## ELE1102 PHYSICAL ELECTRONICS

| 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 |

**Brief Course Description**

The course addresses the physics of basic physical concepts of electronic devices.

**Course Objectives**

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

- Understand the behaviour of electrons in electrical and magnetic fields in materials.
- Understand the design and operation of diodes and bipolar junction transistors.

**Detailed Course Content:**

History of Electronic devices and its impact on society. **[ 2 Hours]**

**Charged Particle Dynamics**: **[ 9 Hours]**

Electron motion in uniform electric fields and current in external circuit. Electrostatic deflection in Cathode Ray Oscilloscope (CRO). Motion in uniform magnetic fields. Magnetic deflection and focusing. Motion of changed particles in crossed uniform electric and magnetic fields. Cycloidal trajectories in a magnetron. Magnetron cut-off. Electron optics-magnetic lens, electrostatic electron optics. The electron microscope. Electrostatic lens.

**Conductors, Semi-conductor and Insulators**: **[9 Hours]**

Electron theory of metals, Classical theory of conduction. Electronic collisions. Dependence of conductivity on temperature. Production of free charge carriers-Band and Band models. Carrier drift and mobility. Mobility variation with temperature. A derivation of ohm's Law. Drift current equations.

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

**I**ntrinsic: band model, effective mass, density states, hole ans electron conduction. Extrinsic: donor acceptor and acceptor states, Fermi level and its variation with temeperature and dopants, Carrier concentration: Carrier diffusion. Flux equation. Fick's laws. The Eistein relation. Total current density. Carrier recombination and diffusion length. Intrinsic semiconductor - Variation of carrier concentration and mobility with temperature. Extrinsic semiconductors-Doping methods. Donors and acceptors. Minority and majority carriers.

**The Semiconductor Junction Diode:** **[ 8 Hours]**

Contact between two materials, metal to semiconductor contacts. Junction diode manufacturer Current/voltage characteristic of a diode. The p-n junction in thermal equilibrium. Junction barrier height. Forward and Reverse bias. The Ideal diode equation. Relative magnitude of hole and electron current. Junction breakdown.

**The Bipolar Junction Transistor (BJT):** **[ 8 Hours]**

The Transistor Action. Carrier density profile. Potential and energy distribution. Band diagram under equilibrium, forward and reverse bias. Current distribution under these conditions. Emitter injection efficiency, transport factor, current gain and collector leakage current, in terms of the device physical conditions. Distribution of excess. Charge in the base and base width modulation. BJT D-C characteristics.

**Learning Outcomes**

- Identify some contributors to electronics and relate their achievements to the knowledge area; describe a transistor and its functionality; identify some storage elements; articulate the purpose of buses; indicate the importance of designing data conversion circuits; identify two software products used for designing and simulating circuits; and describe how computer engineering uses or benefits from electronics.
- 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.
- Explain the differences between the different BJT logic families; and articulate the advantages of each.

**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