

International Islamic University Chittagong
Department of Electrical and Electronic Engineering

Final Examination Spring-2019

Program: B.Sc. Engg. (EEE)

Course Code: EEE-3515

Course Title: Electrical Properties of Materials

Time: 02 hours 30 minutes

Full Marks: 50

Use separate script for each part. Figures in the right margin indicate full marks.

Part-A

[Answer any two questions from the followings]

- 1(a). What do you understand by LCAO method? Also, Explain the atomic bond in a hydrogen fluoride molecule. 4
- 1(b). What wavelength of light can be absorbed by a Si photo-detector given $E_g = 1.1$ eV? 3
Can such a photo-detector be used in fiber-optic communications at light wavelengths of 1.33 μm and 1.55 μm .
- 1(c). The Be atom has an electronic structure of $1s^2 2s^2$. Although the Be atom has a full 2s energy level, solid Be is a metal. Explain why? 3
- 2(a). Differentiate between Fermi-Dirac and Boltzmann classical statistics. 2
- 2(b). What is density of states? Why the density of states are more at the middle of the band? Show that the density of states 5
$$g(E) = (8\pi^2)^{(1/2)} (m_e/h^2)^{(3/2)} E^{(1/2)}$$
- 2(c). Given that the width of an energy band is typically 10 eV. Calculate the following, in per cm^3 and per eV units: 3
i. The density of states at the center of the band.
ii. The number of states per unit volume within a small energy range kT about the center.
iii. The density of states at KT above the bottom of the band.
- 3(a). Describe sp^3 hybridization for the formation of bands in Si solids. 4
- 3(b). Define work function of Metals. What do you understand by effective mass of electron? 2
- 3(c). Why H_2^- is possible to form but H_2^{2-} is not possible? 4
Do you think that He-He bonding is possible? Give your logical argument in favor of your opinion.

Part- B

[Answer any three questions from the followings]

- 4(a). Define local field. Also, Derive the Clausius-Mossotti equation considering local field E_{loc} 5
- 4(b). Explain the factors for which the electronic polarization is more for the covalent solids. 2
- 4(c). What do you mean by ionic polarization? Also, Briefly describe the orientational polarization. 3
- 5(a). Define magnetic susceptibility. Also, Explain how it is related to the relative permeability? Derive the proper relationship between them. 4
- 5(b). Show that orbital momentum is in the opposite direction to the angular momentum. 3
- 5(c). Define magnetic dipole moment and gyromagnetic ratio. Also, show the classification of material in respect of the magnetic properties and mention one example for each of them. 3
- 6(a). What is superconductor and Meissner effect? Also, Explain the Meissner effect for a superconductor using suitable experimental example. 5
- 6(b). What do you mean by critical current density? How can you classify the superconductors in respect of the critical field? Also, Explain the characteristics of those types of superconductors using suitable diagrams. 5
- 7(a). Explain how the charge storage capability of a parallel-plate capacitor changes when a dielectric material is inserted between the plates. 3.5
- 7(b). Explain magnetic domain in brief. Also, define domain wall. 2
- 7(c). Consider a pure Si crystal that has $\epsilon_r = 11.9$. 3.5
- i. What is the electronic polarizability due to valence electrons per Si atom?
- ii. If a Si crystal sample is electroded on opposite faces and has a voltage applied across it, by how much is the local field greater than the applied field?
- The number of Si atoms per unit volume is $5 \times 10^{28} \text{ m}^{-3}$.
- 7(d). Which type of superconductor is widely used and why? 1