

MS ISEE Study Track: Solar Cell Systems and Materials

Study plan and Course Table: 2018/2019

Year 1 at DTU: DTU Management Engineering, Associate Professor Lise-Lotte Pade

Year 2 at NTNU: Department for Material Science and Engineering, Professor Marisa Di Sabatino Lundberg

Study track focus and goals

The overall goal of the study track is to educate MSc level candidates with theoretical knowledge and practical competence, qualified to a professional career in the PV industry, or for PhD level studies in the field. The study track focuses on the fundamental principles behind- and the application and development of- photovoltaic materials and/or devices, and systems.

In the first year at DTU, a broad basis in energy systems, technology and economics will be offered to all students. The fundamentals of solar energy harvesting are provided, in addition to basic courses in semiconductor physics and materials synthesis.

In the second year at NTNU, courses in solid state physics, optics, process metallurgical-, electro-chemical and chemical methods to synthesize semiconducting and light harvesting PV materials will be offered. In addition, courses in PV silicon materials processing such as crystallization, wafering and passivation are available. The year at NTNU contains a 15 ECTS project, in addition to the 30 ECTS MSc project. Depending on project and MSc direction, course choice will be recommended by project supervisor.

Course Table

1. Semester	2. Semester	3. Semester	4. Semester
Technical University of Denmark (DTU) Search the course number (i.e.42002)		Norwegian University of Science and Technology (NTNU) Search for courses	
42002 Modelling and Analysis of Sustainable Energy Systems Modelling using Operations Research, 5 ECTS	Chose 30 ECTS of Elective courses list	Chose 15 ECTS of Elective courses list	TFY 4915 Solar Cell Systems and Materials, Master's Thesis 30 ECTS (Department of Physics) or TMT 4915 Solar Cell Systems and Materials, Master's Thesis 30 ECTS (Department of Materials Science and Engineering)
42003 Energy Economics, Markets and Policies, 10 ECTS			
42004 Feasibility Studies of Energy Technologies (recommended), or 28870 Energy and Sustainability, or 10333 Physics of sustainable energy 5 ECTS		TFY 4530 Solar Cell Systems and Materials Specialization Project 15 ECTS (Department of Physics), or TMT 4520 Solar Cell Systems and Materials, Specialization Project 15 ECTS (Department of Materials Science and Engineering)	
47311 Analytical Imaging of Energy Materials by Electron Microscopy, or 34540 Light emitting diodes and photovoltaics for energy applications, or 11128 Development of solar energy systems, or 34032 Optical Properties of Solids 5 ECTS			
= 30 ECTC	= 30 ECTS	= 30 ECTS	= 30 ECTS

Elective course DTU

- **January:** 10386 Experimental Techniques in Quantum Technology, 5 ECTS
- **January:** 31070 Hands-on microcontroller programming, 5 ECTS
- **January:** 34551 Thin Film Photovoltaics, 5 ECTS
- **Spring:** 10302 Electronic Structure Methods in Material Physics, Chemistry and Biology, 10 ECTS
- **Spring:** 11117 Solar heating systems, 10 ECTS
- **Spring:** 26510 Catalysis and Sustainable Chemistry, 10 ECTS
- **Spring:** 31756 High Power Electronics, 10 ECTS
- **Spring:** 31778 Emerging Energy Technologies, 5 ECTS
- **Spring:** 33250 Semiconductor Technology, 5 ECTS
- **Spring:** 34552 Photovoltaic Systems, 5 ECTS
- **Spring:** 34051 Nanophotonics, 10 ECTS*
- **Spring:** 46230 Power system balancing with large scale wind power, 5 ECTS
- **Spring:** 47303 Applied Inorganic Chemistry, 5 ECTS
- **Spring:** 47304 Ceramic Science and Engineering, 10 ECTS
- **Spring:** 47305 Electrochemistry, 5 ECTS
- **Spring:** 47317 Exergy Analysis, 5 ECTS
- **Spring:** 47319 Functional Materials, 5 ECTS
- **June:** 34553 Applied Photovoltaics, 5 ECTS

**Requires Bachelor in Physics*

Elective course list NTNU

Depending on background, one can for example choose:

- **Fall:** TFE4164 Nanoelectronics 1
- **Fall:** TFY4300 Energy and environmental Physics 7.5 ECTS
- **Fall:** FY3114 Functional Materials 7.5 ECT
- **Fall:** TFY4255 Materials Physics 7.5 ECT
- **Fall:** TMT4322 Solar Cells and Photovoltaic Nanostructures 7.5 ECTS
- **Fall:** TMT4330 Resources, energy and environment 7.5 ECTS
- **Fall:** TMT4326 Refining and Recycling of Metals 7.5 ECTS
- **Fall:** TMT4322 Solar Cells and Photovoltaic Nanostructures 7.5 ECTS

Research areas for projects / master thesis for NTNU-DTU

NTNU, Responsible prof., department	DTU, Second supervisor, department	Research area Topic (P= Physics line, M=Materials line)
<ul style="list-style-type: none"> Gabriella Tranell Merete Tangstad Jafar Safarian Department of Materials Science and Engineering	Ole Hansen, ole.hansen@nanotech.dtu.dk , DTU Nanotech	<u>Si feedstock (M)</u> Si production and SoG-Si Refining
<ul style="list-style-type: none"> Marisa Di Sabatino Eivind Johannes Øvrelid Department of Materials Science and Engineering	Ole Hansen, ole.hansen@nanotech.dtu.dk , DTU Nanotech Jørgen Schou, josc@fotonik.dtu.dk , DTU Fotonik Jacob Bowen jrbo@dtu.dk (electron microscopy), DTU Energy	<u>Crystallization (M)</u> Material properties Characterization Wafering
<ul style="list-style-type: none"> Mari-Ann Einarsrud Fride Vullum-Bruer Department of Materials Science and Engineering	Ole Hansen, ole.hansen@nanotech.dtu.dk , DTU Nanotech Jørgen Schou, josc@fotonik.dtu.dk , DTU Fotonik Sara Engberg, sleen@fotonik.dtu.dk , DTU Fotonik.dtu.dk Brian Seger, brse@fysik.dtu.dk , DTU Physics	<u>Wet chemistry/sol gel (M)</u> TCO, nanoparticles Intermediate band materials
<ul style="list-style-type: none"> Turid W. Reenaas Ursula Gibson Randi Holmestad Ton Helvoort Justin Wells Dag Breiby Morten Kildemo Mikael Lindgren Ingve Simonsen Department of Physics	Ole Hansen, ole.hansen@nanotech.dtu.dk , DTU Nanotech Stela Canulescu, stec@fotonik.dtu.dk , DTU Fotonik Sara Engberg, sleen@fotonik.dtu.dk , DTU Fotonik, Jørgen Schou, josc@fotonik.dtu.dk , DTU Fotonik Jacob Bowen, jrbo@dtu.dk (electron microscopy), DTU Energy Brian Seger, brse@fysik.dtu.dk , DTU Physics	<u>Thin film/third generation solar cells (P)</u> Intermediate band solar cells Thin film/Intermediate band solar cells TEM characterization Optical characterization Modeling light/matter interaction

<ul style="list-style-type: none"> • Bjørn-Ove Fimland • Helge Weman <p>Department of Electronics and Telecommunications</p>	<p>Ole Hansen, ole.hansen@nanotech.dtu.dk, DTU Nanotech Stela Canulescu, stec@fotonik.dtu.dk, DTU Fotonik</p>	<p><u>III-V solar cells (P)</u> Nanowire and intermediate band solar cells Nanowire solar cells</p>
	<p>Sune Thorsteinsson, sunth@fotonik.dtu.dk, DTU Fotonik.</p>	<p>Modules Deployment BIPV</p>

Degree requirements for admission process

A BSc degree corresponding to a minimum of 180 ECTS credits in the following fields: Physics or relevant BSc, Materials Science or Inorganic Chemistry/Chemical Engineering. Applicants must document that they have fulfilled the following minimum requirements:

- Mathematics: 25 ECTS including linear algebra, calculus and differential equations
- Statistics and probability theory: 5 ECTS Numerical methods and elementary programming using e.g. MATLAB or a similar programming language
- Physics: 80 ECTS
- Mathematics and statistics: 60 ECTS
- Chemistry: 15 ECTS
- Thermodynamics: 7.5 ECTS
- Materials Science: 15 ECTS