St. Philomena's College (Autonomous), Mysore
PG Department of Physics

III Semester

Course: Condensed Matter Physics - 1
QP Code: 88332

Question Bank

Sl. No.	Module	Question	Marks
1.	1	The dielectric constant of He at 273K is 1.000074. The density of He atoms is $2.7 \times 10^{25}/m^3$. Calculate the induced dipole moment in each atom when the He gas is in an electric field of 3×10^4 V/m.	5
2.	1	The dielectric constant of sulphur is 3.4. Assuming a cubic lattice for its structure calculate the electronic polarizability of lattice of sulphur. Given, density of sulphur = 2.07g/cc and atomic weight = 32.07.	5
3.	1	The dielectric constant of He gas at NTP is 1.0000684. Calculate the electronic polarizability of He atom if the gas contains 2.7×10^{25} atoms/m^3.	5
4.	1	The refractive index of diamond is 2.4. Calculate the electronic polarizability of carbon atom. Given, $N = 1.8 \times 10^{23}$ atoms/cc.	5
5.	1	The relative permittivity of argon at 273K and 1 atm pressure is 1.000435. Calculate the polarizabilty of the Ar atom. Given: Number of atoms of Argon at NTP = $2.6 \times 10^{25}/m^3$.	5
6.	1	An elemental solid dielectric material has polarizability of 7×10^{-40} F-m^2. Assuming the local field to be Lorentz field, calculate the dielectric constant of the material if it contains 3×10^{28} atoms/m^3.	5
7.	1	The dielectric constant of He gas at NTP is 1.0000684. Calculate the electronic polarizability of He if the gas contains 2.7×10^{25} atoms/m^3.	5
8.	1	A solid elemental dielctric containing 3×10^{28} atom/m^3 shows an electronic polarizability of 10^{-40} F-m^2. Calculate the dielectric constant of the material dielectric.	5
9.	1	Find the electronic polarization produced in a dielectric medium of relative permittivity 15 in the presence of an electric field of 500V/m.	5
10.	1	For a solid, the dielectric constant is 1.56, density is 1.899kg/m^3 and atomic weight = 63.5. Estimate the polarizability of the solid.	5

11.	1	A parallel plate capacitor consists of 2 plates each of area 5×10^{-4} m^2. The two plates are separated by a distance of 1.5×10^{-3}m and the gap between the two plates is filled with a material of dielectric constant ε_r = 6. Calculate the charge on the capacitor if it is connected to a 100V dc supply.	5
12.	1	An elemental solid contains 5×10^{28} identical atoms per m^3, each with a polarizability of 2×10^{-40} F-m^2. Assuming the local field to be a Lorentz field, calculate the ratio of local field to the applied field.	5
13.	1	There are 1.6×10^{20} molecules/m^3 in NaCl vapour. Determine the orientational polarization at room temperature if the vapour is subjected to an electric field of 50,000V/cm. Assume that NaCl molecule consists of Na^+ and Cl^- ions separated by 0.25nm.	5
14.	1	The following data refers to a dielectric material: ϵ_r = 4.94 and n^2 =2.69, where n is the index of refraction. Calculate the ratio between electronic and ionic polarizabilities for this material.	5
15.	1	Calculate the dipolar polarizability of NH_3 at 448K. Given: the dipole moment of NH_3 molecule = 5.30×10^{-30} C-m, $k_b = 1.38 \times 10^{-23}$ J/K.	5
16.	1	Calculate the field strength required to reach 0.1% of the saturation value of the orientational polarization of a dipolar gas at room temperature if the dipoles have a strength of 1 debye unit.	5
17.	1	Calculate the atomic polarizability in a solid with concentration of 10^{23} atoms/cm^3. Given: the dielectric constant ϵ = 10.	5
18.	1	A paraelectric substance has 10^{26} atoms/m^3, the electric dipole moment of each atom is 3.4×10^{-28} C-m. Calculate the paraelectric susceptibility at 500K.	5
19.	1	The polarizability of NH_3 is 1.74×10^{-39} F-m^2 and 2.42×10^{-39} F-m^2 respectively at 448 and 309K. Calculate the dipole moment of the molecule.	5
20.	1	Calculate the orientational polarizability of water molecule at room temperature. Given the dipole moment of water = 1.9×10^{29} C-m.	5
21.	1	Assuming there are 10^{27} molecules/m^3 in HCl vapour calculate the orientational polarization at room temperature if the vapour is subjected to an electric field of 10^5 V/m. The dipole moment of HCl molecule is 3.46×10^{-30} C-m.	5
22.	1	The dielectric constant of a solid is 5. It is placed between the plates of a capacitor which are 1mm apart and which is charged to 100 Volts. Calculate the local field in the dielectric solid.	5

23.	1	Calculate the orientational polarizability of HCl molecule at room temperature. Given the dipole moment of HCl molecule is equal to 3.46×10^{-30} C-m.	5
24.	1	On what factors does the breakdown voltage of a dielectric material depend? Explain	5
25	1	Explain the mechanisms that lead to dielectric breakdown.	5
26	1	Explain absorption of energy in dielectrics.	5
27	1	Explain graphically how the real and the imaginary components of the complex dielectric constant vary with respect to the frequency of the applied field.	5
28	1	Explain the terms (i) dielectric breakdown (ii) dipole relaxation	5
29	1	For ammonium dihydrogen phosphate the Curie temperature is 390K and Curie constant is 400K. Find the dielectric constant of the material at T = 407K.	5
30	1	Calculate the polarization of $BaTiO^3$ when the oxygen ion in the lattice is displaced by 0.1Å relative to Barium ions. Given: the cube edge of $BaTiO^3$ = 4.00Å.	5
31	1	Find the dielectric constant of Rochelle salt along a-axis at 23^0C, whose Curie temperature is 296K and the Curie constant = 178K.	5
32	1	In $BaTiO_3$, saturation polarization P_S at room temperature is 8×10^4 esu. The volume of the unit cell is 64×10^{-24} cm^3. Find the dipole moment of the unit cell of $BaTiO_3$.	5
33	1	In $BaTiO_3$ crystal the unit cell is a cube of side 4Å. If Ba and Ti ions are moved by 0.1Å w.r.to oxygen ions, calculate the polarization P of the sample.	5
34	1	Calculate the dipole moment of $BaTiO_3$ having saturation polarization 8×10^4 esu/ cm^2. Given its lattice constant a = 4Å.	5
35	1	For a ferroelectric material $\gamma = 0.044$, $N = 10^{21}/cm^3$ at a temperature (T_C) = 260K. Find the dipole moment of the material.	5
36	1	Define the terms (i) electric flux density and (ii) electric susceptibility χ_e . Show that the electric susceptibity is related to the dielectric constant ϵ_r in the form $\chi_e = (\epsilon_r - 1)$.	5
37	1	Explain what is ionic polarizability.	5
38	1	Derive an expression for electronic polarization and explain its temperature dependence.	5
39	1	What are polar and non-polar dielectrics? Explain with examples.	5
40	1	Explain what is dielectric constant. Show that the dielectric constant ϵ_r is related to electronic polarizability in the form: $\varepsilon_r = 1 + \frac{N\alpha}{\varepsilon_0}$.	5

41	1	Define the terms (i) Electric dipole and (ii) Electric polarizaation.	5
42	1	Explain what are dielectrics and list any three important applications of dielectric solids.	5
43	1	Briefly describe ionic and orientational polarizations in a dielectric subjected to an electric field.	5
44	1	For a dielectric medium possessing cubic symmetry, show that: $\frac{\varepsilon_r - 1}{\varepsilon_r + 2} = \frac{N\alpha}{3\varepsilon_0}$.	5
45	1	Explain the terms (i) the complex dielectric constant and (ii) the phase factor.	5
46	1	Explain what is meant by (i) complex dielectric constant and (ii) relaxation time.	5
47	1	Explain what is complex dielectric constant.	5
48	1	Explain the terms (i) relaxation time and (ii) dielectric loss.	5
49	1	Explain the classification of ferroelectric crystals with examples.	5
50	1	Describe the basic properties of $BaTiO_3$.	5
51	1	What are the objections against the dipole theory of ferroelectrics? Explain.	5
52	1	Explain the mechanism of domain growth in ferroelectrics	5
53	1	Describe any six general properties of ferroelectric materials.	5
54	1	Discuss the dipole theory of ferroelectricity.	5
55	1	Describe the basic properties of Rochelle salt.	5
56	2	Write a note on ferromagnetic domains.	5
57	2	List any five important properties of ferromagnetic materials.	5
58	2	Describe with suitable diagram the Neel's two sub-lattice model.	5
59	2	Compare the paramagnetic spin-spin and spin-lattice relaxation.	5
60	2	Estimate the Weiss constant for a ferromagnetic material showing curie temperature of 1000K. Given: The number of atomic dipoles per unit volume $N=10^{28}$ and $\mu_B = 9.27X10^{-24J}\ J/T$.	5
61	2	Calculate the group velocity for the spin wave, in a ferromagnetic solid, in the long wavelength limit. Given: J_e=0.1eV and S=1/2, lattice constant = $7.87x10^{-10}$m.	5
62	2	Find the magnetic moment of an electron and a proton. $m_e=9.101x\ 10^{-31}$kg, $m_p=1.67x10^{-27}$kg and $h=6.626x10^{-34}$.	5
63	2	Explain residual magnetism for a ferromagnetic material.	5
64	2	A paramagnetic material has a magnetic field intensity of 10^4 A/m. If the susceptibility of the material room temperature is $3.7x10^{-5}$ emu then calculate the magnetization and flux density in the material.	5
65	2	Explain qualitatively the relaxation mechanism in paramagnetic solids.	5

66	2	Calculate the group velocity for the spin wave in the long wavelength limit for a ferromagnetic solid with J_e=0.1 eV and S=1/2. Given: the lattice constant a = 7.87Å.	5
67	1	Discuss the classical theory of electronic polarization in dielectrics.	10
68	1	Explain the types of polarization of a dielectric solid when subjected to an electric field.	10
69	1	Discuss in detail, the different polarization mechanisms that exsist in dielectrics and explain their temperature dependence.	10
70	1	Discuss the theory of electronic polarization.	10
71	1	Derive Langevin-Debye equation for the total polarizability in a dielectric.	10
72	1	Explain a method of determining the dipole moment of gaseous molecules in the laboratory.	10
73	1	Explain a method of determining the dipole moment of gaseous molecules in the laboratory.	10
74	1	Obtain Clausius-Mosotti relation and hence Lorenz-Lorentz relation for a medium possessing cubic symmetry.	10
75	1	Derive an expression for the orientational polarization as a function of temperature in a polar dielectric material.	10
76	1	Explain what is meant by local field in a dielectric. Obtain expression for it in a dielectric medium possessing cubic symmetry.	10
77	1	Show that in the presence of the applied field of strength $\vec{E}$, the local field ($\vec{E}$) seen at any lattice site in a dielectric solid is given as $\vec{E} = \vec{E}_0 + \frac{\vec{P}}{3\varepsilon_0}$	10
78	1	Obtain Clausius-Mosotti relation relating macroscopic dielectric constant (ϵ_r) with microscopic polarizability (α_e).	10
79	1	Discuss with necessary theory the effect of temperature on the static dielectric constant of gases.	10
80	1	Obtain expression for the average energy dissipated per second per unit volume in a dielectric subjected to an ac field of frequency ω.	10
81	1	Obtain expressions for $\epsilon'(\omega)$ and $\epsilon''(\omega)$ in terms of frequency ω and relaxation time τ and show that $\epsilon''(\omega)$ is a measure of the dielectric loss.	10
82	1	With relevant theory show that the energy absorbed by a dielectric in the presence of an applied field of frequency ω varies proportional to $\epsilon''(\omega)$.	10
83	1	Discuss with relevant theory and suitable figures the frequency dependence of the real and imaginary parts of the complex dielectric constant of a dielectric solid.	10
84	1	Explain with necessary theory the temperature dependence of spontaneous polarization in ferroelectric materials.	10
85	1	Describe the classification and properties of representative ferroelectrics.	10
86	1	Discuss with relevant theory the Curie-Weiss law for ferroelectrics.	10

87	2	What are magnons? Derive the magnon dispersion relation for one dimensional ferromagnetic spin waves.	10
88	2	What are spin waves? Obtain the dispersion relation for one dimensional antiferromagnetic spin waves.	10
89	2	Derive Bloch's $T^{3/2}$ law for magnetization in ferromagnets.	10
90	2	Derive Bloch's $T^{3/2}$ law for magnetization in antiferromagnets.	10
91	2	Discuss the theory of Casimir-Durpe for spin-lattice relaxation and obtain the expression for the real and imaginary parts of the complex magnetic susceptibility.	10
92	2	Explain the theory of ferromagnetism and also discuss temperature dependance of spontaneous magnetism.	10
93	2	With relevant theory explain Curie-Weiss law for ferromagnetics.	10
94	2	Discuss with relevant theory the effect of temperature on the magnetic susceptibility in the case of Ferrormagnetic material in its paramagnetic phase.	10
95	2	Discuss with necessary theory the Curie-Weiss law for ferromagnets.	10
96	2	Obtain the magnon dispersion relation for ferromagnets.	10
97	2	Using Neel's two sub lattice model obtain an expression for antiferromagnetic susceptibility at $T>T_N$.	10
98	2	Show that in the presence on an ac magnetic field of frequency ω the energy 'A' absorbed by paramagnetic material varies as $A \propto \chi''$. Here χ''refers to the imaginary component of the complex paramagnetic susceptibility.	10

For 2 credit soft core courses

St. Philomena's College(Autonomous), Mysuru		
I/II/III/IV Semester M.Sc. Examination Month – Year		
Subject:		
Title:		
Time: 3 hours		**Max. Marks:70**
Instruction: Answer any four full question from Section – A and any of the five questions from Section – B.		
Section - A		
1.	Question to be asked from unit I	**05**
2.	Question to be asked from unit I	**05**
3.	Question to be asked from unit I	**05**
4.	Question to be asked from unit II	**05**
5.	Question to be asked from unit II	**05**
6.	Question to be asked from unit II	**05**
Section - B		
7.	Question to be asked from unit I	**10**
8.	Question to be asked from unit I	**10**
9.	Question to be asked from unit I	**10**
10.	Question to be asked from unit II	**10**
11.	Question to be asked from unit II	**10**
12.	Question to be asked from unit II	**10**

Note : Marks of Section A and B can be any combinations of 5 and 10 respectively. For example in section – A we may have (3+2). In section-B we may have (6+4) and (5+5).