

Tentative schedule online course “Analytics for Photovoltaics” at FU Berlin, WS 2020/21

Date	Time/Location	Lecture	Seminar
Tuesday 03.11.2020	10:15 – 12:00 Online via Webex	1.1 General introduction to the course, general introduction to topic Renewable Energy (RE) 1.2 General introduction to analytics	
Friday 06.11.2020	10:15 – 12:00 Online via Webex	2.1 Solar radiation, black body radiation 2.2 Introduction to PV	
Tuesday 10.11.2020	10:15 – 12:00 Online via Webex	3.2 Introduction to PV 3.2 Introduction to PV: Shockley-Queisser limit	
Tuesday 10.11.2020	12:15 – 14:00 Online via Webex		S 1.1 Introduction to the Seminar „Analytics for PV” and discussion S 1.2 Introduction to the Seminar „Analytics for PV” and discussion
Friday 13.11.2020	10:15 – 12:00 Online via Webex	4.1 Introduction to PV 4.2 Electrical measurements, Lock-in amplifier	
Tuesday 17.11.2020	10:15 – 12:00 Online via Webex	5.1 Semiconductors: Density of states, doping 5.2 Fermi Level, effective mass	
Tuesday 17.11.2020	12:15 – 14:00 Online via Webex		S 2.1 Fundamental electrical characterization of thin-film solar cells

			S 2.2 Discussion: Lock-in amplifier
Friday 20.11.2020	10:15 – 12:00 Online via Webex	6.1 Semiconductors: Bands, mobility, 6.2 Measurement of conductivity & Hall effect	
Tuesday 24.11.2020	10:15 – 12:00 Online via Webex	7.1 Semiconductors: Optical properties (direct and indirect bandgap) 7.2 Semiconductors: Radiative and non-radiative recombination, Auger recombination	
Tuesday 24.11.2020	12:15 – 14:00 Online via Webex		S 3.1 Absorption and photocurrent spectroscopy (Photothermal Deflection Spectroscopy (PDS) and Constant Photocurrent Methods (CPM)) S 3.2 Discussion of homework
Friday 27.11.2020	10:15 – 12:00 Online via Webex	8.1 Light management, Yablonovitch limit 8.2 Measurement of absorption and reflection	
Tuesday 01.12.2020	10:15 – 12:00 Online via Webex	9.1 Semiconductors: Defects 9.2 pn junction	
Tuesday 01.12.2020	12:15 – 14:00 Online via Webex		S 4.1 Photoluminescence spectroscopy and its application to PV materials S 4.2 Discussion of homework
Friday 04.12.2020	10:15 – 12:00 Online via Webex	10.1 pn junction 10.2 Capacitance of pn junction	

Tuesday 08.12.2020	10:15 – 12:00	11.1 Silicon Solar Cells (multicrystalline Si)	
	Online via Webex	11.2 Silicon Solar Cells (monocrystalline Si)	
Tuesday 08.12.2020	12:15 – 14:00		S 5.1 Transient optoelectronic characterization: Charge extraction and transient photovoltage methods
	Online via Webex		S 5.2 Discussion of homework
Friday 11.12.2020	10:15 – 12:00	12.1 Non-coherent light sources	
	Online via Webex	12.2 Non-coherent light sources	
Tuesday 15.12.2020	10:15 – 12:00	13.1 Laser	
	Online via Webex	13.2 Laser	
Tuesday 15.12.2020	12:15 – 14:00		S 6.1 Time resolved THz spectroscopy for charge carrier mobility measurements
	Online via Webex		S 6.2 Discussion of homework
Friday 18.12.2020	10:15 – 12:00	14.1 Detectors	
	Online via Webex	14.2 Monochromator	
Tuesday 22.12.2020	10:15 – 12:00	15.1 X-ray radiation	
	Online via Webex	15.2 X-ray sources	
Tuesday 22.12.2020	12:15 – 14:00		S 7.1 Electroluminescence analysis of solar cells
	Online via Webex		S 7.2 Discussion of homework
Tuesday 05.01.2021	10:15 – 12:00	16.1 Synchrotron	

Tuesday 05.01.2021	Online via Webex	16.2 Synchrotron	
	12:15 – 14:00 Online via Webex		S 8.1 Capacitance Spectroscopy: CV profiling, DLTS S 8.2 Discussion of homework
Friday 08.01.2021	10:15 – 12:00	17.1 Disorder induced effects	
	Online via Webex	17.2 Thin film Si solar cells	
Tuesday 12.01.2021	10:15 – 12:00	18.1 EPR spectroscopy: Introduction, spin counting	
	Online via Webex	18.2 EPR spectroscopy: Bloch sphere, relaxation	
Tuesday 12.01.2021	12:15 – 14:00		S 9.1 EPR spectroscopy: defect analysis of solar cell materials
	Online via Webex		S 9.2 Discussion of homework, Demo of EPR
Friday 15.01.2021	10:15 – 12:00	19.1 EPR spectroscopy: Magnetic interaction, line shapes, g tensor	
	Online via Webex	19.2 EPR spectroscopy: Introduction to pulsed EPR, FID, inv. recovery echoes	
Tuesday 19.01.2021	10:15 – 12:00	20.1 NMR spectroscopy	
	room 1.3.21 T1	20.2 NMR spectroscopy	
Tuesday 19.01.2021	12:15 – 14:00		S 10.1 Transient optoelectronic Characterization: Charge extraction and transient photovoltage methods
	Online via Webex		S 10.2 Discussion of homework

Friday 22.01.2021	10:15 – 12:00 Online via Webex	21.1 Grain boundaries: Classification, Seto model 21.2 Grain boundary characterization (SEM, EBSD,)	
Tuesday 26.01.2021	10:15 – 12:00 Online via Webex	22.1 Grain boundary characterization (EDX, WDX,) 22.2 CIGS and CdTe thin film solar cells	
Tuesday 26.01.2021	12:15 – 14:00 Online via Webex		S 11.1 Scanning probe spectroscopy on thin film materials for solar cells S 11.2 Discussion of homework
Friday 29.01.2021	10:15 – 12:00 Online via Webex	23.1 III-V materials and multi junction solar cells 23.2 III-V materials and multi junction solar cells	
Tuesday 02.02.2021	10:15 – 12:00 Online via Webex	24.1 Third Generation PV: Concepts, Up Conversion 24.2 Third Generation PV: Singlet Fissio Lecturer: Rowan MacQueen (HZB)	
Tuesday 02.02.2021	12:15 – 14:00 Online via Webex		S 12.1 Accessing elemental distributions in thin film materials for solar cells (SIMS, GD-OES, AES, atom probe) S 12.2 Discussion of homework
Friday 05.02.2021	10:15 – 12:00 Online via Webex	25.1 Time resolved PL, fs spectroscopy, Pump and probe, fs-2PPE	

		25.2 Time resolved PL, fs spectroscopy, Pump and probe, fs-2PPE Lecturer: Rowan MacQueen (HZB)	
Tuesday 09.02.2021	10:15 – 12:00 Online via Webex	26.1 Quantum dot solar cells 26.2 Hybrid solar cells: Dye and perovskites SC	
Tuesday 09.02.2021	12:15 – 14:00 Online via Webex		S 13.1 Fourier-transform infrared spectroscopy (FTIR) and application to PV materials S 13.2 Preparation for oral examination
Friday 12.02.2021	10:15 – 12:00 Online via Webex	27.1 Vibrational spectroscopy: Introduction 27.2 Vibrational spectroscopy: Raman and Infrared spectroscopy	
Tuesday 16.02.2021	10:15 – 12:00 Online via Webex	28.1 Scanning probe techniques (STM, AFM, SNOM) 28.2 Elemental distribution profiling: Mass spectroscopy, SIMS, RBS, ERDA	
Tuesday 16.02.2021	12:15 – 14:00 Online via Webex		S 14.1 X-rays and neutron diffraction S 14.2 Discussion of homework
Friday 19.02.2021	10:15 – 12:00 Online via Webex	29.1 Hybrid Solar Cells: Organic molecules, vibronic states, OPV 29.2 Hybrid Solar Cells: Organic molecules, vibronic states, OPV	

<p>Tuesday 23.02.2021</p>	<p>10:15 – 12:00 Online via Webex</p>	<p>30.1 Surface/interface analysis: UPS, XPS, 30.2 Surface/interface analysis: XES, XRF, XAS, (NEXAFS, EXAFS), inverse PES</p>	
<p>Tuesday 23.02.2020</p>	<p>12:15 – 14:00 Online via Webex</p>		<p>S 15.1 X-ray and inverse photoemission: core level spectra, electronic band alignment and density of states spectroscopy in PV materials S 15.2 Preparation for oral examination</p>
<p>Thursday/Friday 25.02/26.02.2020</p>	<p>10:15 – 18:00 Online via Webex or EMIL@HZB</p>	<p>Oral Examination</p>	
<p>Tuesday 11.02.2020</p>	<p>10:15 – 18:00 EMIL@HZB</p>	<p>33.1 Morphology and structure: XRD, SAX, neutron scattering 33.2 Morphology and structure: TEM</p>	
<p>Tuesday 11.02.2020</p>	<p>12:15 – 14:00 room 1.3.21 T1</p>		
<p>Monday 10.02.2020</p>	<p>09:00 – 12:00 BESSY II, Berlin- Adlershof</p>	<p>31.1 Visit at BESSY II Synchrotron (Adlershof) 31.2 Presentation “EMIL and the detectors” 32.1 Visit at EMIL 32.2 Lab visit at HZB Adlershof</p>	