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B.TECH
(SEM III) THEORY EXAMINATION 2022-23
THERMODYNAMICS

Time: 3 Hours ***Total Marks: 70***

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

SECTION A

1. Attempt *all* questions in brief. 2 x 7 = 14

(a) Differentiate between intensive and extensive properties.
(b) State Zeroth law of thermodynamics and its application.
(c) What are the causes of irreversibility?
(d) What do you understand by second law efficiency? How does it differ from first law efficiency?
(e) Draw psychometric chart and show psychometric processes in the chart.
(f) Define relative humidity and absolute humidity.
(g) Write short notes on Reversed Brayton cycle.

SECTION B

2. Attempt any *three* of the following: 7 x 3 = 21

(a) Derive an expression for SFEE. In a nozzle air at 627^0C and twice atmospheric pressure enters with eligible velocity and leaves at a temperature at 27^0C. Determine velocity of air at exist, assuming no heat loss and nozzle being horizontal. Take C_P = 1.005 kJ/Kg-K for air.
(b) Using Maxwell relation derives the first and second Tds equation.
(c) Eight kg of water at 100°C are mixed with 50 kg of water at 60°C, while the temperature of the surroundings is 15°C. Determine the decrease in available energy due to mixing.
(d) In a piston-cylinder arrangement the steam at 1.0 MPa, 80% dryness fraction, and 0.05 m^3 volume is heated to increase its volume to 0.2 m^3. Determine the heat added.
(e) With a neat sketch, explain the working principle of vapour compression refrigeration system. Construct Pressure – Enthalpy (p-h) chart of Vapor compression cycle.

SECTION C

3. Attempt any *one* part of the following: 7 x 1 = 7

(a) Derive the work done for following process:
(i) Isochoric process
(ii) Isobaric process
(iii) Adiabatic process.
(b) In a compressor the air enters at 27°C and 1 atm and leaves at 227°C and 1 MPa. Determine the work done per unit mass of air assuming velocities at entry and exit to be negligible. Also determine the additional work required, if velocities are 10 m/s and 50 m/s at inlet and exit respectively.

4. Attempt any *one* part of the following: 7 x 1 = 7

(a) Explain Second Law of Thermodynamics. Prove that violation of Kelvin Plank statement leads to violation of Clausius statement.

(b) A metal block of 5 kg and 200°C is cooled in a surrounding of air which is at 30°C. If the specific heat of metal is 0.4 kJ/kg-K, calculate:

(i) Entropy change of block
(ii) Entropy change of surrounding
(iii) Entropy change of universe.

5. Attempt any *one* part of the following: 7 x 1 = 7

(a) Discuss the Joule-Thomson effect with a T-p plot. Prove that Joule Thomson coefficient is zero for ideal gas.

(b) In a steam generator, water is evaporated at 260°C, while the combustion gas (c_p = 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).

6. Attempt any *one* part of the following: 7 x 1 = 7

(a) Define critical temperature and critical pressure. Draw a neat sketch of temperature volume diagram for water showing liquid and vapour phases. Mark all the salient points on the diagram.

(b) A steam turbine plant operates on Rankine cycle with steam entering turbine at 40 bar, 350°C and leaving at 0.05 bar. Steam leaving turbine condenses to saturated liquid inside condenser. Feed pump pumps saturated liquid into boiler. Determine the net work per kg of steam and the cycle efficiency assuming all processes to be ideal. Also show cycle on T-s diagram. Also determine pump work per kg of steam considering linear variation of specific volume.

7. Attempt any *one* part of the following: 7 x 1 = 7

(a) What are the desirable properties of refrigerant? Discuss the effect of super heating and sub- cooling on performance of vapour compression refrigeration cycle.

(b) A Vapour compression refrigerator works between the pressure limits of 60 bar and 25 bar. The working fluid is just dry at the end of compression and there is no under cooling of the liquid before the expansion valve. Determine (i). C.O.P of the cycle (ii). Capacity of the refrigerator if the fluid flow is at the rate of 5 kg/min.

Pressure (Bar)	Temperature ◦ C	Enthalpy (kj / kg)		Entropy (Kj / kg K)	
		Liquid	Vapour	Liquid	Vapour
60	295	151.96	293.29	0.554	1.0332
25	261	56.32	322.58	0.226	1.2464