## ELE1202 ELECTRICAL MATERIALS

| Hours per Semester | | | | Weighted Total Mark | Weighted Exam Mark | Weighted Continuous Assessment Mark | Credit Units |
|---|---|---|---|---|---|---|---|
| LH | PH | TH | CH | WTM | WEM | WCM | CU |
| 45 | 30 | 00 | 60 | 100 | 60 | 40 | 4 |

[Pre-requisite: Physical Electronics].

### Brief Course Description

The course exposes students to the basic understanding of atomic theory and spectrum of electrical engineering materials that include dielectrics, semiconductors and their applications.

### Course Objectives

By the end of the course students should be able to:

- Understand the basic principles of atomic theory and wave mechanics.
- Understand the characteristics of dielectrics and semi-conductors materials and their applications.

### Detailed Course Content:

**Atomic theory:** **[ 4 Hours]**

Rutherford and Bohr atoms, Emission spectra, wave-particle duality, photoelectric effect.

**Dielectric materials and processes:** **[ 9 Hours]**

Chemistry and physics of insulating materials, brief review of electrostatic relationships: coulomb's law dielectric displacement, dielectric constant, polarization density, electric susceptibility, Lorentz force field, clausius - Moseti equation. Temperature and frequency dependency of permittivity: dipolar polarization, langevin function, complex dielectric constant, loss tangent. Electric processes in dielectrics:piezoelectric effect, ferroelectricity, ionic conductivity, pyroelectricity,electrostriction and the curie-weiss law. Electric breakdown in dielectrics: thermal, electrolytic, dipole, collision and gas discharge breakdown.

**Basic Theorems of Quantum Mechanics:** **[ 6 Hours]**

The Schroedinger wave equation, the uncertainty principles; Electron orbits; Bohr theorem; energy levels and spectra; the tunnel effect; the harmonic oscillator. Lattice dynamics; laser oscillations; laser systems: pumping and laser efficiency; Ruby laser; He-Ne laser; semiconductor lasers.

**Transistor Stuctures:** **[ 10 Hours]**

Permeable base Transistors, Planar Doped Barrier Devices, Super lattice Devices, Resonant Tunnelling Devices

Photonic Devices: Optoelectronic Devices: Optical Absorption, Crystalline and Amorphous, Solar Cells, Electroluminescence and Light Emitting Diodes, Photo detectors. Light Emitting Diodes Issues: Material Systems for LED, Light-Current characteristics, Spectral Purity of LEDs, LED Temporal Response, Temperature dependence of LED emission, LED Reliability.

**Integrated Circuit Design & Technology:** **[ 8 Hours]**

Planar Technology, Pattern Generation and Photomask. Photolithography. Epitaxy Oxidation, Diffusion and Ion Implantation. Metallization and Interconnections. Encapsulation; The Integrated Circuit Components-Design Philosophy. Some Basic Building Blocks of Analog Bipolar ICs.

**Lasers:** **[ 8 Hours]**

Spontaneous and Stimulated emission, semiconductor lasers, Optical Absorption, loss and gain.

Superconductivity: Occurrence of Superconductivity, Critical Field, The Meissner Effect, The Penetration Depth, Quantum Tunnelling, Theory of Superconductivity, Engineering Applications of Superconductivity.

**Mode of Delivery**

The course will be taught by using lectures, tutorials and assignments.

**Assessment**

Assignments, tests and final examination. Their relative contributions to the final grade are :

| **Requirement** | **Percentage contribution** |
|---|---|
| Course work (Assignments, tests) | 40 |
| % Final examination | 60 |
| % **Total** | **100%** |

**Learning Outcomes**

- Indicate the properties of materials that lead to be useful for the construction of electronic circuits, giving reasons; and explain the uses of one particular material (as opposed to alternatives) to serve a stated purpose.
- Explain the properties of diodes; and outline the use of diodes in the construction of a range of circuits including rectifiers, ac/dc converters, and common logic functions.

**Method of Teaching /Delivery**

The course will be taught by using lectures, tutorials and assignments.

**Mode of Assessment**

Assignments, tests and final examination. Their relative contributions to the final grade are :

| **Requirement** | **Percentage contribution** |
|---|---|
| Course work (Assignments, tests) | 40 |
| % Final examination | 60 |
| % **Total** | **100%** |

**Recommended and References Books**

*[1]* Agarwal, Anant, and Jeffrey H. Lang. **Foundations of Analog and Digital Electronic Circuits**.
San Mateo, CA: Morgan Kaufmann Publishers, Elsevier, July 2005. ISBN: 9781558607354.
*[2]* Earl D. Gates, *Introduction to Electronics*, 4th ed., Thomson, 2004
*[3]* D. C. Green, *Electronics 4,* 3rd ed., Longman, 1995

**Possible Lecturers:**

Dr. E. Lugujjo
Dr. T. Togboa
Ms. M. Tumwebaze