Total No. of printed pages = **2**

SUBJECT CODE = MEE024102

Roll No. of candidate | | | | | | | | | | |

2017

End Semester M.TECH. (Thermal & Fluid Engineering) Examination

1st Semester

ADVANCED THERMODYNAMICS

Full Marks- 70 Pass marks- 21 Time- 3 hours

The figures in the margin indicate full marks.

PART-A

Answer all questions

Q.1. **(1 x 16=16)**

a. Write the expression for Steady Flow Energy Equation.
b. Write the Gibbs equation for a closed systems
c. Write the expression for Clapeyron Equation.
d. Write the expression for second-law efficiency.
e. What is the number of molecules in one kgmol of a gas?
f. Write the expression of root-mean-square velocity of molecules in an ideal gas.
g. How many degrees of freedom does a diatomic molecules have?
h. Write the expression for Universal Gas Constant in terms of the specific heats.
i. Define mean free path of a molecule.
j. Write an expression for the collision cross-section.
k. What is the Van der Waals equation of state for a real gas?
l. Name two irreversible processes.
m. Write the exergy balance for steady flow process.
n. Name the working fluids used in binary vapour cycle.
o. In fuel cells which two elements are used?
p. In thermo-electric generator what phenomena are applied?

PART-B

Answer all questions

Q.2. **(3.5 x 4 = 14)**

a. Explain the Joule Thompson Effect.
b. State the assumptions for the molecular model of an ideal gas.
c. Explain the Onsager equations.
d. What is co-generation and how is it more efficient.

PART-C

Answer all questions

Q.3.

a. (i) Derive expressions for the Maxwell Relations. **(5)**

(ii) Explain the phase transition processes of water with the help of a phase diagram on *p-T* coordinates. **(5)**

OR

b. (i) Define exergy. **(2)**

(ii) Calculate the decrease in exergy when 25kg of water at 95^{O}C mix with 35kg of water at 35^{O}C, the pressure being taken as constant and the temperature of the surrounding being 15^{O}C (c_p of water = 4.2 kJ/kg K). **(8)**

Q.4.

a. Using kinetic theory of gases, derive an expression for the pressure of an ideal gas. **(10)**

OR

b. A cylinder containing hydrogen at 400 K & 1 atm. is placed in an evacuated chamber. If a hole of area $0.03mm^2$ is made in the cylinder. Calculate the number of molecules leaking through the hole per second. Take the average velocity of the molecules as 0.725 of the rms. speed. **(10)**

Q.5.

a. Derive the equation for the corrected mean free path of a molecule in terms of diameter of molecule, pressure and temperature of the gas. **(10)**

OR

b. Derive the equation for the entropy production in a copper rod in which both heat and electric current are flowing. **(10)**

Q.6.

a. Steam enters a turbine steadily at 3MPa and 450°C at a rate of 10 kg/s and exits at 0.2MPa and 150°C. The steam is losing heat a rate of 400 kW to the surrounding air which at 0.1MPa and 25°C. Determine (i) energy efficiency and (ii) exergy efficiency of the turbine. **(10)**

Pressure (MPa)	Temperature (^{O}C)	Enthalpy (kJ/kg)	Entropy (kJ/kgK)
3.0	450	3344.9	7.0856
0.2	150	2769.1	7.2810
0.1	25	104.8	0.3672

OR

b. Describe any two of following direct energy conversion systems **(5+5=10)**

(i) Fuel cells (ii) Thermo-ionic

(iii) Magneto hydrodynamic (iv) Photovoltaic cells