Registration no:

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M .TECH
HTPC201 / TFPC201

Second Semester Examination 2013

ADVANCED ENGINEERING THERMODYNAMICS

Time: 3 Hours

Max marks: 70

Answer Question No.1 which is compulsory and any five from the rest.
The figures in the right hand margin indicate marks.

Q1 Answer the following questions: (2 x 10)

a) Define isothermal compressibility and volume expansivity.
b) Write down the Maxwell's equations
c) What is the compressibility factor?
d) What are the viral coefficients? When do they become zero?
e) What is heat of reaction?
f) Define adiabatic flame temperature.
g) Explain thermochemical exergy and chemical energy.
h) For a given T_2, show that COP of a refrigerator increases as T_1 decreases.
i) How can a heat pump upgrade low grade waste heat.
j) Under what conditions SFEE does the SFEE reduce to Euler's equation

Q2 Two kg of air at 500kPa, 80°C expands adiabatically in a closed system until its volume is doubled and its volume is doubled and its temperature becomes equal to that of surroundings which is at 100kPa, 5°C. for this process, determine (i) the maximum work (ii) the change in the availability (iii) irreversibility (10)

Q3 a) Derive the equation (5)

$$\left(\frac{\partial C_p}{\partial p}\right)_T = -T\left(\frac{\partial^2 V}{\partial T^2}\right)_p$$

b) In the case of a gas obeying the equation of state (5)

$$\frac{pv}{RT} = 1 + B' p$$

Where B' is a function of T only, s
Show that

$$C_p = \bar{R}Tp\frac{d}{dT^2}\left(B'T\right) + \left(C_p\right)_o$$

Where $\left(C_p\right)_o$ is the value at very low pressures.

Q4 A gasoline engine delivers 150 kW. The fuel used is C_8H_{18} (*l*) and enters the engine at 25°C. 150% theoretical air is used and it enters at 45°C. the products of combustion leave the engine at 750K, and the heat transfer from the engine is 205 kW. Determine the fuel consumption per hour, if complete combustion is achieved. (10)

Q5 a) What do you undersrant by standard Gibbs function change? (4)

b) For the chemical reaction (6)

$CO_2 + H_2 \square \quad CO + H_2O$

The equilibrium value of the degree of reaction at 1200K is 0.56. determine the equilibrium constant and Gibbs function change.

Q6 a) 10 litres of gas at atmospheric pressure is compressed isothermally to a volume of 1 litre and then allowed to expand adiabatically to 10 litres. (10)

(i) sketch the processes on a pV diagram for a manoatomic gas

(ii) make a similar sketch for a diatomic gas

(iii) is a net work done on or by the system?

(iv) Is it greater or less for the diatomic gas?

Q7 a) Briefly explain Fermi Dirac and Bose – Einstein statistics. (5)

b) Explain (i) fugacity (ii) activity (5)

Q8 Write short notes (any two) (5+5)

a) Entropy generation

b) Gibbs phase rule

c) Clausius-Clapeyron equation