards and the air expands to 2 bar pressure and 350 K temperature. Assume that the system is insulated and the ambient conditions are at 1 bar and 290 K. Further for air R = 0.287 kJ/kg-K, C_v = 0.718 kJ/kg-K and C_p = 1.005 kJ/kg-K. Determine: **(i)** The availability in the initial state, **(ii)** availability in the final state, **(iii)** the maximum useful work and **(iv)** the irreversibility for the system. **[2×4]**