School of
Engineering and Computer Science
Te Kura Mātai Pūkaha, Pūrorohiko

Prescription

This course will provide an overview of the role of energy systems in sustainability, and the development trends, past and future, of different technologies. The ways in which the technologies influence industry, government, and society will be examined from a range of different perspectives. Students will also gain practical skills in energy generation and utilisation through a range of experiments, as well as skills in modelling renewable energy systems for different contexts.

Course learning objectives

Students who pass this course will be able to:

1. Identify a broad range of renewable energy interventions to address specific energy requirements, particularly related to solar, wind and hydro sources.
2. Determine the sustainability challenges of different renewable energy interventions.
3. Identify key scientific principles affecting renewable energy generation and utilisation.
4. Utilise industry standard modelling packages to compile basic renewable energy systems.

Course content

The course comprises of three components. First, it is intended to give students a broad understanding of the accepted principles of sustainable development, and how the related goals manifest on a global scale and influence the energy sector specifically at different levels; from the macro-economy, to local communities. Second, it is intended for students to gain the necessary insight to critique the sustainability of a variety of renewable energy technology systems that aim to address equitable energy access, and a just transition to a low-carbon economy. Third, it is intended for students to gain experience with energy generation and utilisation from renewable resources, and especially solar photovoltaic and wind, through experimentation, basic calculations, and software modelling; to understand the key scientific principles that underpin different renewable energy technology systems.

Required Academic Background

Mathematics and physics at NCEA level 3 are recommended, but not essential to take this course.

Withdrawal from Course

Withdrawal dates and process:
https://www.victoria.ac.nz/students/study/course-additions-withdrawals

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Teaching Format

There are weekly lectures, tutorials, and laboratory sessions, supported by online materials and discussion. The practical work in the labs involves experimentation on energy generation, and utilisation. An individual project and a group project will involve modelling renewable energy systems for specific contexts. Students are also required to enrol and complete (demonstrated by a certificate of proficiency) "The Age of Sustainable Development" - an online, on-demand course of the SDG Academy.

Student feedback

Student feedback on University courses may be found at:
http://www.cad.vuw.ac.nz/feedback/feedback_display.php

Dates (trimester, teaching & break dates)

- Teaching: 08 July 2019 - 13 October 2019
- Break: 19 August 2019 - 01 September 2019
- Study period: 14 October 2019 - 17 October 2019
- Exam period: 18 October 2019 - 09 November 2019

Class Times and Room Numbers

08 July 2019 - 18 August 2019

- **Monday** 15:10 - 16:00 – LT101, Maclaurin, Kelburn
- **Tuesday** 15:10 - 16:00 – LT205, Hugh Mackenzie, Kelburn
- **Thursday** 15:10 - 16:00 – LT101, Maclaurin, Kelburn

02 September 2019 - 13 October 2019

- **Monday** 15:10 - 16:00 – LT101, Maclaurin, Kelburn
- **Tuesday** 15:10 - 16:00 – LT205, Hugh Mackenzie, Kelburn
- **Thursday** 15:10 - 16:00 – LT101, Maclaurin, Kelburn

Other Classes

A laboratory session will take place on Fridays from 12h00 to 14h00 in CO239, Cotton Building, Kelburn Campus.
Students are also required to enrol for, and complete, the SDG Academy online course: "Age of Sustainable Development". The enrolment details will be communicated via Blackboard in the first week of the trimester.

Set Texts and Recommended Readings

Required

The course will use the set text below..

Additional material is made available online, via Blackboard, to assist with understanding the various concepts and the current debate around the renewable energy technology systems, which include: webinars, explanation videos, and other resources. Journal papers are made available via Talis Aspire with specific case studies and academic literature that are discussed and/or from part of the tutorials. In some weeks students are required to identify relevant literature, as part of online discussions, through the University library.

- Buchla D, Kissell T, Floyd T, 2015, *Renewable Energy Systems*. Pearson. Available through the University library: https://www.pearson.com/us/higher-education/program/Buchla-Renewable-Energy-Systems/PGM143285.html

Mandatory Course Requirements

In addition to achieving an overall pass mark of at least 50%, students must:

- Achieve an average of at least 40% on the individual modelling project/assignment.
- Achieve at least 40% in the test.

If you believe that exceptional circumstances may prevent you from meeting the mandatory course requirements, contact the Course Coordinator for advice as soon as possible.

Assessment

Assessment Item	Due Date or Test Date	CLO(s)	Percentage
The Age of Sustainable Development certificate of proficiency (1 hr/week for 14 weeks)	11 October	CLO: 1,2	15%
Group case study analysis assignment/essay (1000 words)	29 July	CLO: 1,2,3	10%
Six laboratory exercises with a report on their learning (2.5 hrs each)	2,9,16 Aug,6, 13, 20 Sep	CLO: 3	10%
Test (2 hr)	4 October	CLO: 1,2,3	35%
Individual modelling project with a report (simulation model & 2-4 page report)(40 hrs)	1 November	CLO: 3,4	30%

Penalties

Work submitted late will be subject to a penalty of 10% of the total mark per day.

Extensions

Individual extensions will only be granted in exceptional personal circumstances, and should be negotiated with the course coordinator before the deadline whenever possible. Documentation (eg,

medical certificate) may be required.

Submission & Return

All work must be submitted through the Blackboard submission system. Marks and comments will also be returned through the Blackboard marking system.

Workload

Although the workload varies from week to week, students should expect to spend approximately 10 hours per week on the course, to give a total of 150 hours study time. A plausible and approximate breakdown for these hours would be: lectures (2 hours); tutorials (1 hour); laboratories (2 hours); SDG online course (1 hour); reading, review and online discussions (1 hours); and modelling and written assignments (3 hours).

Teaching Plan

The intended lectures and other activities over the learning period are outlined in the Teaching Plan, which may be updated as the Trimester progresses.

Week 1

Lecture	▪ Sustainability perspectives, SDGs and the role of energy, and global and local energy trends. ▪ Energy and climate protection calculations, energy efficiency and losses basics, with an overview of RE conversion options. A combination of contact lectures and a webinar. Work through sections 2-1 to 2-10 of the textbook.
Tutorial	▪ Carbon footprint analyses in various economies/energy systems. This will entail a carbon footprint analysis of various car options.
Laboratory	▪ Health and Safety induction. ▪ Electrical basics. The labs will be in CO239.

Week 2

Lecture	▪ Renewable energy resources. ▪ The basics of solar irradiance (direct and diffuse), solar position and angle of incidence, and why these parameters are important for solar technologies. Work through sections 1-3 to 1-7 of the textbook.
Tutorial	▪ Solar position and angle of incidence calculations for Wellington. ▪ Energy/Power load characterisation.
Laboratory	▪ Cabin project.

Week 3

Lecture	▪ Stand-alone photovoltaic power systems, and sizing. ▪ Solar hot water systems. Work through sections 4-1 to 4-5 of the textbook.
Tutorial	▪ Solar generator and load calculations with a case study.
Laboratory	▪ Cabin project.

Week 4

Lecture	▪ Solar tracking. ▪ DC and stepper motors. Work through sections 5-1 to 5-5 of the textbook.
Tutorial	▪ Costs and benefits of single-axis and dual-axis trackers.
Laboratory	▪ Solar PV characteristics using Ohm's law and power equations.

Week 5

Lecture	▪ Charge controlling with batteries. ▪ Maximum power point tracking and control. ▪ Inverters. Work through sections 6-1 to 6-7 of the textbook.
Tutorial	▪ Maximum power point tracking calculations.
Laboratory	▪ PV configurations experimentation and the implications for power output.

Week 6

Lecture	▪ Overview of how a PV cell works, the cell configurations, and how the technology is applied in different contexts. ▪ PV cell material, and the sustainability thereof. Work through sections 3-1 to 3-8 of the textbook.
Tutorial	▪ Building integrated design and costing. ▪ Individual modelling assignment/project brief.
Laboratory	▪ RETScreen modelling software introduction and experimentation.

Week 7

Break	▪ Opportunity for case study analysis and the modelling assignment.

Week 8

Break	▪ Opportunity for case study analysis and the modelling assignment.

Week 9

Lecture	▪ Fundamentals of airflow and the basic principles that affect a wind generator. ▪ Different wind energy technology configurations and appropriateness for different contexts/applications. Work through sections 7-1 to 7-7 of the textbook.
Tutorial	▪ Theoretical power from a wind turbine.
Laboratory	▪ Wind turbine characteristics analyses.

Week 10

Lecture	▪ Wind turbine control. ▪ Wind farm management. Work through sections 8-1 to 8-5 of the textbook.
Tutorial	▪ Electricity supply from a small wind farm.
Laboratory	▪ Wind turbine configurations experimentation and the implications for power output.

Week 11

Lecture	▪ Fundamental principles of hydropower and marine energy, and technology configurations. ▪ Applications and related sustainability issues. Work through sections 11-1 to 11-5 of the textbook.
Tutorial	▪ Hydro and ocean current and power potential calculations.
Laboratory	▪ Effect of turbulence on wind power generation.

Week 12

Lecture	▪ Sustainability aspects related to hybrid systems with storage, including fuel cells. ▪ An overview of different storage options, and the sustainability thereof. Work through sections 12-1 to 12-4 of the textbook.
Tutorial	▪ Introduction to the HOMER software package
Laboratory	▪ HOMER modelling experimentation.

Week 13

Lecture	▪ Fundamentals and scientific principles of electrical machines, their categorization, and related concepts. ▪ Overview of different system components/configurations, and their applications. Work through sections 13-1 to 13-4 of the textbook.
Tutorial	▪ Test preparation/discussion.
Assessment	▪ Class test/exam.

Week 14

Lecture	▪ Overview of the electrical power grid, and three-phase systems. ▪ Smart grids, and connecting to the grid. Work through sections 14-1 to 14-6 of the textbook.
Tutorial	▪ Power systems analysis.
Laboratory	▪ Exam solutions discussion.

Communication of Additional Information

All online material for this course will be made available via Blackboard, which will also be used to facilitate discussions every week.

Links to General Course Information

- Academic Integrity and Plagiarism: https://www.victoria.ac.nz/students/study/exams/integrity-plagiarism
- Academic Progress: https://www.victoria.ac.nz/students/study/progress/academic-progess (including

restrictions and non-engagement)

- Dates and deadlines: https://www.victoria.ac.nz/students/study/dates
- Grades: https://www.victoria.ac.nz/students/study/progress/grades
- Special passes: Refer to the Assessment Handbook, at https://www.victoria.ac.nz/documents/policy/staff-policy/assessment-handbook.pdf
- Statutes and policies, e.g. Student Conduct Statute: https://www.victoria.ac.nz/about/governance/strategy
- Student support: https://www.victoria.ac.nz/students/support
- Students with disabilities: https://www.victoria.ac.nz/st_services/disability/
- Student Charter: https://www.victoria.ac.nz/learning-teaching/learning-partnerships/student-charter
- Terms and Conditions: https://www.victoria.ac.nz/study/apply-enrol/terms-conditions/student-contract
- Turnitin: http://www.cad.vuw.ac.nz/wiki/index.php/Turnitin
- University structure: https://www.victoria.ac.nz/about/governance/structure
- VUWSA: http://www.vuwsa.org.nz

Offering CRN: 30093

Points: 15
Restrictions: ENGR 110 from 2019
Duration: 08 July 2019 - 10 November 2019
Starts: Trimester 2
Campus: Kelburn