10. (a) Define critical exponents giving one example each in fluid and megnetic systems.

What are the parameters on which critical exponents depend? 4+2=6

(b) Obtain the critical constants of a real system obeying Vander Waal's equation of states. 8

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PG (CBCS) ODD SEMESTER EXAMINATION, 2022

PHYSICS

3rd Semester

Course No. : PHYCC - 302

(Statistical Physics)

Full Marks : 70

Pass Marks : 28

Time : 3 hours

The figures in the margin indicate full marks for the questions

(Answer any five questions, taking one from each unit)

UNIT - I

1. (a) State and prove Boltzmann's entropy reaction. 5

(b) What do you mean by intensive and extensive variables? 3

(c) Consider a homogeneous system whose volume V is the only external parameter. Prove that

(i) $\left(\frac{\partial E}{\partial S}\right)_V = T$

(ii) $\left(\frac{\partial E}{\partial V}\right)_S = P$

(symbols have their usual meaning) 3+3=6

2. (a) Show that Kelvin-Plank and Clausius statements of second law of thermodynamics are equivalent to each other. 6

   (b) Prove that two macrostates A_1 (N_1, V_1, T_1) and A_2 (N_2, V_2, T_2) will be in equilibrium when $T_1 = T_2$, $P_1 = P_2$ and $\mu_1 = \mu_2$

   (symbols have their usual meaning) 8

UNIT - II

3. (a) What is Gibb's paradox? How can it be resolved? 7

   (b) In case of a canonical ensemble, show that the average energy per system (U) 7

$$U = \frac{\in}{N} = \frac{\sum_r E_r \, e^{-\beta E_r}}{\sum_r e^{-\beta E_r}}$$

   (symbols have their usual meaning)

4. Distinguish between different ensembles highlighting their features. Show that in canonical ensemble almost all systems have the same energy, the internal energy of a system at given temperature. 14

UNIT - III

5. (a) An electron is placed is an external magnetic field. The electron's instrinsic spin is $\frac{1}{2}\hbar\hat{\sigma}$ and magnetic moment is μ_b. Find the expectation value of σ_z. 4

   (b) Derive the expression of Fermi-Divec distribution law. 8

   (c) Write the density metrix for grand canomical ensemble. 2

6. (a) A gas of non-relativistic classical particles in one dimention is subjected to a potential $\upsilon(x) = \alpha|x|$, where α is a positive constant. Calculate the partition function and average energy. 6

   (b) If $\hat{\rho}$ is the density operator and $\hat{H}$ is the Hamiltonian of a system, then show that 8

$$i\hbar\,\hat{\rho} = [\hat{H}, \hat{\rho}]$$

UNIT - IV

7. (a) Explain Pauli's theory of paramagnetism. 9

   (b) Discuss the phenomenon of second sound. 5

8. What are the characteristic features of ideal Fermie gas? Find the specific heat of it at finite temperature and hence prove that the ground state presence $\rho_0 \infty n^{5/3}$, where n is the particle density. 14

UNIT - V

9. Discuss Ising model in one dimension briefly. 14