جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

Course Syllabus: Advanced Topics in Solid State Devices - EE 391B

Division	Computer, Electrical and Mathematical Sciences & Engineering
Course Number	EE 391B
Course Title	Advanced Topics in Solid State Devices
Academic Semester	Summer
Academic Year	2016/2017
Semester Start Date	06/04/2017
Semester End Date	08/03/2017
Class Schedule (Days & Time)	01:00 PM - 04:00 PM | Sun Mon

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Jr-Hau He	jrhau.he@kaust.edu.sa	+966128084377		Monday Tuesday 4:00-7:00PM and by appointment

Teaching Assistant(s)

Name	Email

Course Information

Comprehensive Course Description	This course is intended for beginning graduate students and will cover i) aspects of electrical properties of semiconductors, ii) basic principles of operation of p-n junction, bipolar junction transistor (BJT), field effect transistor (FET), LEDs, a& solar cells, and iii) device fabrication technology essential to understanding semiconductor devices. This *course* also covers more *advanced topics* or topics of current interest in semiconductor devices. The future trends will also be introduced.
Course Description from Program Guide	

Goals and Objectives	1. Explain and understand the physical concepts underlying the operation of semiconductor devices. Be able to analyze carrier flow and associated fields due to drift, diffusion, generation, and recombination. Be able to draw and interpret energy band diagrams. 2. Understand and analyze the behavior of a pn junction, BJT, and FET including device physics, device operation, and device characteristics. Understand how device design affects performance. 3. Explain and understand the physical concepts underlying the operation of advanced semiconductor devices including solar cells and LEDs. During the break of each class, one student will be chosen to give a short presentation on how the course content relates to contemporary issues. This could be electronics technology, modern research topics in academia/industry, application of semiconductor devices. This will help students in building communication skills in an informal setting, build knowledge of contemporary issues, and appreciate the importance of electronics in a larger context. Project: The project will be paper electronics covering design and fabrication. Individual-based and faculty-guided projects directed toward the development of paper electronics originating from students' and faculty's suggestions. Propose your own project on paper electronics after discussing with the lecturer on the weekly basis in the office hour. I expect you to spend about 3 hours after class every week. It will be graded based on the following rubrics. -Must contain sufficient integrated knowledge in solid state device physics -Taping your demonstration for 5 min, which will be graded by the faculty and the students.
Required Knowledge	- Materials Science and Engineering - Eletrical Properties of Materials - Fundamentals of devce physics
Reference Texts	**Course textbook:** -*Donald A. Neamen, Semiconductor Physics And Devices: Basic Principles, 4th Ed, New York, NY:* McGraw-Hill 2012 http://eee-ebooks.blogspot.com/2014/06/semiconductor-physics-and-devices-basic.html -*Streetman, S.K. Banerjee, Solid State Electronic Devices, 6th Ed, New Jersey: Prentice Hall 2006.* http://wps.prenhall.com/esm_streetman_solidstateelecdev_6/ If you are confused about a topic in our textbook or my lecture notes, try to look up additional references in the list below. 1. i) Popular textbooks in semiconductor physics - S.M. Sze, *Physics of Semiconductor Devices* - Singh, *Semiconductor Devices* - Pierret, *Semiconductor Device Fundamentals* 1. ii) MIT Open Courseware (http://ocw.mit.edu/OcwWeb/Electrical-Engineering-and-Computer-Science/6-012Fall-2005/LectureNotes/index.htm) iii) Online sources such as Wikipedia (http://www.wikipedia.org). Be careful with online sources because their accuracy cannot be verified. 1. iv) Whether you end up in industry or academics, it is very important to learn how to independently become an expert in a new subject. And of course, feel free to contact me or come to office hours)
Method of evaluation	**10.00**% - Written report **10.00**% - Others - Please specify **10.00**% - Oral presentation **15.00**% - Midterm exam **15.00**% - Homework /Assignments **10.00**% - Final exam **30.00**% - Course Project(s)
Nature of the assignments	? 10% In-class presentation ? 10% Report after in-class presentation ? 15% Midterm exam ? 30% Project (expected to be 3 hours after class every week) ? 15% Homework assignments*5 ? 10% Lab session and assignments*4 ? 10% Final exam

Course Policies	**Attendance Policy:** Students are required to attend class, and attendance will be taken if necessary. 3 absences are allowed for documented personal/medical reasons. Please email me in advance if you know you will miss a class. However, on the exam dates listed in the course calendar, attendance is absolutely mandatory. No makeup exams will be given. **Grading Policy:** ? 10% In-class presentation ? 10% Report after in-class presentation ? 15% Midterm exam ? 30% Project (expected to be 3 hours after class every week) ? 15% Homework assignments ? 10% Lab session and assignments ? 10% Final exam **Presentation:** The presentation will be graded based on the following rubrics. -Must have a clear relation to solid state device physics -Must present some new technology -Must contain sufficient professional references (at least 4-5). -Technical content, demonstrating a thorough understanding of presented materials. -Quality and clarity of presentation -Enthusiasm of speaker, ability to answer questions. The in-class presentation will be graded based on the following rubrics. -Timing: 10 minute limit. 5 minutes for question/answer. -Must be aligned with the weekly content presented in the course calendar. Project: The project will be paper electronics covering design and fabrication. Individual-based and faculty-guided projects directed toward the development of paper electronics originating from students' and faculty's suggestions. Propose your own project on paper electronics after discussing with the lecturer on the weekly basis in the office hour. I expect you to spend about 3 hours after class every week. It will be graded based on the following rubrics. -Must contain sufficient integrated knowledge in solid state device physics -Taping your demonstration for 5 min, which will be graded by the faculty and the students. **Cheating Policy and Penalty for Cheating:** Cheating is defined as "intentionally using or attempting to use, or intentionally providing or attempting to provide, unauthorized materials, information, or assistance in any academic exercise." This includes any group efforts on assignments or exams unless specifically approved by the professor for that assignment/exam. Evidence of fabrication or plagiarism will also result in downgrading for the course. Students who cheat on any assignment or during any examination will be assigned a failing grade for the course. **Feedback:** I as well as the KAUST value your feedback in how we can make this course better and better serve your needs. - The standard KAUST course evaluations will also be given at the end of the term. - We may have midterm teaching evaluations of the course sometime in the middle of the semester. - Anonymous feedback can be posted anytime through blackboard. - If you have any personal issues with the course, please come to office hours or setup an appointment to speak with me individually
Additional Information	

Tentative Course Schedule *(Time, topic/emphasis & resources)*		
Week	**Lectures**	**Topic**
1	Sun 06/04/2017 Mon 06/05/2017	0. Introduction/Motivation – why study semiconductor device physics? 1. Crystal structures, atoms, and electronic properties a). Crystal structure b). Fabrication c). Atomic structure, the Bohr model and Schrodinger wave equation d). Structure of semiconductors, conductors, and insulators. How structure relates to material properties
2	Sun 06/11/2017 Mon 06/12/2017	3. Energy bands and carriers in semiconductors a). Mobile vs. static carriers. Electrons and holes b). Intrinsic semiconductors: carrier concentrations, density of states, conductivity c). Energy band Diagrams: conduction and valence band, Fermi level d). Doped semiconductors: acceptors and donors, how they alter the physical structure and the energy band, effect on carrier concentration e). Carrier transport mechanisms: Drift, Diffusion f). Carrier generation and recombination
3	Sun 06/18/2017 Mon 06/19/2017	4. p-n junction diode -Physical concepts: Depletion layer, mobile and static charges, drift and diffusion, coulomb's law, diffusion/electrical balance -Energy band interpretation: Band bending, junction potential, drift and diffusion -Physical characteristics: depletion width, depletion and diffusion capacitance -Electrical characteristics: IV characteristics, forward and reverse bias, reverse breakdown, small signal model
4	Sun 06/25/2017 Mon 06/26/2017	Eid Al-Fitr break
5	Sun 07/02/2017 Mon 07/03/2017	Midtern 5. MOSFETs -Physical concepts: Inversion channels, channel pinchoff -Physical characteristics: gate thickness, substrate doping, work function -Electrical characteristics: IV characteristics, cutoff/triode/saturation regions of operation, early voltage, small signal model
6	Sun 07/09/2017 Mon 07/10/2017	Lab Session: Fabrication and Process Technology (in class and hand on work in the lab)
7	Sun 07/16/2017 Mon 07/17/2017	Solar cells
8	Sun 07/23/2017 Mon 07/24/2017	Light emitting diodes (LEDs)
9	Sun 07/30/2017 Mon 07/31/2017	- Project Presetation - Final Exam
10		NA
11		NA
12		NA
13		NA
14		NA
15		NA
16		NA
17		NA
18		NA

Note

The instructor reserves the right to make changes to this syllabus as necessary.