GIET UNIVERSITY, GUNUPUR – 765022

RD19MTECH020

Registration No: | | | | | | | | | | |

Total Number of Pages : 02 **M.TECH**

AR-19

M.TECH 1ST SEMESTER EXAMINATIONS NOV/DEC 2019

Branch: TE, MPCTE1010

ADVANCED ENGINEERING THERMODYNAMICS

Time: 3 Hours **Max Marks : 70**

The figures in the right hand margin indicate marks.

PART-A (10 X 2=20 MARKS)

1. Answer the following questions.

a) Explain through a suitable example the difference between the first and second law efficiencies?

b) A refrigerator removes 1.5 kJ from the cold space using 1 kJ work input. How much energy goes into the kitchen, and what is its coefficient of performance?

c) Does the temperature in the clausius inequality relations have to be absolute temperature? Why?

d) A heat engine receives heat from a source at 1200 K at a rate of 500kJ/s and rejects the waste heat to a medium at 300 K. The power output of the heat engine is 180 kW. Determine the reversible power and the irreversibility rate for this process.

e) A 1-m^3 tank is filled with a gas at room temperature (20^oC) and pressure (100 kPa). How much mass is there if the gas is a. air, b. oxygen?

f) What do you mean by enthalpy of formation?

g) Difference between exergy and energy.

h) What are the viral coefficients? When do they become zero?

i) If we say a particular energy level is 10 fold degenerate, then what do you understand from that?

j) What do you mean by fugacity?

PART-B (5 X 10=50 MARKS)

Answer any five questions from the following.

2.

a) Show that there is no change in temperature when an ideal gas is made to undergo a Joule Thomson expansion.

b) Two tanks are connected through a pipe with valve in between. Initially valve is closed and tanks A and B contain 0.6 kg of air at 90^oC, 1 bar and 1 kg of air at 45^oC, 2 bar respectively. Subsequently valve is opened and air is allowed to mix until equilibrium. Considering the complete system to be insulated determine the final temperature, final pressure and entropy change.

3.

a) Water at 90 degree Celsius flowing at the rate of 2kg/sec mixes adiabatically with another stream of water at 30 degree Celsius flowing at the rate of 1 kg/sec. Estimate the entropy generation rate

and the rate of exergy loss due to mixing. Take T_0 = 300K.

b) 500 kJ of heat is removed from a constant temperature heat reservoir maintained at 835K. Heat is received at constant temperature of 720K. Temperature of the surroundings, the lowest available temperature is 280K. Determine the net loss of available energy as a result of this irreversible heat transfer.

4.

a) What is Gibbs phase rule for non reactive system? Explain about degree of freedom.

b) A gasoline engine delivers 150 kW. The fuel used in C_8H_{18} (liq) and it enters the engine at 25^0C. 150 % of theoretical air is used, and enters at 45^0C the products of combustion leave the engine at 750 K and the heat transfer from the engine is 250 kW. Determine the fuel consumption in kg per hour if complete combustion is achieved

5.

a) Write down about Maxwell Boltzmann distribution for different kind of molecular speed.

b) Methane is reversibly compressed at 230 K in a steady state steady flow (sssf) device from 150 bar to 1000 bar. Determine work done in kJ/Kmol. Critical pressure is 46.4 bar and critical temperature is 190.7K.

6.

a) If the thermodynamic variables are P, V, T then prove that $(\delta P/\delta V)T\ (\delta V/\delta T)P\ (\delta T/\delta P)v = -1$.

b) Derive the equation $(\delta Cp/\delta p)T = -T\ (\delta^2 V/\delta T^2)$

7.

a) A compressor operating at steady state takes 1kg/s of air at 1 bar and 25 degree Celsius and compresses it to 8 bar and 160 degree Celsius. Heat transfer from the compressor to its surroundings occurs at a rate of 100 kW. Determine the power input in kW. Evaluate the second law efficiency for the compressor. Neglect KE and PE changes. Take T_o=25 degree Celsius and P_o= 1 bar.

b) Derive the first and second TdS equations. Also derive the expression for difference in specific heat capacities C_p and C_v. What does the expression signify?

8. Write down the short note on:

a) Nernst law.

b) Entropy maximum Vs. Energy minimum principle.

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