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

Course Syllabus: Solar Cell Materials and Devices - MSE 320

Division	Physical Science and Engineering Division
Course Number	MSE 320
Course Title	Solar Cell Materials and Devices
Academic Semester	Fall
Academic Year	2018/2019
Semester Start Date	08/26/2018
Semester End Date	12/11/2018
Class Schedule (Days & Time)	10:30 AM - 12:00 PM | Wed , 01:00 PM - 02:30 PM | Mon

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Derya Baran	DERYA.BARAN@KAUST.EDU.SA	+966128087238	3336, 5, Al-Kindi (bldg. 5)	Mon- 15:00-16:00 Wed- 9:00-10:00

Teaching Assistant(s)

Name	Email

Course Information

Comprehensive Course Description	320 Solar Cell Materials and Devices course is an elective course for MSc./PhD. students offered from Material Science and Engineering Department. The students interested in solar cells, solar technology and fundamentals behind solar cells from other departments can take the course by registering to the course. The objective of this course is to provide an insight into the fundamentals of solar cells and describe the manufacturing processes of different types of photovoltaics (PV). Throughout the course, students will learn physical principles of solar irradiation and solar cell operation. Emerging concepts of polymer, hybrid and quantum-dot-based solar cells will be described including device physics, manufacturing and technological development. The principles and materials addressed in this lecture will be useful for a wide range of applications such as solar cells, light emitting diodes, thermoelectrics and transistors.
Course Description from Program Guide	This course will provide the students with an up-to-date basic knowledge of the physical and chemical principles of materials used in solar cells of various kinds including but not limited to technologies such as: 1) silicon-based solar cells, 2) CIGS, CIS and other inorganic thin film solar cells, 3) multijunction solar cells, 4) nanoparticles and quantum dots solar cells, 5) organic and hybrid solar cells and 6) thermal and concentrator solar power generation.
Goals and Objectives	The objective of this course is to provide an insight into the fundamentals of solar cells and describe the manufacturing processes of different types of photovoltaics (PV). Throughout the course, students will learn physical principles of solar irradiation and solar cell operation. Emerging concepts of polymer, hybrid and quantum-dot-based solar cells will be described including device physics, manufacturing and technological development.
Required Knowledge	This course is elective and no prerequisite course. However, knowledge on physical chemistry, semiconductor physics and thermodynamics is beneficial to understand the concepts that will be addressed during the semester.

Reference Texts	There will be no single textbook following the content of the course. However, there are several books and scientific papers about solar cells can be useful to follow the course content. Some of them are as below: Physics of semiconductor devices- S. M. Sze, Wiley-VCH Physics of solar cells, from principles to new concepts- Peter Wurfel, Wiley-VCH The physics of solar cells- Jenny Nelson, Imperial College Press The photophysics behind photovoltaics and photonics- Guglielmo Lanzani, Wiley-VCH Solar energy: The physics and engineering of photovoltaic conversion technologies and systems, Organic light emitting devices- Edited by Klaus Muleen and Ullrichj Scherf, Weiley-VCH (chapters 2,3,6) Generalized detailed balance theory of solar cells- Thomas Kirchartz, Forschungszentrum Julich GmbH
Method of evaluation	**40.00**% - Final exam **20.00**% - Oral presentation **40.00**% - Midterm exam
Nature of the assignments	There will be a 10 minute presentation for each student during the semester. The details and concept will be discussed in the first week or the semester. The mid-term will be after the fundamental concept chapters. Final exam will be focusing on chapters after mid-term; however will cover the whole semester. **20.00**% - Presentation **40.00**% - Midterm exam **40.00**% - Final exam
Course Policies	It is expected that all students attend to all the lectures. There might be shifts in the time of the lecture hours due to committments. These will be discussed previously in the lectures.
Additional Information	The course will cover the topics: -Introduction to photovoltaics -Fundamentals, limits and losses in solar cells - Semiconductors - Conversion of chemical energy into electrical energy -Types of solar cells -Processing of solar cells

Tentative Course Schedule

(Time, topic/emphasis & resources)

Week	Lectures	Topic
1	Mon 08/27/2018	This week will focus on Fundamentals on the light, energy, electromagnetic spectrum, conservation of energy, second law of thermodynamics, solar irradiation and spectrum, photovoltaic effect and photovoltaic history.
1	Wed 08/29/2018	This week will focus on Fundamentals on the light, energy, electromagnetic spectrum, conservation of energy, second law of thermodynamics, solar irradiation and spectrum, photovoltaic effect and photovoltaic history.
2	Mon 09/03/2018	This week lecture will cover band gap (direct and indirect gap semiconductors), absorption, types of semiconductors (intrinsic and extrinsic) and fundamental processes in a solar cell starting from light absorption to charge collection
2	Wed 09/05/2018	This week lecture will cover band gap (direct and indirect gap semiconductors), absorption, types of semiconductors (intrinsic and extrinsic) and fundamental processes in a solar cell starting from light absorption to charge collection
3	Mon 09/10/2018	This week lectures will focus on the types of recombination and efficiency limits of solar cells.
3	Wed 09/12/2018	This week lectures will focus on the types of recombination and efficiency limits of solar cells.
4	Mon 09/17/2018	The concept of electron transport, drift and diffusion, electronic band structure, band bending and doping will be covered.
4	Wed 09/19/2018	The concept of electron transport, drift and diffusion, electronic band structure, band bending and doping will be covered.
5	Mon 09/24/2018	Junctions (p-n, p-i-n), origin of photovoltaic action, Shottky and Ohmic contacts, p-n junction characteristics under dark and light will be addressed.
5	Wed 09/26/2018	Junctions (p-n, p-i-n), origin of photovoltaic action, Shottky and Ohmic contacts, p-n junction characteristics under dark and light will be addressed.
6	Mon 10/01/2018	Silicon solar cells, architectures, processing and other inorganic materials for solar energy
6	Wed 10/03/2018	Silicon solar cells, architectures, processing and other inorganic materials for solar energy
7	Mon 10/08/2018	**Mid-term exam on 8th**
7	Wed 10/10/2018	Questions from the mid-term exam will be discussed
8	Mon 10/15/2018	Perovskite solar cells, characterization and degradation
8	Wed 10/17/2018	Perovskite solar cells, characterization and degradation
9	Mon 10/22/2018	Organic solar cells: materials and state-of-the-art
9	Wed 10/24/2018	Organic solar cells: materials and state-of-the-art
10	Mon 10/29/2018	Optical characterization methods for solar cells
10	Wed 10/31/2018	Optical characterization methods for solar cells
11	Mon 11/05/2018	Electrical characterization methods for solar cells
11	Wed 11/07/2018	Electrical characterization methods for solar cells
12	Mon 11/12/2018	Morphological characterization methods for solar cells
12	Wed 11/14/2018	Morphological characterization methods for solar cells
13	Mon 11/19/2018	Presentations
13	Wed 11/21/2018	Presentations
14	Mon 11/26/2018	Presentations
14	Wed 11/28/2018	Presentations

15	Mon 12/03/2018	Last week of lecture series will focus on the photovoltaic market and use of photovoltaic devices in real life, Intellectual property and start-up company ideas.
15	Wed 12/05/2018	The topics will be covered together with questions from the students for the final exam.
16	Mon 12/10/2018	Final exam. Date TBA.

Note

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