Ex/Prod/T/124/2018

B. E. PRODUCTION ENGG. 1ST YEAR 2nd SEMESTER EXAMINATION, 2018

THERMODYNAMICS

Time: Three Hours **Full Marks: 100**

All parts of a question (*a, b, c* etc) should be answered at one place.
Assume any missing data with proper justification.

GROUP A

1. Answer any SEVEN questions of the following. **7x5 = 35**

a) What is thermodynamic property? Mention the various types of thermodynamic property with examples. (2+3) = 5

b) What is the thermodynamic equilibrium? What do you understand by 'Quasistatic process'? (3+2) = 5

c) What do you mean by the following terms?
(i) Tonne of Refrigeration, (ii) Dryness Fraction, (iii) Triple Point
$(2+ 1\frac{1}{2} + 1\frac{1}{2}) = 5$

d) Explain the following terms:
(i) Dew point temperature, (ii) Specific humidity (iii) Psychometric chart
$(1\frac{1}{2} + 1\frac{1}{2} + 2) = 5$

e) Mention the difference (i) between steady flow and unsteady flow systems and (ii) between reversible and irreversible processes
$(2\frac{1}{2} + 2\frac{1}{2}) = 5$

f) What do you understand by Exergy, Anergy and Availability?
$(1\frac{1}{2} + 1\frac{1}{2} + 2) = 5$

g) What do you understand by Internal Energy, Enthalpy and Entropy?
$(2+ 1\frac{1}{2} + 1\frac{1}{2}) = 5$

h) Explain the following terms:
(i) PMM1 and (ii) PMM2
$(2\frac{1}{2} + 2\frac{1}{2}) = 5$

GROUP B

2. Answer ALL questions. **5x3 = 15**

a) State and explain the Zeroth law of thermodynamics.

b) State and explain the Carnot theorem of thermodynamics.

c) State and explain Clausius statement of second law of thermodynamics

d) What is principle of increase of entropy? - Explain.

e) State and explain the Clausius Inequality.

GROUP C

3. Answer any THREE questions of the following. **3x10 = 30**

a) With the help of entropy principle shows that the mixing of two non-reactive fluids is an irreversible process.

10

b) Two identical finite bodies of constant heat capacity (C_p= 8.4 kJ/K) are initially at temperatures 500° C and 30° C respectively. If a heat engine is operated in cycle between these two bodies calculate the maximum work obtained from the engine by using the entropy principle. Deduce an expression for maximum work you have used.

10

c) A refrigerator uses R-12 as the working fluid and operates on Vapour compression refrigeration cycle between -10°C to 35°C. The vapour being dry at the end of isentropic compression. There is no subcooling of liquid refrigerant and the liquid is expanded through a throttle valve after leaving the condenser. The compression is considered as wet compression done by compressor. Sketch the cycle on T-s diagram. Calculate COP of refrigeration.

Temp. (°C)	Entropy (kJ/ K-kg)		Enthalpy (kJ/ K-kg)		Sp. Volume (m^3/kg)	
	s_f	s_g	h_f	s_g	v_f	v_g
-10	0.1079	0.7014	26.851	156.207	0.7	0.766
+35	0.2557	0.6834	69.494	131.805	0.786	0.0268

c_p for liquid = 0.921 kJ/kg-K and c_p for vapour = 0.7 kJ/ kg-K

10

d) At the inlet to a certain nozzle the specific enthalpy of the fluid is 3025 kJ/kg and the velocity is 60 m/s. At the exit from the nozzle the specific enthalpy is 2790kJ/kg. The nozzle is horizontal and there is a negligible heat loss from it. Calculate:

(i) the velocity of the fluid at exit;

(ii) the rate of flow of fluid when the inlet area is 0.1 m^2 and the specific volume at inlet is 0.19 m^3/kg and

(iii) the exit area of the nozzle when the specific volume at the nozzle exit is 0.5 m^3/kg.

10

e) (i) An inventor claims to have developed a heat engine that takes in 105 MJ at a temperature of 400K, rejects 42 MJ at a temperature of 200 K and delivers 15 kWhr of workdone. Is the claim of inventor justifiable? Give reason to your answer.

(ii) If the gas mixture contains 3 kg of N_2 and 5 kg of CO_2 at a pressure of 3 bar and a temperature of 20° C is heated at constant volume to 40° C find the change in internal energy, enthalpy and entropy. Take (c_p) of N_2= 1.04 kJ/kg-K; (c_p) of CO_2 = 0.755 kJ/kg-K.

(5+5) = 10

GROUP D

4. Answer any ONE question of the following. **10x1 = 10**

a) Illustrate about the Carnot cycle heat engine with the aid of ***T-s*** diagram and derive the expression of the thermal efficiency in terms of temperature.

10

b) Discuss briefly the working principle of Vapour compression refrigeration cycle with the help of flow diagram and ***p-h*** diagram.

10

c) Discuss the working principle of Heat Pump cycle with the help of flow and block diagrams.

10

GROUP E

5. Answer any ONE question of the following. **10x1 = 10**

a) Analyse the effects of superheating and sub-cooling on the performances of vapour compression refrigeration system.

(5+5) = 10

b) (i) Compare the COP of vapour compression refrigeration system with COP of vapour absorption refrigeration system.

(ii) Show that the COP of a heat pump= 1+ COP of refrigerator.

(7+3) = 10

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