Hong Kong Baptist University
Faculty of Science – Department of Physics

Title (Units): **PHYS 4017 SEMICONDUCTOR PHYSICS AND DEVICES (3,3,1)**

Course Aims: This course introduces the basic physics of semiconductor materials and the physical principles of key semiconductor devices. Both electronic and optical properties of semiconductors are covered. Selected applications of the semiconductor devices, e.g., light-emitting diodes, solar cells, photo-detectors and transistors, will be presented.

Pre-requisite: PHYS3015 Structure and Properties of Matter or consent of instructor

Course Reviewed by: Prof. Shu-kong So and Prof. Fu-rong Zhu

Course Intended Learning Outcomes (CILOs):

No.	**Upon successful completion of this course, students should be able to:**
1	Describe the key properties of semiconductor crystals, their fabrication techniques, and the impact of semiconductor devices in modern world.
2	Explain the concepts of energy bands, density-of-states, and apply these concepts to deduce free carrier concentrations in intrinsic and extrinsic semiconductors.
3	Explain how charge carriers migrate in semiconductors by diffusion and drift motions.
4	Analyze a *p*-*n* junction under forward and reverse biases with energy diagrams, and compute its current-voltage behaviors.
5	Explain and analyze the operations of practical semiconductor devices, such as light-emitting diodes, solar cells and transistors.

Teaching & Learning Activities (TLAs)

CILOs	**TLAs will include the following:**
1-5	Students will learn the basic concepts and principles of semiconductor materials and semiconductor physics by attending lectures, reviewing lecture notes, reading references and doing assignments.
4,5	Demonstrations will be used to illustrate the working principles of some key semiconductor devices, e.g., solar cells and photo-detectors.
3,4,5	Small scale experiments may be conducted to illustrate theoretical concepts. For example, students may be asked to measure doping concentration of a semiconductor using depletion capacitance technique.

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Assessment Methods (AMs):

Type of Assessment Methods	Weighting	CILOs to be addressed	Description of Assessment Tasks
Continuous Assessment (tutorial assignments, homework assignments, quizzes, midterm examination)	50%	1-5	Tests and assignments are designed to measure and guide the learning process of students.
Final Examination	50%	1-5	Final Examination questions are designed to see how far students have achieved their intended learning outcomes.

Learning Outcomes and Weighting:

Content	CILO No.	Teaching (in hours)
I. Introduction to Semiconductor Physics and Technology	1	2
II. Fundamentals of Semiconductor Physics	2	8
III. Carrier Transport Phenomena	2-3	8
IV. Junction Theory	2-4	8
V. Semiconductor Devices	2-5	10

Textbook: S. M. Sze, Ming-Kwei Lee, Semiconductor Devices – Physics and Technology, 3rd Ed., Wiley, 2012

References:
1. Safa Kasap, Principles of Electronic Materials and Devices,3rd Edition, McGraw Hill, 2005.
2. D. A. Neaman, Semiconductor Physics and Devices, McGraw Hill, 2003
3. R. F. Pierret, Advanced Semiconductor Fundamentals, Prentice Hall, 2004

Course Content in Outline:

	Topic	Hours
I.	Introduction to Semiconductor Physics and Technology	2
II.	Fundamentals of Semiconductor Physics	8
	A. Energy Bands	
	B. Density of States	
	C. Intrinsic Carrier Concentration	
	D. Donors and Acceptors	

III.	Carrier Transport Phenomena	8
	A. Drift and Diffusion	
	B. Generation and Recombination	
	C. Continuity Equation	
IV.	Junction Theory	8
	A. P-n Junctions in Equilibrium	
	B. Schottky Barriers and Ohmic Contact	
	C. Current Voltage Characteristics	
V.	Topics in Semiconductor Devices (examples are given in B,C and D)	10
	A. Optical Properties of Semiconductors	
	B. Light Emitting Diodes	
	C. Solar Cells	
	D. Transistors	