M.Sc. Physics Semester – 3 Examination
Phys-C-302 - {Advanced Quantum Mechanics and Statistical Mechanics}
Paper Code: 21709

Time: 01 Hour 30 Min 07 DEC 2020 **Maximum Marks: 42**

Note: Answer any three questions. Figures to the right indicate marks allotted.
All symbols have their usual meaning.

1	a)	i) Write detailed note on the spin and helicity of a Dirac particle. ii) What is Gibbs paradox?	12 02
		OR	
	a)	i) Derive Dirac's relativistic equation for a free particle. Explain the term negative energy of Dirac particle. ii) Define: microstate, macrostate, ensemble, phase space.	10 04
2	a)	i) Give quantum mechanical definition of "ensemble". Define density matrix. Derive quantum-mechanical analogue of classical Liouville equation. ii) Write two properties of density matrix.	12 02
		OR	
	a)	i) For a linear harmonic oscillator, derive an equation for partition function, mean energy of the oscillator, and also interpret these results. ii) Discuss the concept of *entropy* using quantum mechanical microcanonical ensemble.	12 02
3	a)	i) What are phonons? Write detailed note on Debye theory of specific heat for solids. ii) Write detailed note on ultra-relativistic Bose gas.	10 04
		OR	
	a)	i) For black-body radiation, derive an expression for internal energy and hence derive Planck's distribution law. ii) Write note on relativistic Fermi gas.	10 04
4	a)	i) Based on Landau theory, write detailed note on the *superfluidity*, taking an example of liquid helium. What is *roton*? ii) Write importance of Clausis-Clapeyron equation.	12 02
		OR	
	a)	i) Write detailed note on neutron stars and white dwarf stars. What is Chandrasekhar limit for limiting mass of a white dwarf star. ii) Explain with proper graphs P-V and P-T phase diagram of a substance. Discuss first- and second-order phase transition.	10 04