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

Course Syllabus: Photophysics of Organic Semiconductors - MSE 390B

Division	Physical Science and Engineering Division
Course Number	MSE 390B
Course Title	Photophysics of Organic Semiconductors
Academic Semester	Fall
Academic Year	2019/2020
Semester Start Date	08/25/2019
Semester End Date	12/10/2019
Class Schedule (Days & Time)	10:30 AM - 12:00 PM | Mon Thu

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Frederic Laquai	frederic.laquai@kaust.edu.sa	+966128087243	3233, 5, Al-Kindi (bldg. 5)	8am - 5pm. Please send an email to arrange a meeting.

Teaching Assistant(s)

Name	Email

Course Information

Comprehensive Course Description	This course offers an introduction to electronic processes in organic and hybrid organic-inorganic materials, nowadays used in many optoelectronic devices such as light-emitting diodes (LEDs), photovoltaic (PV) cells, and photodetectors. First, the theoretical basics of electronic transitions and excited state dynamics are discussed, specifically: emission spectra of single molecules, molecular aggregates, and bulk samples as well as concepts of energy transfer, charge transport, and photophysical processes in conjugated polymers and organic and hybrid photovoltaic devices. Furthermore, the course offers an introduction to the most common steady-state and time-resolved (transient) all-optical and electro-optical spectroscopy techniques and analysis and interpretation of experimental data from different spectroscopy techniques. Finally, modeling of excited state dynamics using different software tools, for instance multivariate curve resolution analysis of complex spectroscopic data consisting of several components are discussed.
Course Description from Program Guide	This course offers an introduction to electronic processes in conjugated organic materials nowadays used in many different optoelectronic devices such as light-emitting diodes and organic solar cells. The theoretical basics of electronic transitions and excited states (excitons) are discussed first, followed by an overview of basic measurement (spectroscopy) techniques. Furthermore, emission spectra of single molecules, ensembles, and aggregates are reviewed and basic concepts of energy transfer and photoexcitations in conjugated polymers are introduced. Finally, the course offers an overview of technological applications of semiconducting organic materials and an introduction to advanced (time-resolved) spectroscopy and data analysis techniques.
Goals and Objectives	At the end of the course the attendees will: - be familiar with the description of electronic transitions in organic and hybrid materials - be familiar with the description of charge transfer, transport, and recombination - be familiar with common steady-state and time-resolved optical spectroscopy techniques - be familiar with advanced spectroscopy techniques and data analysis tools - be able to analyze and interprete spectroscopic data from common steady-state and time-resolved spectroscopic techniques
Required Knowledge	No specific knowledge required; previous exposure to quantum mechanics, physical chemistry, spectroscopy beneficial, but not compulsory.

Reference Texts	1.) Course Script and Lecture Slides. 2.) Anna Köhler, Heinz Bässler: Electronic Processes in Organic Semiconductors – An Introduction, Wiley VCh, April 2015 3.) Further reference texts will be provided during the lectures.
Method of evaluation	**40.00**% - Final exam **30.00**% - Midterm exam **30.00**% - Homework /Assignments
Nature of the assignments	Paper presentation, case studies, problem solving, and lab experiments.
Course Policies	Absences need to be fully justified.
Additional Information	None.

Tentative Course Schedule *(Time, topic/emphasis & resources)*		
Week	**Lectures**	**Topic**
1	Mon 08/26/2019	Theoretical Basics I: Einstein Coefficients, Quantum Yields, Oscillator Strength, and Transition Dipole Moment
1	Thu 08/29/2019	Theoretical Basics II: Einstein Coefficients, Quantum Yields, Oscillator Strength, and Transition Dipole Moment
2	Mon 09/02/2019	Basics of Measurements I: Absorption and Emission Spectroscopy
2	Thu 09/05/2019	Basics of Measurements II: Absorption and Emission Spectroscopy
3	Mon 09/09/2019	Assignment I (lab work): Photoluminescence quantum efficiency
3	Thu 09/12/2019	Spectra of Molecules I: Electronic Wavefunction, Transitions, Solvent Shifts, Radiationless Processes
4	Mon 09/16/2019	Spectra of Molecules II: Electronic Wavefunction, Transitions, Solvent Shifts, Radiationless Processes
4	Thu 09/19/2019	Assignment II: Solvatochromism of a molecule
5	Mon 09/23/2019	Saudi National Day
5	Thu 09/26/2019	High-Resolution Optical Spectroscopy I: Line shapes, site-selective spectroscopy
6	Mon 09/30/2019	High-Resolution Optical Spectroscopy II: Line shapes, site-selective spectroscopy
6	Thu 10/03/2019	Molecular aggregates I: H- and J-aggregates, CT-complexes, excimers, and exciplexes
7	Mon 10/07/2019	Molecular aggregates II: H- and J-aggregates, CT-complexes, excimers, and exciplexes
7	Thu 10/10/2019	Foerster and Dexter Energy Transfer Processes I
8	Mon 10/14/2019	Foerster and Dexter Energy Transfer Processes II
8	Thu 10/17/2019	Excitons I – Introduction and Basics, Experimental Evidence for Excitons
9	Mon 10/21/2019	Excitons II – Introduction and Basics, Experimental Evidence for Excitons
9	Thu 10/24/2019	Mid-term exam
10	Mon 10/28/2019	Mid-semester break
10	Thu 10/31/2019	Photoexcitations in Conjugated Polymers I: Oligomers, Model for Oligomers, Neutral and Charged Excited States
11	Mon 11/04/2019	Photoexcitations in Conjugated Polymers II: Oligomers, Model for Oligomers, Neutral and Charged Excited States
11	Thu 11/07/2019	Specific Examples: Polydiacetylenes, Poly-para-phenylene-vinylene, polyfluorenes, and others
12	Mon 11/11/2019	Charge Carrier Transport in Organic Semiconductors and Mobility Measurement Techniques
12	Thu 11/14/2019	Applications of Organic Semiconductors: OLEDs, OFETs, and OPV
13	Mon 11/18/2019	Assignment III: Preparation and characterization of an organic solar cell
13	Thu 11/21/2019	Time-resolved (TR) optical spectroscopy I: TR-Photoluminescence and Transient Absorption Pump-Probe Spectroscopy
14	Mon 11/25/2019	Time-resolved (TR) optical spectroscopy II: TR-Photoluminescence and Transient Absorption Pump-Probe Spectroscopy
14	Thu 11/28/2019	Introduction to analysis of transient spectroscopy data I
15	Mon 12/02/2019	Introduction to analysis of transient spectroscopy data II
15	Thu 12/05/2019	Final exam preparation
16	Mon 12/09/2019	Exams

Note

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