



Photovoltaics Specialisation Syllabus

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Cell and Module Technology (KD7047) (compulsory / examinable, Standard Module)
Syllabus
<p>The module delivers four main themes of theoretical and technical content related to Solar photovoltaics.</p> <p>Material Fabrication Technologies</p> <p>Introduction to the characteristics of the Sun - relevant to solar cell operation. The solar spectrum and its intensity and total energy available from the sun. Relevant semiconductor physics together with important semiconductor materials used in solar cells will be introduced. Underpinning quantum theory, required to understand energy bandgap, direct and indirect transitions and the electrical and optical behaviour of these materials, will also be reviewed.</p> <p>Ideal junctions - equilibrium and under illumination</p> <p>Ideal behaviour of the junction will be considered under equilibrium conditions and the electrical behaviour derived. This will be extended to consider the behaviour when operating as a solar cell under illumination to include key performance parameters such as the open circuit current, short circuit current and cell conversion efficiency.</p> <p>Non-ideal behaviour, characterisation and module design</p> <p>The module will proceed to introduce factors that affect solar cell behaviour under non-ideal conditions. The influence of temperature and the quality of electrical contacts on device performance will be examined.</p> <p>Processes for production of semiconductors and devices and their characterisation</p> <p>An overview of device characterisation techniques, module design and applications of photovoltaic devices will be presented.</p> <p>Delivery of this module will be through a combination of lectures, laboratory work and independent learning. Classes will be instructed to read ahead in the notes and to use the reading lists for background reading. Lectures may also provide a formative approach to assessment with integrated exercises and problems to solve. Dissemination of information through lectures will be integrated with, and re-enforced by, laboratory experiments.</p>
Laboratories
Device operation and characterisation
Assessment
<p>Literature review for a chosen cell category and examination.</p> <p>Assessment will include an extended Laboratory report (40%) and an end of year final exam (60%).</p> <p>The end of year exam will cover all the theoretical material and aspects of learning, this will cover all LOs</p> <p>The extended laboratory report will focus on testing Los 1- 2. 3 laboratory experiments must be completed to pass the module and an extended report on one of the laboratory experiments must be submitted. Marks awarded will be based on the extended report.</p>
Learning outcomes
<p>Knowledge & Understanding:</p> <p>The student will have:</p> <ul style="list-style-type: none"> • Understanding of the physical principles relating to the operation and design of photovoltaic (PV) cells and developing this to PV modules. • Critical understanding of the effect of material purity and crystallinity on the device performance. <p>Intellectual / Professional skills & abilities:</p> <ul style="list-style-type: none"> • Compare the design and operation of the main types of photovoltaic cells evaluate different fabrication methods in terms of device properties and manufacturing issues. • Compare and evaluate methods for the fabrication of photovoltaic modules, including performance and manufacturing issues.

Photovoltaic Development and Implementation
(KD7049) (compulsory / examinable, Standard Module)

Syllabus

This module considers the development of photovoltaic technology, in terms of photovoltaic cell design and manufacturing advances, the progress in economic and environmental aspects and the definition and use of policy measures to aid market development. The student will develop a wide range of skills from the understanding of research directions and how these can lead to improvement of cell and system performance to the ability to conduct economic and environmental assessments of current and new technologies. This wide range of subjects will equip the student to contribute to the development of photovoltaics as it becomes a mainstream energy source worldwide.

An overview of the subjects to be studied is provided below:

- Advanced photovoltaic cell design (high efficiency approaches, multijunction concepts, material reduction strategies, organic and polymer cells)
- Advanced characterisation methods (methods to determine the detailed performance of advanced cell concepts)
- Economic analysis methods (economic theory, production economics, financing mechanisms)
- Environmental impact assessment (process definition, hazard assessment, embodied energy and emissions analysis)
- Policy issues (market development, climate change and security aspects, government policies and market development approaches)

The module is delivered by a combination of lectures and seminars, including class based exercises. The format will encourage discussions in class regarding the major issues of development and implementation of photovoltaics.

Assessment

SUMMATIVE ASSESSMENT

1. Literature review (50%)
2. Written assignment and presentation (50%)

The student will also undertake two individual assignments. The first of these will be a literature review concerning one of the photovoltaic cell technologies under development at the time of delivery of the module. This gives the student experience in gathering and assimilating technical information. The student will be asked to make a critical comparison of the advantages and disadvantages of the technology under development with the current market standards.

The second assignment will concern a comparison of the economic and environmental aspects of photovoltaics with a different renewable energy option of their choice for a specific region or country. This allows the student to put into context their learning on photovoltaics and develop opinions on the strategy for implementation of renewable energy technologies. The student will also make a presentation of their work, worth 20% of the total marks for this assignment.

Each assignment will be worth 50% of the marks for this module.

FORMATIVE ASSESSMENT

1. In-course seminars and discussion

Learning outcomes

Knowledge & Understanding:

- Critical appraisal of the choices for materials, design, manufacture and characterisation of advanced photovoltaic devices
- Critical analysis of international policies for the development of photovoltaics, including their strategic, economic and environmental aspects

Intellectual / Professional skills & abilities:

- Ability to perform economic and environmental assessment of processes
- Ability to undertake a critical literature review

Personal Values Attributes (Global / Cultural awareness, Ethics, Curiosity):

- Ability to present a clear argument (technical or non-technical) in both written and oral format

Photovoltaic System Technology
(KD7050) (compulsory / examinable, Standard Module)

Syllabus

This module, considers the principles of photovoltaic (PV) system, design, operation and application. This will include consideration of the system components and the design and configuration of the solar array, together with examples of stand-alone, grid-connected and space applications. The module will also help you to appreciate the issues relating to the implementation of photovoltaic systems.

The topics within the module syllabus include:

- PV arrays and system components
- Grid connected PV systems, including large scale and building integrated systems
- Stand-alone PV systems and applications • Concentrator PV systems
- PV arrays for satellite power supply
- Monitoring and performance analysis
- Operation and maintenance, system lifetime, standards and regulations

The material will be delivered via a combination of lectures and seminars, including some class-based design exercises. An individual design project, in which the student will develop a system design for a defined customer, considering both technical and non-technical issues to achieve the best design compromise and utilising specialist software for the design of photovoltaic systems.

Assessment

SUMMATIVE:

1. Examination (60%)
2. Written assignment and presentation (40%)

The module is assessed by an examination (60%) which investigates the student's knowledge and understanding of the principles of PV systems. The design project mentioned above will determine the student's ability to apply their knowledge to a real life application.

Feedback on the examination is provided individually and also generically.

Feedback on the assignment is also provided individually, with particular emphasis on constructive advice to enhance skills in system design and the presentation of technical material.

Formative feedback is provided in lectures and seminars with regard to the development of understanding of the module content. The knowledge and skills acquired in this module significantly enhance employability, particularly in the field of renewable energy.

FORMATIVE

1. In-course seminars and discussions

Learning outcomes

Knowledge & Understanding:

- Assess the system requirements for both grid-connected and stand-alone applications of PV systems
- Critically evaluate the performance of a PV system in contrast to a theoretical model of such a system, calculating yields and efficiencies
- Analyse the main system losses and compare methods for minimising these for various system designs

Intellectual / Professional skills & abilities:

- Design and develop a PV system evaluating complex and contradictory customer needs in relation to an application

Personal Values Attributes (Global / Cultural awareness, Ethics, Curiosity):

- Undertake an individual project including definition of goals and time management