EE2800: SEMICONDUCTOR PHYSICS FOR ENGINEERS

Effective Term
Semester B 2024/25

Part I Course Overview

Course Title
Semiconductor Physics for Engineers

Subject Code
EE - Electrical Engineering
Course Number
2800

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
AND
MA1200 Calculus and Basic Linear Algebra I or MA1201 Calculus and Basic Linear Algebra II
OR
MA1300 Enhanced Calculus and Linear Algebra I or MA1301 Enhanced Calculus and Linear Algebra II

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Additional Information

Nil

Part II Course Details

Abstract

The course aims to give students a fundamental understanding of semiconductor physic and its applications to realize various semiconductor devices. The working mechanism of the selected devices will be studied.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe physical and chemical structures of commonly used semiconductor materials.		x	x	
2	Describe the physical properties of semiconductors with energy band diagrams.		x	x	
3	Describe and solve for the carrier distributions and carrier transport in semiconductors.		x	x	
4	Describe the working mechanisms of selected semiconductor devices.		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.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures	Students will participate in lectures where they will learn various fundamental knowledge and concepts in semiconductor physics, which they will apply in subsequent activities to deepen their understanding and practical skills.	1, 2, 3, 4	3 hrs/wk

2	Laboratories	Students will engage in lab sessions designed to reinforce key concepts covered in lectures and tutorials, enabling them to apply theoretical knowledge through hands-on practice and collaborative problem-solving.	1, 2, 4	3 hrs/wk (3 weeks)
3	Tutorials	Students will work through key concepts by solving practical problems, enhancing their ability to apply theoretical knowledge to real-world scenarios.	1, 2, 3, 4	1 hr/wk

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	20	
3	Lab Exercises/Reports (min.: 2)	1, 2, 4	10	

Continuous Assessment (%)

60

Examination (%)

40

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

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

Part III Other Information

Keyword Syllabus

Introduction to Semiconductors physics
Basic crystal structures of semiconductors. Energy bands and energy gap. Fundamentals of band structure and statistical carrier distribution. The density of states. Fermi-Dirac distribution functions, doping and intrinsic carrier concentration.

Physical Properties of Semiconductors
Physical properties of semiconductors. Carrier-transport phenomena, drift and mobility, resistivity. Drift-diffusion and trap statistics. Current continuity equation. Phonon, optical, and thermal properties of semiconductors.

Basic Devices based on Semiconductors
Basis structure of p–n junctions. Biased and non-biased junction properties. Charge storage and transient behavior: junction capacitors and junction breakdown. Zener diodes. Schottky diodes. Bipolar Junction Transistor (BJT), Metal-oxide-semiconductor field-effect transistors (MOSFETs).

Laboratory Experiment:
Unit 1 Characterization of p-n junction
Unit 2 Characterization of bipolar junction transistor
Unit 3 Characterization of MOSFET

Reading List

Compulsory Readings

	Title
1	Ben G Streetman: Solid State Electronic Devices (Prentice-Hall), 2016

Additional Readings

	Title
1	S. M. Sze: Physics of Semiconductor Devices (John Wiley & Sons, Inc), 4th Edition, 2021
2	Chenming Hu: Modern Semiconductor Devices for Integrated Circuits (Pearson Education) 2021