Subject Description Form

Subject Code	AP40006
Subject Title	Semiconductor Materials and Devices
Credit Value	3
Level	4
Pre-requisite / Co-requisite/ Exclusion	AP20002
Objectives	The aim of the subject is to provide the students with an understanding of semiconductor physics, semiconductor materials properties and operation of various types of semiconductor junction diodes and transistors.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: (a) apply band theory to explain the behaviors of intrinsic and extrinsic semiconductors at different temperatures; (b) explain nonequibrium with excess carriers, and solve problems of the quasi-Fermi level splitting; (c) solve problems in one-dimensional transport of carriers in drift (including Hall effect) and in diffusion; (d) explain the behaviors of pn junctions under bias, and solve problems on the design of pn junctions; (e) apply the theory of semiconductors to explain the functions of various semiconductor devices, such as switching diodes, breakdown diodes, solar cells, photodiodes and photodetectors, light-emitting diodes, etc.; and (f) explain charge transport in semiconductor transistors and I-V characteristics.
Subject Synopsis/ Indicative Syllabus	**Semiconductor materials and growth**: structure and physical properties of semiconductor materials; crystal and epitaxial growth, energy bands **Charge carriers in semiconductors**: electrons and holes; intrinsic and extrinsic semiconductors; Fermi level; carrier concentrations; drift; mobility and conductivity; Hall effect. **Excess carriers**: optical absorption; luminescence; recombination and carrier lifetime; quasi-Fermi levels; photoconductivity; diffusion; steady-state carrier injection; diffusion length. **p-n junctions and diodes**: fabrication; contact potential; space charge and depletion layer; biased junction and diode equation; reverse-bias breakdown; capacitance of p-n junctions; metal-semiconductor junctions; switching diodes; varactor diodes; tunnel diodes; solar cells; photodetectors; light-emitting diodes. **Transistors**: charge transport in a bipolar junction transistor (BJT) and field-effect transistor (FET); I-V characteristics; amplification; switching using transitors; integrated circuit (IC) technology.

Teaching/Learning Methodology

Lecture: The fundamentals of semiconductor physics, materials and various devices will be described. Students are free to request help. Students are encouraged to solve problems and to use their own knowledge to verify their solutions before seeking assistance.

Tutorial: A set of problems and group discussion topics will be arranged in the tutorial classes. Students are encouraged to solve problems before having solutions.

Laboratory: A set of laboratories/demonstrations will be provided. Students will have the opportunity to apply the fundamental knowledge gained from the lecture into practical materials test and device applications and hence develop a deeper understanding of the subject.

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)					
		a	b	c	d	e	f
(1) Continuous assessment	40	✓	✓	✓	✓	✓	✓
(2) Examination	60	✓	✓	✓	✓	✓	✓
Total	100						

Continuous assessment consists of assignments, laboratory reports and mid-term test. The continuous assessment will assess the students' understanding of basic concepts and principles in materials science. Examination will be conducted to make a comprehensive assessment of students' intended learning outcomes as stated above.

Student Study Effort Expected

Class contact:	
• Lecture	26 h
• Tutorial	6 h
• Laboratory	9 h
Other student study effort:	
• Self-study	79 h
Total student study effort	120 h

Reading List and References

B. G. Streetman, Solid State Electronic Devices, Prentice-Hall (2006).

S. M. Sze and Kwok K. Ng, Physics of Semiconductor Devices, 3rd Edition, John Wiley & Sons, Inc. (2007).

D. A. Neaman, Semiconductor Physics and Devices: Basic Principles, 3rd Edition, McGraw-Hill (2003).