



# National Institute of Technology Delhi

Mid Semester Examinations March 2023

Roll No:

Name of Specialization – B.Tech (EE)

Year – 2<sup>nd</sup> Semester – 4<sup>th</sup>

Course Name- Electrical Engg. Materials.

Maximum Marks – 25

Course Code: EEL-263

Total Time: 1:30 Hours

**Instructions:** All questions are compulsory.

Symbols used in the questions are having their usual meaning.

Assume if any data is missing.

- Q-1:** What is free electron model for explaining the electric properties of the materials? Show that at absolute temperature the Fermi energy of the metal is proportional to  $n^{2/3}$ , where  $n$  is the density of electron. (5)
- Q-2:** Discuss the high frequency conduction in metals and show that the frequency dependence of conductivity is given by  $\sigma_{\omega} = \frac{\sigma_{static}}{1 + \omega^2 \tau^2}$ , where  $\omega$  is the operating frequency and  $\tau$  is the mean collision time. (5)
- Q-3:** Explain the difference between type-I and type-II superconductor using Meissner effect. Calculate the penetration depth of lead at 5.2 K if the London penetration depth at 0 K is 37 nm. The critical temperature of lead is 7.193 K. (5)
- Q-4:** Discuss the difference between Seebeck and Peltier effects? For Fe-Cu thermocouple it is observed that the thermo emf is zero when one of the junction is at 20° C and other is at higher temperature. If the neutral temperature is 285° C, calculate the higher temperature. Hence find out the temperature of inversion, if the cold junction temperature is at –20° C. (5)
- Q-5:** How does the paramagnetic susceptibility of a substance vary with temperature? A charge of  $e$  coulomb is uniformly distributed over the surface of a sphere shell of radius  $r$ . If the sphere rotates with an angular velocity  $\omega$ , find the magnetic dipole moment developed. If this sphere is placed in an external magnetic field flux  $B$ , what would be the value of magnetic susceptibility in it? (5)

\*\*\*\*\*End of Paper

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