



# LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

**M.Sc. DEGREE EXAMINATION – PHYSICS**

**THIRD SEMESTER – NOVEMBER 2014**

**PH 3814 - STATISTICAL MECHANICS**

Date : 30/10/2014  
Time : 09:00-12:00

Dept. No.

Max. : 100 Marks

## Part A

**Answer all the questions:**

**(10 x 2 = 20 Marks)**

1. What is meant by phase-space? Define phase trajectory.
2. Relate the thermo dynamical variables, P, T and  $\mu$  as partial derivatives of entropy.
3. If the number of microstates  $\Omega(N, V, E) \propto V^N$ , then show that P, V and T are related through the ideal gas law.
4. Write down the canonical partition function of a system of n identical particles distributed in two energy levels  $\epsilon_1$  &  $\epsilon_2$ .
5. Show that in microcanonical ensemble the density matrix satisfies the relation  $\rho^2 = \rho$
6. Differentiate between density of states  $g(\epsilon)$  and degeneracy  $g_i$ .
7. What causes BE condensation in a system of Bosons?
8. Why is the chemical potential for photons zero?
9. What is meant by thermionic emission? Define work function of a metal.
10. Draw the variation of the chemical potential  $\mu$  of an ideal Fermi gas as a function of  $(T/T_F)$ .

## Part B

**Answer any four questions:**

**(4 x 7.5 = 30 Marks)**

11. Prove that Phase trajectory of a harmonic oscillator is an ellipse.
12. Having defined  $P_r$  in the canonical ensemble, obtain the thermodynamic parameters like S, P,  $\mu$ , V,  $C_v$  as partial derivatives of Helmholtz free energy
13. Find the number fluctuation using grand canonical ensemble in terms of isothermal compressibility of the system
14. Discuss the lambda transition in liquid He<sup>4</sup>.
15. Discuss the thermodynamic properties of a weakly degenerate Fermi gas.
16. Derive an expression for the fluctuation in the pressure for a canonical ensemble.

## Part C

**Answer any four questions:**

**(4 x 12.5 = 50 Marks)**

17. State and prove Liouville's theorem
18. From a discussion on the thermodynamics of magnetic systems account for the significance of the negative temperature.
19. Obtain the expression for the entropy and equation of state of an ideal gas in grand canonical ensemble.
20. Explain the super-fluidity of liquid helium using Landau's theory.
21. Show that mass of a white dwarf star cannot be larger than a limiting mass known as Chandrasekar limit.
22. (a) State and prove Virial theorem.  
(b) The restoring force of an anharmonic oscillator is proportional to the cube of the displacement. Show that the mean kinetic energy of the oscillator is twice its mean potential energy.