# EE3115: APPLIED OPTOELECTRONIC DEVICES

**Effective Term**
Semester B 2022/23

## Part I Course Overview

**Course Title**
Applied Optoelectronic Devices

**Subject Code**
EE - Electrical Engineering
**Course Number**
3115

**Academic Unit**
Electrical Engineering (EE)

**College/School**
College of Engineering (EG)

**Course Duration**
One Semester

**Credit Units**
3

**Level**
B1, B2, B3, B4 - Bachelor's Degree

**Medium of Instruction**
English

**Medium of Assessment**
English

**Prerequisites**
EE2005 Electronic Devices and Circuits
or
EE2301 Basic Electronic Circuits

**Precursors**
Nil

**Equivalent Courses**
Nil

**Exclusive Courses**
Nil

# Part II Course Details

**Abstract**

The course aims to provide students with the basic concepts of semiconductor physics and the technology of semiconductor optoelectronic devices such as light-emitting diodes, laser diodes, and photodiodes. These devices are the essential components in today's consumer optoelectronics, IT communication, robotic control, industrial instrumentation, etc.

**Course Intended Learning Outcomes (CILOs)**

| | CILOs | Weighting (if app.) | DEC-A1 | DEC-A2 | DEC-A3 |
|---|---|---|---|---|---|
| 1 | To understand and identify the characteristics of semiconductor and optoelectronic materials and the basic semiconductor physic concepts, such as band structure, Fermi function, the density of state, and carrier concentration. | | x | x | |
| 2 | To understand and describe the doping and conductivity of semiconductors, p-n junctions, and metal-semiconductor junctions. | | x | x | |
| 3 | To describe the operation mechanisms of semiconductors under different conditions, such as recombination, light absorption, and generation. | | x | x | |
| 4 | To describe the basic concepts and the underlying operation principles of commonly used optoelectronics devices and their applications. | | x | x | |

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

**Teaching and Learning Activities (TLAs)**

| | TLAs | Brief Description | CILO No. | Hours/week (if applicable) |
|---|---|---|---|---|
| 1 | Lectures | Key concepts are described and illustrated<br><br>Key concepts are worked out based on problems | 1, 2, 3, 4 | 3 hrs/wk |
| 2 | Laboratories | Key concepts are applied to build practical circuits | 1, 2, 4 | 3 hrs/wk(3 weeks) |

**Assessment Tasks / Activities (ATs)**

| | ATs | CILO No. | Weighting (%) | Remarks (e.g. Parameter for GenAI use) |
|---|---|---|---|---|
| 1 | Tests (min.: 2) | 1, 2, 3, 4 | 30 | |
| 2 | #Assignments (min.: 3) | 1, 2, 3, 4 | 10 | |
| 3 | Lab Exercises/Reports | 1, 2, 4 | 10 | |

**Continuous Assessment (%)**

50

**Examination (%)**

50

**Examination Duration (Hours)**

2

**Additional Information for ATs**

Remark:
To pass the course, students are required to achieve at least 30% in course work and 30% in the examination. Also, 75% laboratory attendance rate must be obtained.

# may include homework, tutorial exercise, project/mini-project, presentation

**Assessment Rubrics (AR)**

**Assessment Task**

Examination

**Criterion**

Achievements in CILOs

**Excellent (A+, A, A-)**

High

**Good (B+, B, B-)**

Significant

**Fair (C+, C, C-)**

Moderate

**Marginal (D)**

Basic

**Failure (F)**

Not even reaching marginal levels

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**Assessment Task**

Coursework

**Criterion**

Achievements in CILOs

**Excellent (A+, A, A-)**
High

**Good (B+, B, B-)**
Significant

**Fair (C+, C, C-)**
Moderate

**Marginal (D)**
Basic

**Failure (F)**
Not even reaching marginal levels

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# Part III Other Information

**Keyword Syllabus**

Introduction to Semiconductor Physics and Optoelectronic Materials
Introduction to semiconductor physics. Metals, insulating and semiconductor. Formation of band gap and band structure. Properties of common direct and indirect band gap semiconductors. Fermi-Dirac distribution function. Carrier concentrations.

Introduction to Carrier (Electrons and Holes) Behaviors in Semiconductors
Doping of Semiconductors. Conductivity and mobility of carriers. Drift and diffusion of carriers. Injection, generation, and recombination of carriers.

Junction Devices
PN-junction under equilibrium, forward and reverse bias conditions. Charge storage and transient behaviors: depletion layer and diffusion capacitances. Junction breakdown-Zener and avalanche effects. Schottky diode. Rectifying and ohmic contacts. Interaction of photons with a semiconductor (light generation and recombination)

Principles of Commonly used Optoelectronic Devices
Introduction to the basic concepts and working principles of commonly used optoelectronic devices like Photodetectors. Solar cells. Light emitting diode. Laser diodes. Display.

**Laboratory Experiment:**
Unit 1 Photoresistor Sensor Experiment
Unit 2 Solar Cell Experiment

**Reading List**

**Compulsory Readings**

| | Title |
|---|---|
| 1 | S.O. Kasap: Optoelectronic and Photonics. (Prentice-Hall) |

**Additional Readings**

| | Title |
|---|---|
| 1 | Ben G Streetman: Solid State Electronic Devices. (Prentice Hall) |
| 2 | Robert F. Pierret: Semiconductor Device Fundamentals. (Addison Wesley) |