Print course syllabus

Syllabus

PV1x Solar Energy Engineering: Photovoltaic Energy Conversion

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1. Introduction

The key factor in getting more efficient and cheaper solar energy panels is the advance in the development of photovoltaic cells. In this course you will learn how photovoltaic cells convert solar energy into usable electricity. You will also discover how to tackle potential loss mechanisms in solar cells. By understanding the semiconductor physics and optics involved, you will develop in-depth knowledge of how a photovoltaic cell works under different conditions. You will learn how to model all aspects of a working solar cell. For engineers and scientists working in the photovoltaic industry, this course is an absolute must to understand the opportunities for solar cell innovation.

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1.1. Course overview

This course is part of the Solar Energy Engineering MicroMasters Program designed to cover all physics and engineering aspects of photovoltaics: photovoltaic energy conversion, technologies and systems. We recommend that you complete this course prior to taking the other courses in this MicroMasters program.

This course PV1x: Photovoltaic Energy Conversion is one of the 5 courses in the MicroMasters Solar Energy Engineering. This instructor-paced course is designed to be completed within 10 weeks, if you devote around 10 hours per week to the course. The course should be finished before August 11, 2019. We have therefore set a weekly structure to guide you. The level of the course is graduate level and the course is in spoken English.

To enjoy the extra support offered during the course, and be able to obtain a certificate at the end, you can upgrade to the verified learner experience. More information can be found in the verified learner experience section of the syllabus. A Solar Energy Engineering MicroMasters Program Leaflet is also available.

1.2. Learning objectives

By the end of this course you will be able to:

- master semiconductor physics necessary to understand solar cell performance and engineering
- understand the optics and light management tools that are necessary to design an optimal solar cell
- understand the principles behind the potential loss mechanisms in photovoltaic devices
- design solar cell concepts, model all aspects of a working solar cell, understand the efficiency limits and design rules

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1.3. What we expect from you

As an online student we expect you to be an active participant in this course, contributing to a positive atmosphere by questioning, sharing and helping out others, engaging in meaningful discussions where knowledge construction is revealed. We encourage people to post their question or discussions related to lectures, questions and assignments in the specific Discussions you'll find each week.

Please be aware that it's extremely important to follow the forum and collaboration guidelines, to respect the course policies and academic integrity.

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1.4. What you can expect from us/the course team

The e-Moderator and Lecturers will guide you throughout the course, promoting and engaging in discussions. Guidance and support will happen on a regular basis, mainly every day. The course team aims to keep the videos up to date and topical content will be introduced through the live webinars.

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2. Course structure

The course is organized in 4 parts, divided over 8 weeks of content, plus 2 additional weeks for the practice exam, final exam and resit. A brief summary of each week is presented below.

Introduction and Extras

In the Introduction and Extras section you'll get to know the course structure, meet your fellow students and the e-moderator. In this section the extra features are introduced, such as the live webinars and useful resources.

:: Part 1. Introduction ::

Week 1. Introduction

1.1 Energy
1.2 Solar radiation
1.3 The photovoltaic effect
1.4 Solar cell design

:: Part 2. Semiconductor physics ::

Week 2. Introduction to semiconductor physics

2.1 Introduction to semiconductor physics
2.2 Semiconductor properties in equilibrium
2.3 Semiconductor properties in non-equilibrium
2.4 Charge carrier transport mechanisms

Week 3. Generation and recombination

3.1 Introduction to generation and recombination
3.2 Continuity and ambipolar transport
3.3 Injection dependent lifetime

Exam 1 (verified learners)

Week 4. The p-n junction

4.1 P-N junction at thermal equilibrium
4.2 P-N junction under bias voltage
4.3 P-N junction under illumination

Week 5. Advanced concepts in semiconductors

5.1 Advanced semiconductor physics
5.2 Metal-semiconductor junction
5.3 Heterojunctions

Exam 2 (verified learners)

:: Part 3. Optics ::

Week 6. Light management I: refraction/dispersion/diffraction

6.1 Introduction to optics

6.2 Light management basics
6.3 Refraction and dispersion
6.4 Diffraction

Week 7. Light management II: light scattering

7.1 Scattering
7.2 The external quantum efficiency

:: Part 4. Engineering ::

Week 8. Solar cell engineering

8.1 Shockley-Queisser limit
8.2 Additional losses and conversion efficiency
8.3 Reducing losses
8.4 Third generation concepts

Exam 3 (verified learners)

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3. Verified learner experience

All the video content in this course, as well as a number of ungraded practice assignments are available for free. By upgrading to the verified learner experience, you will get access to:

- ALL exercises: the practice and graded assignments and the exams
- The PV1x verified certificate if you successfully complete the course
- access to the archived course after the end date.

Do you need financial assistance? EdX offers up to a 90% discount on our verified certificates to learners who cannot afford to pay full price. Check the edX support page for financial assistance.

If you're interested in a certificate you need to obtain an minimal overall grade of 60%. These certificates will indicate you have successfully completed the course, but will not include a specific grade. Certificates will be issued by edX under the name of DelftX, designating the institution from which the course originated.

Generating an ID verified certificate

In order to qualify for a certificate, you must achieve a total grade of 60% or higher (for more information please read 4. Assessment & Deadlines). An ID verified Certificate of Achievement is available for $250. You can Upgrade on your edX Dashboard to Verified during the course.

This PV1x course offers on-demand certificates, allowing you to generate your own certificate as soon as you qualify. Certificates can be downloaded from your Student Dashboard (look for the Download button next to the name of our course). For more information on downloading your on-demand certificate, go to the corresponding page of the edX learner's guide.

Once produced, a certificate cannot be reissued, hence it is very important that you verify the way in which your name appears. Check that, in your edx.org account, your name is correctly spelled, since it will appear on the final certificate.

MicroMasters Program Details

PV1x Photovoltaic Energy Conversion is part of the Solar Energy Engineering MicroMasters program. You can obtain a verified certificate for PV1x by achieving an overall score of 60% or higher. You can earn the MicroMasters credential by completing and successfully earning a Verified Certificate in all 4 courses plus the PV5x Solar Energy Engineering Comprehensive exam.

If you successfully earn the MicroMasters Credential and decide to apply to the Master of Science program Sustainable Energy Technology (SET) or the Master of Science program Electrical Engineering (track: Electrical Power Engineering) at TU Delft, you will need to go through the regular admission procedures for MSc students and meet the entry requirements for those MSc programs.

If you are admitted and you would like to be exempted from courses in the aforementioned MSc programs, you are required to send a formal waiver request. Campus courses that can be waived (up to 16-18 credits) are courses that are equivalent to the solar energy courses of the MSc program in question.

More information can be found at the online learning website of Delft University of Technology

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4. ASSESSMENT & DEADLINES

In order to successfully complete the course you need to score **60%** or more for your final grade. In the course there are (ungraded) practice assignments and graded exercises, as well as 3 exams. Only verified learners have access to the graded exercises and exams. The exact weight of the different assignments is as follows:

- Weekly Exercises: 40%
- 3 exams: 60%

The course ends August 11, 2019 at 23:59 UTC. All Weekly Exercises and the Exams are due on this date.

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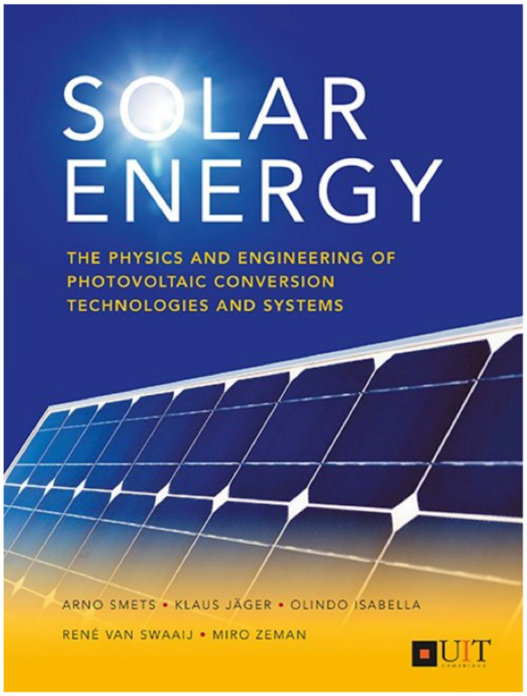
5. Resources & Tools

This course makes use of the book "Solar Energy, the physics and engineering of photovoltaic conversion technologies and systems" written by the TU Delft staff from the Photovoltaic Material and Devices (PVMD) department, and published at UIT Cambridge. We are happy to announce that the e-book is available for free in the online bookstores. You can order a hard copy as well at the online retailers for typical prices ranging from $25 up to $32.



Moreover, you will find plenty of instructional videos each week. These videos (available in 360p, 720p or 1080p) including the subtitles, the transcripts and the slides used can be downloaded through the links below the videos.

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