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DAMOC Project Meeting
Stellenbosch University - South Africa
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Structured MEng (Elec Eng)
Smart Grid Technology
Course Module Content

Prof Roger Wang

CENTRE FOR RENEWABLE AND SUSTAINABLE ENERGY STUDIES

ELECTRICAL & ELECTRONIC ENGINEERING
STELLENBOSCH UNIVERSITY

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Structured MEng Program in Smart Grid Technology

- Admission: Hold at least a BEng, a BSc Hons, another relevant four-year bachelor's degree, an MTech, or a PGDip (Eng.).
- Course approved in 2018, registered and running for the 4th year in 2021.
- Course consists of 8 modules (*3 common, 4 compulsory and 1 elective*), each 15 credits, total 120 credits.
- Successful completion of modules followed by an individually supervised half-dissertation (60 credits).
- Duration and Teaching Load: One or two years; Full-time or part-time basis.
- Format: One week block per module with 45 hours of contact and additional work via distance education (*Formal Lectures, Tutorials, Group work, Assignments, Examination*)

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Programme Course Structure

SMART GRID TECHNOLOGY STRUCTURED MASTERS PROGRAM: E&E Eng.

8 Modules (120 Credits) plus a Thesis Project (60 Credits)

COMMON MODULES (3)	CREDITS	HOST DEPARTMENT
Data Science 874	15	Industry Engineering
Advanced Topics in Engineering Management 873	15	Industry Engineering
Numerical Methods 876	15	Applied Mathematics
Project Management 873	15	Industry Engineering
Project Economics and Finance 812	15	Civil Engineering

COMPULSORY MODULES (4)	CREDITS	HOST DEPARTMENT
Smart Grid Technology Overview 874	15	E&E Engineering
Integrated Supply Side Technology 874	15	E&E Engineering
Smart Grid Communications 874	15	E&E Engineering
Integrated Demand Side Technology 874	15	E&E Engineering

ELECTIVE MODULES (1)	CREDITS	HOST DEPARTMENT
Advanced PV Systems 844	15	E&E Engineering
Energy Storage Systems 874	15	E&E Engineering
Wind Energy 844	15	M&M Engineering

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Programme Enrolment Since 2018

SMART GRID TECHNOLOGY STRUCTURED MASTERS PROGRAM: E&E Eng.

- Currently registered MEng SGT students: 22

Year	New Enrolment	Graduated	Discontinued
2018	5	-	-
2019	16	2	1
2020	4	8	1
2021	11	(2)	-

Number of Students by Gender	12 (F)	24 (M)
Number of Students by Nationality	25 (RSA)	11 (RoA)

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Common Modules (3)

1. Data Analytics

Data science is the application of computational, statistical, and machine learning techniques to gain insight into real world problems. The main focus of this module is on the data science project life cycle, specifically to gain a clear understanding of the five steps in the data science process, namely obtain, scrub/wrangling, explore, model, and interpret.

2. Advanced Topics in Engineering Management

The purpose of the module is to present principles of general management within the context of technical disciplines. The course themes include the business environment and strategic management on a firm level, touching on the role of innovation and technology for competitiveness on a systems level from international and national perspectives.

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Common Modules (3)

3. Numerical Methods

The module focuses on matrix computations. We study the effective solution of linear systems, involving both square and rectangular matrices (least-squares). Direct as well as iterative methods are considered, with the emphasis on sparse matrices and matrices with structure. Numerical methods for the eigenvalue problem are also considered.

4. Project Management

The module focuses on advanced topics in project management, and it is expected that participants have either attended a project management course or have experience in managing projects. The module builds on the traditional project scheduling by addressing critical chain management and looks at managing project risks through the identification and assessment of risk potentials and mitigating strategies, including resource / cost management and contingency planning.

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Common Modules (3)

5. Project Economics & Finance

The module focuses on how to finance a business opportunity (project) that can be isolated from the rest of a company's business activities. Financing through a combination of debt and equity are discussed, based on the future profitability of the project where project cash flow is the main source of capital recovery and the project assets are the only collateral. The concepts of construction loans and public private partnerships are discussed. A number of case studies will be covered in the module, including projects to construct a bridge, a satellite and a wind turbine farm.

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Compulsory Modules (4)

1. Smart Grid Technology Overview (new developed)

The module defines the concept of a SG, and presents a broad overview of all components and technologies associated with this concept.

2. Integrated Supply Side Technologies

The module provides an insight into the supply side of the power system. The focus will be on power delivery characteristics of conventional power stations, intermittent renewable power stations and utility-scale energy storage. Economic dispatch, energy storage scheduling, load frequency control and inter-area power flow, dynamic system stability and inertia will also be covered. An overview of applicable network codes and regulations, and introduction to power system modelling and simulation software will be discussed.

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Compulsory Modules (4)

3. Integrated Demand Side Technologies (new developed)

The course provides an insight into the demand side of the power system. Load models and modelling strategies, load forecasting, demand side management, measurement & verification, advanced metering infrastructure and data management, tariff design and microgrids will be covered. An overview of applicable network codes and regulations will also be provided.

4. Smart Grid Communications (new developed)

Provides an overview of fundamental SG-related communications, including the following topics: transmission media introduction, waves, spectrum and units, modulation and demodulation fundamentals, noise and SNR, antenna basics, digital transmission and media, data networking principles and performance, industrial interfaces & protocols, performance criteria for distributed SG comms, data transfer integrity for SG, wide area network types and principles, telemetry for SG and finally rural network options.

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Elective Modules (1)

1. Advanced PV Systems

The aim of the course is to provide attendees with the understanding and tools to design grid-tied (including hybrid configurations with backup power) PV systems within the South African solar resource, technical and legislative contexts. The underlying design criteria will be to optimise the energy yield versus lifecycle costs of the PV system within the given resource, technical and legislative constraints, i.e. the optimising the financial viability of the system.

2. Energy Storage Systems

The objective of the module is to enable participants to understand the concepts and technologies used for electrical Energy Storage. The course highlights Lithium-Ion batteries as the dominant technology in new projects and addresses the complex safety, performance and life issues of this technology. The technical and financial parameters that drive the project design of grid-connected and off-grid energy storage systems will also be discussed.

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Elective Modules (1)

3. Wind Energy

This module deals with the harvesting of energy from wind. It addresses the availability of the resources, the types of systems and machines, their capabilities and limitations, the processes of setting up such systems, and their associated costs and environmental impacts

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Research Project

An electrical engineering research project that entails formulating objectives, planning the project, surveying the relevant literature and applying what was learned in the modules as well as from the literature review and own research. Critical evaluation of the research results will also be required.

(1) Quantifying demand flexibility potential with targeted demand response for a municipal distribution network
(2) Demand side management of a retail store through consideration of the different levels of the energy pyramid
(3) Investigation into the optimisation of the electrical load profile of a commercial site through the implementation a battery storage system
(4) A probabilistic approach for determining the maximum PV hosting capacity of a residential estate
(5) An investigation of the presence of applicable policies that enable the national energy regulator of South Africa licensed distributors to participate in the renewable energy industry in South Africa

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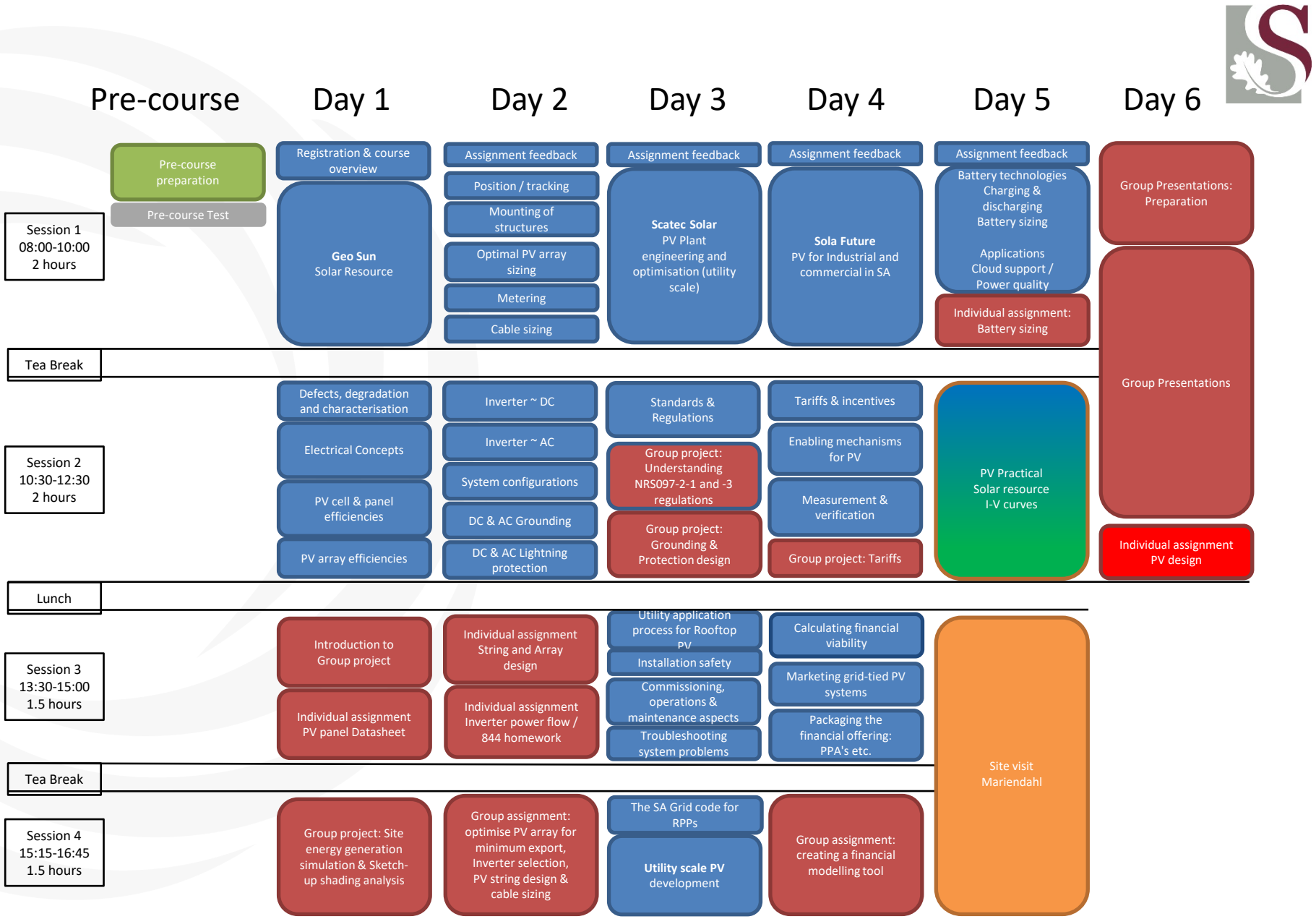
An Example of Week-long Block Module

- Advanced Photo Voltaic Systems (Dr Arnold Rix)

Main topics:

- Solar resource & irradiation data sources
- Different solar PV technologies
- Photo-voltaic panels:
  - *Electrical characteristics, maximum power point, influence of shading & diffuse irradiation, etc.*
- Photo-voltaic arrays:
  - *Impact of positioning & tracking, string design and DC cable sizing, etc.*
- Connection to the distribution grid:
  - *Power electronics basics, earthing and circuit-breaker design, system sizing, AC cable sizing, South African regulations & standards, etc.*
- Financial viability:
  - *Understanding tariffs, payback, etc.*



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Thank you

Questions?