EE3800: SEMICONDUCTOR MATERIALS AND DEVICES

Effective Term
Semester A 2022/23

Part I Course Overview

Course Title
Semiconductor Materials and Devices

Subject Code
EE - Electrical Engineering
Course Number
3800

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
EE2800 Semiconductor Physics for Engineers
and
MA2001 Multi-variable Calculus and Linear Algebra

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

The course aims to give students a deeper understanding of the physical characteristics, structures, and fabrication process of electronic and optoelectronic semiconductor devices involving different semiconductor materials.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	To describe the crystal structures of semiconductors of different semiconductor material.		x	x	
2	To apply mathematical models to analyze the physical properties of semiconductor materials and working mechanisms of various semiconductor devices.		x	x	
3	To describe the structures of various semiconductor devices.		x	x	
4	To describe the process and key equipment used to fabricate 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.

Teaching and Learning Activities (TLAs)

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

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Tests (min.: 2)	1, 2, 3, 4	20	
2	#Assignments (min.: 2)	1, 2, 3, 4	10	
3	Lab Exercises/Reports (min.: 2)	1, 2, 4	10	

Continuous Assessment (%)

40

Examination (%)

60

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

1. 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

2. 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

Overview of Semiconductor Materials
Review of the basic crystal structures of semiconductors. Energy structures and energy bandgaps. Group IV, group III-V and group II-VI semiconductors. Alloyed semiconductor materials. Wide bandgap semiconductors. Newly emerging 2D semiconductors. Generate and degenerate semiconductors. The growth and preparation of semiconductor materials.

Physical Properties of Semiconductor Materials
Carrier-transport phenomena. Drift and mobility. Doping effects. Optical and thermal properties of semiconductor materials. Physical model and current-voltage curve of p–n junctions. Metal-semiconductor contact. Physical model and current-voltage curve of Schottky junctions.

Semiconductor Devices
Bipolar junction transistor (BJT) structure and switching. Working mechanism of field-effect transistors (FET). Complementary metal-oxide-semiconductor (CMOS) structure and charge coupled device (CCD). Thin film transistors (TFT). Phototransistor/detector. Light-emitting diode/ Laser diode.

Micro/Nano Fabrication Technology
Introduction to cleanroom. Basic silicon wafer processing. Chemical vapor deposition (CVD). Evaporation and sputter deposition. Ion implantation and photolithography. Wet processing and plasma processing. Advanced CMOS technologies. Introduction to integrated circuit designs. Packaging technology for integrated circuits.

Laboratory Experiment:
Unit 1 Characterization of MOSFET
Unit 2 Characterization of LED and Laser Diode

Reading List

Compulsory Readings

	Title
1	Chenming Hu: Modern Semiconductor Devices for Integrated Circuits. (Pearson Education), 2021

Additional Readings

	Title
1	Dieter K. Schroder: Semiconductor Material and Device Characterization. (Wiley), 3rd Edition, 2015
2	S. M. Sze: Physics of Semiconductor Devices. (John Wiley & Sons, Inc), 4th Edition, 2021