DEPARTMENT OF ENERGY SCIENCE AND TECHNOLOGIES
COURSE SYLLABUS

Course Details					
Code	**Academic Year**			**Semester**	
EBT315	3			5	
Title	**T**	**A**	**L**	**ECTS**	
Physics of Solar Cells	2	1	0	6	

Language	German					
Level	**Undergraduate**	X	**Graduate**		**Postgraduate**	
Department / Program	Energy Science and Technology					
Forms of Teaching and Learning	Face-to-face					
Course Type	**Compulsory**		**Elective**	X		
Objectives	The objective of this course is to explain the structures of solar cells, their interactions, methods and mechanisms of electron-hole production in solar cells, and the parameters of solar cells in electricity production. The course aims to teach the semiconductor properties and efficiency calculations of solar cells.					
Content	This course covers the types of solar cells, their structures, and the materials used. It also includes the mechanisms of electron-hole formation and electricity production in solar cells. Topics include doping types and calculations, physical interactions within solar cells, and working principles. The course also covers power calculations during the transition from cell to array and from array to module.					
Prerequisites	None					
Coordinator	Assist. Prof. Dr. Gülsüm Gündoğdu					
Lecturer(s)	Assist. Prof. Dr. Gülsüm Gündoğdu					
Assistant(s)						
Work Placement	None					

Recommended or Required Reading	
Books / Lecture Notes	Semiconductor Physics and Devices Basic Principles, Fourth Edition, Donald A. Neamen
Other Sources	Grundlagen der Halbleiterphysik, Springer, Jürgen Smoliner Photovoltaik, Wie Sonne zu Strom wird, Viktor Wesselak Sebastian Voswinckel Physik der Sollarzellen, Spektrum, Peter Würfel

Additional Course Material	
Documents	-
Assignments	-
Exams	-

Course Composition

DEPARTMENT OF ENERGY SCIENCE AND TECHNOLOGIES
COURSE SYLLABUS

Mathematics und Basic Sciences	10	%
Engineering	30	%
Engineering Design		%
Social Sciences		%
Educational Sciences		%
Natural Sciences	30	%
Health Sciences		%
Field Knowledge	30	%

Assessment

Activity	Count	Percentage (%)
Midterm Exam	-	-
Quiz	-	-
Assignments	-	-
Attendance	-	-
Recitations	-	-
Presentation	1	40
Final Exam	1	60
	Total	**100**

ECTS Points and Work Load

Activity	Count	Duration	Work Load (Hours)
Lectures	14	2	28
Self-Study	12	8	96
Assignments	10	3	30
Presentation / Seminar Preparation	1	12	12
Midterm Exam	0	0	0
Recitations	0	0	0
Laboratory	0	0	0
Projects	0	0	0
Final Exam	1	2	2
		Total Work Load	**168**
		ECTS Points (Total Work Load / Hour)	**6**

Learning Outcomes

1	To be able to use basic knowledge about solar radiation, photoelectric effect and energy conversion
2	To be able to express and analyze the structure of semiconductors and electron-vacancy transport in semiconductors physically and mathematically
3	Understanding the structure of solar cells, basic mechanisms, p-n junction characteristics and semiconductor-metal contacts

DEPARTMENT OF ENERGY SCIENCE AND TECHNOLOGIES
COURSE SYLLABUS

4	To be able to model energy conversion in solar cells, the dependence of conversion efficiency on material and operating parameters, to be able to follow basic research on solar cells
Weekly Content	
1	Solar cells, photoelectric effect and photovoltaic energy conversion principles
2	Photon, blackbody radiation, photon density, photon energy distribution, solar spectrum, absorption and emission, atmospheric effects on the spectrum
3	Energy flux, Stefan-Boltzmann radiation law, Kirchoff's law for materials other than blackbody, concentration of solar radiation, Abbe sine condition, geometric optics
4	Electron behavior in semiconductors, distribution function, density of states, vacancies, doping, Fermi energy, energy bands, work function
5	Interactions of radiation with semiconductors, absorption of photons in semiconductor structures, generation of electrons and vacancies, direct and indirect transitions, radiative and non-radiative recombinations, lifetime of electron-vacancy pairs
6	Electron-vacancy transport, field current, diffusion current, diffusion length, relaxation, Diffusion length of minority carriers, dielectric relaxation, ambipolar diffusion, Dember effect
7	Diffusion length of minority carriers, dielectric relaxation, ambipolar diffusion, Dember effect
8	Presentation
9	Basic mechanisms in a solar cell, pn-junction, electrochemical equilibrium of electrons in a pnjunction in the dark, potential distribution across the pn-junction and current-voltage characteristics of the pn-junction
10	Derivation of saturation and short-circuit currents, semiconductor-metal contacts, Schottky contact, MIS contact, role of electric field in solar cells
11	Limits of energy conversion in solar cells, maximum efficiency, efficiency as a function of energy gap, optimal silicon solar cells
12	Thin film solar cells, equivalent circuits, temperature dependence of open circuit voltage, dependence of efficiency on radiation intensity, efficiencies of energy conversion processes in solar cells
13	Concepts of efficiency enhancement in solar cells, tandem cells, electrical connections of tandem cells, concentrator cells, thermal-photovoltaic energy conversion
14	Energy conversion by collisional ionization, hot electron and vacancy
15	Two-stage excitation in three-level systems, impurity photoelectric effect, future of research in solar cells
16	Final Exam

Contribution of Learning Outcomes to Program Objectives (1-5)

	P1	P2	P3	P4	P5	P6	P7	P8	P9
1	3	4	4	5			5		5
2	3	3	4	4			5		5
3	5	5	4	4			5		5
4	3	3	4	5			5		5

Contribution Level	1: Low 2: Low-intermediate 3: Intermediate 4: High 5: Very High
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