Model Question Paper

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Course Code: 1BPHEE102

First Semester B.E. Degree Examination, January 2025
Physics of Electrical and Electronic Materials (Electrical and Electronics Engg.)

TIME:3 hrs. **Max.Marks:100**

Note: 1. Answer any FIVE full questions, choosing ONE question from each MODULE
2. VTU Formula Hand Books Permitted
3. M: Marks, L: Bloom's level,C: Course outcomes.

		Module-1	M	L	C
Q.1	**a**	Derive Clausius-Mossotti relation and hence give its implications and limitations.	8	L2	CO1
	b	Elucidate the importance of Hard and Soft magnetic materials in transformer cores, armatures and permanent magnets.	7	L2	CO1
	c	Given the Curie temperatures for Cobalt 1400 K and Iron 1000K, find the ratio of their magnetic susceptibilities at a temperature of 1600K. (Assume Curie constants are equal for Co and Fe)	5	L3	CO1
		OR			
Q.2	**a**	Discuss the Weiss Molecular Field theory for ferromagnetism and hence explain Curie-Weiss law.	8	L2	CO1
	b	Explain the applications of Solid, Liquid and Gas dielectrics with suitable examples.	7	L2	CO1
	c	The atomic weight and density of Sulphur are 32 and 2.08×10^3 kg m^{-3}. The electronic polarizability of the atom is 3.28×10^{-40} Fm^{-2} . If Sulphur solid has a cubic structure, calculate its dielectric constant.	5	L3	CO1
		Module–2			
Q.3	**a**	Describe the principle, construction, working of thermocouple and thermopile with neat sketches.	9	L2	CO2
	b	Derive an Expression for thermo-EMF in terms of Temperatures of Cold (T1) and Hot (T2) Junctions.	6	L2	CO2
	c	Material **A** has S_A=+160 μV/K (vs. reference), material **B** has S_B=−40 μV/K. A junction sees ΔT=100 K. What is the emf between the two leads?	5	L3	CO2
		OR			
Q.4	**a**	Discuss the laws of thermoelectricity and their practical significance.	6	L2	CO2
	b	Discuss the variation of thermo-EMF with temperature and hence derive the relation between inversion and neutral temperatures.	9	L2	CO2
	c	For a material with Seebeck coefficient S=250 μVK^{-1}, electrical conductivity $\sigma = 1.0\times10^5$ Sm^{-1}, thermal conductivity κ=1.5 $Wm^{-1}K^{-1}$ at temperature T=300 K. compute the thermoelectric figure of merit Z and ZT.	5	L3	CO2
		Module–3			
Q.5	**a**	Discuss Fermi-Dirac statistics and hence explain the variation of Fermi Factor with Temperature.	8	L2	CO3
	b	Derive an expression for carrier concentration in conductor using quantum free electron theory of metals.	7	L2	CO3

	c	Calculate the free electron concentration in aluminium metal assuming that each of its atom contributes 3 free electrons for conduction. Given, for Aluminium, the resistivity = 2.7×10^{8} Ωm, atomic weight = 26.98 and density = 2.7×10^{3} kgm^{-3}.	5	L3	CO3
OR					
Q.6	**a**	Elucidate Hall effect and hence derive a expression for Hall voltage.	8	L2	CO3
	b	Derive an Expression for electron concentration in intrinsic semiconductor.	7	L2	CO3
	c	A copper strip with a thickness of 1 mm is in a magnetic field of 1.5 T. A current of 200 A is passed through it, and the Hall coefficient is $6x10^{-7}$ m^3C^{-1}. Calculate the Hall voltage.	5	L3	CO3
Q.7	**a**	Explain Silsbee effect and hence derive an expression for the critical current for a super conducting cylindrical wire.	8	L2	CO4
	b	Explain the formation of cooper pairs, mediation of phonons and two fluid model in superconductors.	7	L2	CO4
	c	Find the critical current of a long thin superconducting wire with a radius of 0.4 mm when the critical magnetic field is 7 kAm^{-1}.	5	L3	CO4
Q.8	**a**	Discuss Type-I and Type-II Superconductors and enumerate the differences between them.	8	L2	CO4
	b	Discuss the principle, construction and working of MAGLEV and its application.	7	L2	CO4
	c	Calculate the ratio of critical fields for a superconductor at 6K and 5K give the critical temperature 8K.	5	L3	CO4
Module–5					
Q.9	**a**	Explain the application of rare earth materials in energy systems and discuss the magnetic phase diagram of terbium (Tb).	8	L2	CO5
	b	Explain the principle, composition and mechanism of electro-rheological materials and magneto-rheological materials.	7	L2	CO5
	c	A polymer actuator with an electrostrictive coefficient $M=12.2x10^{-16}$ m^2V^{-2} is subjected to an electric field of 1000kVm^{-1}. Calculate the induced strain.	5	L3	CO5
OR					
Q.10	**a**	Discuss the types of electrical ceramics and their applications in capacitors and surge protectors.	8	L2	CO5
	b	Discuss the structure properties and application of PMN and PLZT.	7	L2	CO5
	c	A parallel-plate capacitor has an electric field of magnitude $2x10^{5}$ Vm^{-1} between its plates. Calculate the electrical energy density in the region between the plates. Assume the space is a vacuum (free space).	5	L3	CO5

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