MS2018 – Electronic and Magnetic Properties of Materials

Course Code	MS2018					
Course Title	Electronic & Magnetic Properties of Materials					
Co-requisites	MS1017	Introduction to Materials Science				
	MS1018	Properties of Materials				
Pre-requisite for	MS4014	Electronic and Magnetic Properties of Materials				
No of AUs	3					
Contact Hours	LECTURES	26 hrs	TUTORIALS	13 hrs		

Course Aims

This is an introductory course on solid state physics for the second-year undergraduate students. The objective is to provide a theoretical framework for understanding the electrical, dielectric and magnetic properties of various materials. This course exposes the students to theories relevant to the engineering principles of various materials and devices. The materials design of an electronic or magnetic device is based on the understanding of these basic concepts.

Intended Learning Outcomes (ILO)

By the end of the course, you should be able to:

1. Describe the behaviours of an electron under classical theory of metals and derive the conductivity from Drude model. Analyse Hall effect and thermal conductivity based on the classical theory of metals.
2. Illustrate the wave-particle duality and be able to apply it to electrons;
3. Interpret Schrodinger equation and the physical meaning of each terms in Schrodinger equation. Apply Schrodinger equation to describe the behaviours of an electron at 1-D infinite potential well.
4. Analyse the atomic structure, electron filling at different atom shells. Estimate the physical/chemical properties of different elements based on the electron configuration at the shells.
5. Clarify the concepts of energy state, Fermi level, effective mass, E-k Relationship and band gap. Derive these values from Sommerfeld theory of metals.
6. Differentiate the intrinsic, n- and p- type semiconductor. Deduce the semiconductor parameters e.g. carrier concentration, dopant level and conductivity of intrinsic and extrinsic semiconductors with different dopants.
7. Differentiate Ohmic and Schottky contacts. Illustrate the band diagrams of PN junctions and MOSFET. Derive a few key parameters such as current density and depletion region length.
8. Describe the polarization, relative permittivity, dielectric constant and loss, strength in dielectric materials. Compare insulation and describe dielectric response.
9. Deduce the electronic dipoles in dielectric materials. Apply Gauss' Law to describe the dielectric breakdown. Clarify the nature of piezoelectricity, ferroelectricity and pyroelectricity.
10. Interpret the origin of magnetic properties. Differentiate different type of magnetic properties: diamagnetic, paramagnetic, ferromagnetism, antiferromagnetic and ferrimagnetic.
11. Clarify magnetizing field and magnetization. Illustrate magnetic domains and M vs H behaviour. Describe the potential applications of magnetic materials.

Reading and References

1. S. O. Kasap, Priciples of Electrical Engineering Materials and Devices, Mcgraw-Hill 2000

2. Neil W. Ashcroft and N. David Mermin, Solid State Physics, Thomson Brooks/Cole 1976.
3. Donald A. Neamen, Semiconductor Physics and Devices, McGraw Hill 2003

Course Policies and Student Responsibilities

(1) CA

Absentees must be supported by a medical certificate or other valid official documents.

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.