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

[illegible]

Prescription

This course will expose the students to the different energy generation systems, and especially those that utilise renewable resources: wind energy (pumping and power), geothermal, hydro (different scales), solar photovoltaic, solar thermal, and bioenergy. For each system, the theoretical underpinning will be examined; for example, optical physics to harness solar radiation in a concentrating solar technology. The life cycle (sustainability) implications of the different systems will also be explored, including manufacturing.

Course learning objectives

Students who pass this course will be able to:

1. Explain the scientific principles of different renewable energy generation technology systems
2. Analyse the sustainability and efficiencies of the generation technology systems
3. Critically review energy generation technologies to identify the efficiency gains that can be achieved
4. Design and demonstrate an efficiency improvement to energy generation

Course content

The course consists of six components. First, it provides students with the key concepts needed to understand renewable energy, including the basic principles of energy and power, heat and mass transfer, and optics and radiation. Second, it provides a deeper understanding of the thermodynamic power cycles used to convert heat energy to electrical energy. Third, PV technologies are explored in depth to understand the fit with the solar spectrum and the effect of increasing concentration on cell performance, and modelling to explore the output of simple systems. Fourth, solar thermal generation will be studied to understand the effect of temperature on conversion efficiency. Fifth, wind and solar technologies will be simulated to explore the importance of understanding the despatch profiles of renewable energy generation and the role of storage as the electricity market moves to increasing reliance on intermittent sources of supply. Finally, the students will learn about the role of thermal energy in industrial processes and how biomass and solar thermal technologies may be implemented to help decarbonise the economy.

Withdrawal from Course

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

Lecturers

Alan Brent (Coordinator)

alan.brent@vuw.ac.nz 04 4635960

413 Alan MacDiarmid Building, Kelburn

Jim Hinkley

jim.hinkley@vuw.ac.nz 04 4635515

227 Alan MacDiarmid Building, Kelburn Dr Daniel Burmester

Teaching Format

During the trimester there are weekly contact lectures, tutorials, and laboratory sessions. In terms of the latter, the practical work involves simulations with various modelling packages including PVWatts and the System Advisor Model (SAM). Two individual projects are undertaken, which entail the evaluation of the electricity and hot water demand of a small hotel, and the simulation and optimisation of a hybrid renewable electricity power plant. Virtual case study analyses and discussions will also be discussed in tutorials and/or facilitated online via Blackboard.

Student feedback

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

Dates (trimester, teaching & break dates)

- Teaching: 02 March 2020 - 07 June 2020
- Break: 13 April 2020 - 27 April 2020
- Study period: 08 June 2020 - 11 June 2020
- Exam period: 12 June 2020 - 27 June 2020

Class Times and Room Numbers

02 March 2020 - 22 March 2020

- **Tuesday** 10:00 - 10:50 – 407, Alan MacDiarmid Building, Kelburn
- **Wednesday** 10:00 - 10:50 – 407, Alan MacDiarmid Building, Kelburn

27 April 2020 - 07 June 2020

- **Tuesday** 10:00 - 10:50 – 407, Alan MacDiarmid Building, Kelburn
- **Wednesday** 10:00 - 10:50 – 407, Alan MacDiarmid Building, Kelburn

Other Classes

Tutorials are scheduled on Fridays from 10h00 for 50 minutes, and labs from14h00 for 2 hours, in AM407.

Set Texts and Recommended Readings

Required

All students are required to obtain a copy of the text book.
An e-book version is available from the publisher, or it can be bought as a paperback for ~$115 on-line from, for example, Book Depository.

- Quaschning V, 2016. *Understanding Renewable Energy Systems*, 2nd edition, Taylor Francis

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 assignments.
- Achieve at least 40% on the exam.

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

The assessment comprises of two class tests, two modelling projects/assignments, laboratory exercises, and a final exam.

Assessment Item	Due Date or Test Date	CLO(s)	Percentage
In class test	Week 6	CLO: 1,4	5%
Design assignment 1 (2 weeks)	Week 7	CLO: 2	20%
Laboratory exercises (6 weeks)	Week 10	CLO: 1,2,3	10%
In class test	Week 11	CLO: 1,4	5%
Design assignment 2 (2 weeks)	Week 12	CLO: 1,2,3,4	20%
Final examination (3 hours)	TBC during examination period	CLO: 1,2,3,4	40%

Penalties

Late assessment will be penalised at the rate of 10% for every working day the assessment is late. The lecturer may refuse to mark work that has been handed in over a week late, and may also refuse if the assessment has been marked and returned to the class. In such instances, a zero grade for that assessment shall result.

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 the assessment items are submitted on Blackboard, and feedback will be provided electronically and discussed in class as appropriate.

Marking Criteria

Will be discussed in class.

Workload

Although the workload varies from week to week, students should expect to spend around 10 to 12 hours per week on the course, to give a total of 150 hours study time. A plausible approximate breakdown for these hours would be: lectures (2 hours); tutorials (1 hour); laboratories (2 hours); reading, review and online discussions (3 hours); and modelling and written assignments (3 hours).

Teaching Plan

The learning areas/lectures and other activities over the teaching period are outlined below.

Week 1

Lecture	Fundamentals including: energy system principles and units
Tutorial	Energy use in NZ, PJ versus kWh

Week 2

Lecture	Heat and mass transfer, Efficiency of power systems, Basic heat calculations
Tutorial	Introduction to the System Advisor Model
Laboratory	H&S briefing, Basic heat balance

Week 3

Lecture	Solar basics, Optics, Radiative and convective heat loss, and absorption
Tutorial	CSP/concentration ratio and efficiency
Laboratory	Concentration of direct and diffuse light

Week 4

Lecture	Photovoltaics – multi-junction vs silicon, Optimising output through orientation
Tutorial	SAM or PV Watts – tilt angle & tracking in two axes
Laboratory	Absorption of light, heating of water

Week 5

Lecture	Heat engines and basic thermodynamics (Carnot), Steam Rankine cycles
Tutorial	Temperature vs. efficiency
Laboratory	Design assignment 1

Week 6

Lecture	Other thermodynamic cycles, Stirling Engines
Tutorial	Geothermal – cycles, dry/wet, Carnot efficiency
Laboratory	Test 1: heat vs. power, optics

Week 7

Lecture	CSP technologies compared: troughs vs towers, Efficiency of cycles, fields
Tutorial	Answers from Test 1
Laboratory	SAM simulations: Data explorer, heat maps

Week 8

Lecture	Hybrid systems and despatchability (PV and CSP, Wind/PV), Production and load matching
Tutorial	SAM simulations of CSP and PV plants
Laboratory	SAM simulations: CSP yearly performance

Week 9

Lecture	Process and domestic heat, Technologies, economics, CPV - combined heat and power
Tutorial	Design Assignment 2
Laboratory	Trough vs. tower

Week 10

Lecture	Cogeneration: CHP in industry, Geothermal – glasshouses, electrolysis
Tutorial	Combined cycle plants
Laboratory	Design assignment 2

Week 11

Lecture	Biomass and biofuels
Tutorial	Industrial heat, Cogeneration
Laboratory	Test 2: thermodynamics

Week 12

Lecture	Wrap-up of technologies, Integration/storage
Tutorial	Dispatch - supply and demannd
Laboratory	Answers from Test 2

Communication of Additional Information

Any additional information regarding this course will be posted on Blackboard.

Links to General Course Information

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

Offering CRN: 30108

Points: 15
Prerequisites: ENGR 110 or 111; ENGR 121 (or MATH 141 and 151); ENGR 141 (or PHYS 114 and CHEM 114)
Duration: 02 March 2020 - 28 June 2020
Starts: Trimester 1
Campus: Kelburn