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B.TECH.

THEORY EXAMINATION (SEM–IV) 2016-17

CHEMICAL ENGINEERING THERMODYNAMICS-I

Time : 3 Hours ***Max. Marks : 100***

Note : *Be precise in your answer. In case of numerical problem assume data wherever not provided.*

SECTION A

1. Attempt all questions of the following (10 x 2 = 20)

a. State the second law of thermodynamics.
b. What is volume expansivity?
c. What is meant by heat engine?
d. Explain the limitations of first law of thermodynamics
e. Derive an expression for expanding agas.
f. Define the term COP.
g. Define Joule – Thomson Co-efficient
h. What is Third Law of Thermodynamics.?
i. What is meant by thermodynamic property?
j. What is meant by closed system? Give an example.

SECTION B

2. Attempt any five of the following (10 x 5 = 50)

a. 220 kg of CO_2 gas at 27°C and 1 atm is compressed adiabatically to 1/5th of its volume. It is then cooled to its original temperature at constant volume. Find Q, ΔU and W for each step.
b. What is critical point? Draw and discuss P-V diagram.
c. Show that the fugacity of a gas obeying the equation of state p(v – B) = RT, is given by $f = p\,e^{Bp/RT}$
d. Derive fundamental property relation. Also list the four Maxwell's relations.
e. A heat engine operates between a source a 600 °c and a sink at 60^0c Determine the least rate of heat rejection per KW net output of the engine.
f. Derive

$$dH = C_p dT + \left[V - T\left(\frac{\partial V}{\partial T}\right)_P\right]dP$$

g. Derive a relation for entropy change for adiabatic mixing.
A steel casting at a temperature 725K and weighing 35 Kg is quenched in 150Kg oil at 275 K. if there are no heat losses, determine the change in entropy. The specific heat of steel is 0.88 KJ/Kg K and that of an oil is 2.5 KJ/Kg K.
h. One gram mole of a perfect gas with C_P = 7 cal/gmol.°K is to be expanded from 10 atm and 500 K to 1 atm and 300 K by two reversible paths.
i. Cool at 10 atm from 500 K to 300 K and expand isothermally to 1 atm at 300 K.
ii. Expand at 500 K to the final volume and cool at constant volume to 300 K.
. iii. What is the change in entropy for the gas over each path?

SECTION C

Attempt any two of the following (15 x 2 = 30)

3. A turbine operates under steady flow condition receives steam at the following:

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State pressure = 1.2Mpa, Temperature =188^{0}C, Enthalpy = 2785 kJ/kg, velocity = 33.3m/sec and elevation = 3m. The steam leaves the turbine at the following state:
Pressure = 20Kpa, Enthalpy = 2512 kJ/kg, velocity = 100m/sec and elevation = 0m.
Heat is lost to the surrounding at the rate of 0.29kJ/sec. If the rate steam flow to the turbine is 0.42kg/sec, what is the power output of the turbine in KW.

4. Explain in detail with the help of P-V diagram the work required in the case of Isothermal and Adiabatic process.

5. What does Gibbs-Duhem equation relate? Derive various forms of Gibbs-Duhem equation.

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