UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

DOTTORATO DI RICERCA / PHD PROGRAM IN
INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING

Ad hoc course announcement

SOLAR CELLS: MODELLING AND APPLICATIONS

Lecturer: Ilaria Matacena, PhD

University of Naples Federico II
Email: ilaria.matacena@unina.it

BIO NOTES: Ilaria Matacena is an Assistant Professor at University of Naples Federico II. She earned her PhD in Information Technology and Electrical Engineering from the same University discussing the thesis "Impedance spectroscopy for interface characterization in semiconductor devices". Since 2016, Dr. Matacena's research has primarily focused on semiconductor devices characterization techniques with special focus on solar cells. Dr. Matacena authored and co-authored more than 30 works scientific contributions in peer-reviewed international journals, conference proceedings, book series, and book chapters. She was Visiting Researcher at Kyoto University of Advanced Science (KUAS) in Japan where she carried out characterization on power MOSFETs. Dr. Matacena collaborates with Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA) analysing innovative solar cells such as perovskite tandem solar cells and dopant free solar cells. She is responsible of a VIPERLAB project regarding simulations of perovskite solar cells.

Overview

Global energy increasing demand places significant strains on current energy infrastructure. This emerging challenge, coupled with depleting traditional fossil-fuel based energy sources and the threat of climate change, requires the development of renewable energy technologies. Among the possible renewable energy approaches, photovoltaics (PV) represents a promising route. A solid foundation in solar cells working principles and typical behavior will be presented in this course. A better understanding of this topic will be given using PC1D software. Although its first part focuses on solar cells operational modelling, the expertise gained in the use of the presented topics can be easily adopted in alternative areas and scenarios.

The primary target of this course is to guide students in correctly setting up electrical problems and extracting/exploiting key electrical parameters related on photovoltaic world. The course includes a comprehensive schedule, featuring practical experience with commercial software for electrical simulations

within a SPICE environment. Methods and characterization techniques suitable for fault detection and malfunctioning of solar cells will also be explained, ranging from conventional current-voltage characteristics to impedance spectra analysis.

There will be a final assessment, in which students will be required to present how they can effectively apply the course material to a case study falling within their own research areas.

Schedule

Lecture	Date	Time	Room	Topics	Lecturer
1	10/01/25	14.30-17.30	C2A	Introduction on Photovoltaic	I. Matacena
2	14/01/25	14.30-17.30	C2A	Solar cells working principles	I. Matacena
3	17/01/25	14.30-17.30	C2A	Solar cell modelling	I. Matacena
4	24/01/25	14.30-17.30	C2A	Fault detection techniques	I. Matacena
5	28/01/25	14.30-17.30	C2A	Solar cells applications	I. Matacena
		TBD	TBD	Assessment test	

Content details

Lesson 1 – Introduction on Energy problem and Photovoltaic Energy. Brief overview on Renewable Energy. Overview of possible applications of solar cells energy in different domains.

Lesson 2 –The fundamental concepts of solar cells will be presented. Working principles and typical behavior of solar cells under illumination will be explained. To simulate new device performance and also for new users to develop an understanding of device physics the software PC1D will be used.

Lesson 3 – Operational modelling of solar cells will be introduced. Students will receive detailed instructions on how to perform static and dynamic electrical simulations within LTSpice software.

Lesson 4 – Focus will be given to the fundamentals of fault detection and malfunctioning of solar cells and more in general photovoltaic modules. The understanding of these problems will be explained also through simulations performed in LTSpice software.

Lesson 5 – Applications of solar cells-based solutions to real problems arising in different application fields, from space satellites to wearable applications will be shown.

Credits: 4 CFU/ECTS

Participants are requested the following MS Teams group:

https://teams.microsoft.com/l/channel/19%3An2cTDuPEYX70FzaV-l4-Xv49RrCvJekPIaI9v_eY3OI1%40thread.tacv2/?groupId=97c79362-e8c7-42ff-8605-9c3d5454d0e6&tenantId=2fcfe26a-bb62-46b0-b1e3-28f9da0c45fd

Once accepted in the Teams group, students have to fill the following .xlsx file with their information:

https://communitystudentiunina.sharepoint.com/sites/SOLARCELLSMODELLINGANDAPPLICATIONS/Shared%20Documents/Forms/AllItems.aspx?FolderCTID=0x012000E2D8B3D0F6B832419C5DAC7EF4A95803&id=%2Fsites%2FSOLARCELLSMODELLINGANDAPPLICATIONS%2FShared%20Documents%2FGeneral

The course is conducted on-site. However, students pursuing their PhD period abroad (for research purposes) have the option to request remote attendance for classes via MS Teams

For information: Dr. Ilaria Matacena (DIETI, UniNA) – ilaria.matacena@unina.it