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B. TECH
(SEM IV) THEORY EXAMINATION 2017-18
THERMODYNAMICS-I

[Time: 3 hr]

[Total Marks:100]

Note: 1. Attempt all sections if require any missing data, then choose suitably.

2. Steam table is permitted.

SECTION A

Q1. Attempt **all** parts. All parts carry **equal** marks. Write answer of all part in **short**. **(2x10=20)**

- a. Write the difference between Critical temperature and triple point temperature of a pure substance.
- b. An automobile having a mass of 1250 kg is travelling at 40 m/s. What is its kinetic energy in kJ?
- c. A vacuum gauge connected to a tank reads 30 kPa at a location where the barometric reading is 755 mm Hg. Determine the absolute pressure in the tank. Take density of mercury = 15590 kg/m³.
- d. What is the principle of corresponding state?
- e. What is the difference between a refrigerator and a heat pump?
- f. Define one ton of refrigeration.
- g. An ideal gas at 2500 kPa is throttled adiabatically to 150 kPa. What is the change in entropy?
- h. Write Maxwell's equation.
- i. How does a diesel engine differ from a gasoline engine? Explain in two points only.
- j. Draw a P-V diagram of a substance that contracts on freezing. Show all three phases.

SECTION B

Q2: Attempt any three of the following:

(10x3=30)

- a. A rigid tank with a volume of 2.55 m³ contains 5kg of saturated liquid vapor mixture of water at 75-degree C. Now the water is slowly heated. Determine the temperature at which the liquid in the tank is completely vaporized.
- b. The actual efficiency of a heat engine is 36% and its second law efficiency is 60%. If the cold reservoir temperature is 300K. Determine the temperature of the hot reservoir.
- c. A heat pump is to be used to heat a house during the winter. The house is to be maintained at 21 degree C at all the times. The house is estimated to be losing heat at a rate of 135,000 kJ/h when the outside temperature drops to -5-degree C. Determine the minimum power required to drive this heat pump unit.
- d. Throttling a real gas from conditions of moderate temperature and pressure usually results in a temperature decrease. Under what conditions an increase in temperature would be expected?
- e. A gas turbine engine with a compression ratio $P_B/P_A = 6$ operated with air entering the compressor at 25-degree C. If the maximum permissible temperature in the turbine is 760 degree C. Determine the efficiency of the ideal air cycle for those conditions if $\gamma = 1.4$.

SECTION C

Q3: Attempt any **one** part of the following:

(10x1=10)

- A 1.5 m^3 tank contains 550 kg of liquid water in equilibrium with pure water vapor, which fills the remainder of the tank. The temperature and pressure are 100 Degree C and 101.33 kPa. From a water line at a constant temperature of 70-degree C and a constant pressure somewhat above 101.33 kPa, 750 kg of liquid water is blend into the tank. If the temperature and pressure in the tank are not to change as a result of the process, how much heat must be transferred to tank?
- In a steady state flow process, 1 mol/sec of air at 650 K and 1 atm is continuously mixed with 2 mol/sec of air at 500 K and 1 atm. The product stream is at 400 K and 1 atm. Determine the rate of heat transfer and the rate of entropy generation for the process. Assume the air is an ideal gas with $C_p = (7/2) R$, that the surroundings are at 300 K, and that kinetic and potential energy changes are negligible. ($R = 8.314 \text{ j/mole/K}$).

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

(10x1=10)

- Derive a relation for thermal efficiency of a diesel cycle.
- Sketch the air-standard Otto cycle on a PV diagram and derive an equation giving the thermal efficiency of this cycle in relation to the compression ratio r .

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

(10x1=10)

- An absorption refrigeration system is to remove heat from the refrigerated space at -10-degree C at a rate of 15 kW while operating in an environment at 25-degree C. Heat is to be supplied from a source at 85-degree C. What is the minimum rate of heat supply required?
- Explain regenerative cycle for power generation.

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

(10x1=10)

(a) Derive the given equation

$$du = c_v dT + \left[T \left(\frac{\partial P}{\partial T} \right)_v - P \right] dv$$

(b) Derive the given equation

$$\left(\frac{dT}{dP} \right)_{sat} = \frac{h_{fg}}{T v_{fg}}$$

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

(10x1=10)

- Describe Linde gas liquefaction process.
- Explain absolute temperature scale.