B

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2015

Mechanical Engineering

(Common to Thermal sciences and Thermal Engineering)

01ME6201 Advanced Thermodynamics

Max. Marks : 60 Duration: 3 Hours

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Module I&II

(Answer any Two full question)

1a.Explain Gibbs and Helmholtz minimum energy principles. 4

1b.A vander Waal gas undergoes an isothermal expansion from specific volume v_1 to specific volume v_2.Calculate the change in the specific Helmholtz function and calculate the change in the specific internal energy in terms of v_1 and v_2. 5

2a.Prove that for binary elastic collision relative velocity is conserved. 5

2b.Show that for an open system with one component $dG = -SdT + Vdp + \mu dn$ where μ is chemical potential 4

3a.Derive survival equation and write the expression for collision frequency. 4

3b. For carbon dioxide at 1 atm and 300K,find the mean free path.What is the ratio of mean free path to the molecular diameter?What is the collision frequency? 5

Module III&IV

(Answer any Two full question)

4a.Derive an expression for thermal conductivity using kinetic theory. 5

4b.The experimental value of the viscosity of argon gas is found to be $22.0*10^{-6}$Pa-s at 15^0C and atmosheric pressure.The atomic weight of argon is 39.94.Estimate the diameter of an argon atom. 4

5a. What is Boltzmann H theorem .Explain 4

5b.Calculate the coefficient of friction of a disc sliding on an air table with speed of 1m/s .The diameter of the disc is 0.1m and its mass is 0.3kg.Assume that it glides 10^{-4} m above the table.The diameter of nitrogen molecule is about $4*10^{-10}$m. 5

6. Derive continuity and momentum equation from Boltzmann moment equation . 9

Module V&VI

(Answer any Two full question)

7a.At room temperature(300K),what is the equilibrium number of bosons per state (N_j/g_j) for an energy ϵ_j ,

i. 0.001 eV above the chemical potential μ

ii. 0.1 eV above the chemical potential μ 5

7b.A system has energy levels at ε=0, ε=300k and ε=600k,where k is Boltzmann's constant.The

degeneracies of the levels are 1,3 and 5 respectively.

i. Calculate the partition function,relative populations of the energy levels, and the average energy ,all at 300k.

ii. At what temperature is the population of the energy level at 600k equal to the population of the energy level at 300k. 7

8a. Develop distribution formula of indistinguishable particles obeying Pauli's exclusion principle 6

8b. At room temperature(300K),what is the equilibrium number of fermions per state (N_j/g_j) for an energy ϵ_j , 0.1 eV above the chemical potential μ 6

9. Derive maxwellian distribution function from kinetic theory of gases. 12