UNSW SYDNEY | Australia's Global University

Photovoltaic and Renewable Energy Engineering

Course Outline

Term 1 2021

SOLA 5053
WIND ENERGY CONVERTERS

Contents

1. Staff contact details

Contact details and consultation times for course convenor

Name: m.kay@unsw.edu.au
Office location: 215 TETB
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Moodle: https://moodle.telt.unsw.edu.au/course/view.php?id=57141

Please email for any questions regarding he course or to arrange a consultation.

Contact details and consultation times for additional lecturers/demonstrators/lab staff
A/Prof Iain MacGill and Prof John Fletcher will also be involved in the course giving lectures on wind energy integration, and generators. Liam Reid (ex-Infigen, now at Lightsource BP) will give the lecture on Economics of wind farms. Their emails will be available during their lectures.
Demonstrators for the course are:
Dimitri Lazos: dimitris.lazos@unsw.edu.au
Tracey Yeung: tracey.yeung@unsw.edu.au

Please see the course Moodle.

2. Important links

- Moodle
- Health and Safety
- Student Resources
- UNSW Timetable
- UNSW Handbook
- Engineering Student Support Services Centre
- UNSW Photovoltaic and Renewable Energy Engineering

3. Course details

Credit points

This is a 6 unit-of-credit (UoC) course and involves between 4 - 6 hours per week (h/w) of face-to-face contact.

The normal workload expectations of a student are approximately 25 hours per term for each UOC, including class contact hours, other learning activities, preparation and time spent on all assessable work.

You should aim to spend about 6 h/w on this course. The additional time should be spent in

making sure that you understand the lecture material, completing the set assignments, further reading, and revising for any examinations.

Contact hours

This course comprises three-four hours of formal contact per week. The timing and rooms are given below. Tuesday are lecture classes (with additional lectures in weeks 2,3,9 and 10), and the tutorial sessions are assigned for revision of key aspects, questions, group work and assignments. All lectures will be given online via teams.
https://teams.microsoft.com/l/team/19%3a515ba57fa5b64a35877695755ee296ad%40thread.tacv2/conversations?groupId=c9c8d250-3842-4b89-a877-6442d1c6b484&tenantId=3ff6cfa4-e715-48db-b8e1-0867b9f9fba3

Term	Component	Section	Day/Time	Weeks	Location
Term 1 2021	LEC	A	Wed 02:00PM - 03:00PM	2-3,6,9-10	Online
			Mon 10:00AM - 12:00PM	1-5,7,9-10	Online
	TUT	H14A	Fri 01:00PM - 02:00PM	4-5	Online
			Fri 01:00PM - 04:00PM	6	Online
			Thu 02:00PM - 04:00PM	1-10	Online
	TUT	T10A	Fri 10:00AM - 11:00AM	4-5	Electrical Engineering G10
			Tue 10:00AM - 12:00PM	1-10	Electrical Engineering G10
	TUT	W10A	Wed 10:00AM - 12:00PM	1-10	Law Building 201
			Fri 11:00AM - 12:00PM	4-5	Law Building 275
	TUT	W15A	Fri 02:00PM - 03:00PM	4-5	Quadrangle G034
			Wed 03:00PM - 05:00PM	1-10	TETB LG07

Additional revision sessions will be hosted during stuvac and closer to the exam.
Please refer to your class timetable for the learning activities you are enrolled in and attend only those classes.
Week 6 all groups will come together for a revision session and group work

Summary and Aims of the course

The purpose of this course is to provide students with fundamental knowledge and relevant skills for engineers designing and developing wind energy systems. It will largely focus on grid-connected wind farms. Students will be given an overview of wind energy technology, exploring the advances in wind turbine development over the years. An understanding of the wind resource and characteristics of weather phenomena relevant to wind turbine performance is investigated, along with outlining the aerodynamic principles and mechanics of the wind turbine. Turbine siting and integration issues are covered as well as the wider social and economic issues associated with wind farms. All the topics covered give background information necessary for completion of the major design project – creating a full wind farm feasibility study.

Student learning outcomes

At the end of the course students should be able to:

1. Explain the key underlying science of wind energy, and engineering aspects of wind turbines and wind farms, and their integration into power systems.

2. Be able to demonstrate key techniques and skills required for designing and siting wind energy systems as well as perform a full wind farm assessment.
3. Have a good understanding of the wider economic, social and environmental aspects of wind energy systems.

Syllabus

The course will cover topics including:

- The nature of the wind and its use for the production of mechanical and electrical energy
- Components of wind turbines
- Wind turbine aerodynamics
- Mechanical design of components
- Different generator types
- Power system connection of wind turbines
- Operational control of wind turbines
- Wind turbine and wind farm planning and design considerations including community perceptions and environmental issues
- Wind energy economics

Assumed Knowledge

Students should have a good working knowledge of university level physics and mathematics. A basic knowledge of energy systems or renewable energy technologies is useful.

Graduate Attributes

This course will assist students in their development of the following UNSW graduate attributes (as listed at https://my.unsw.edu.au/student/atoz/GraduateAttributes.html):

1. Understanding their discipline in its interdisciplinary context;
2. Able to apply their knowledge and skills to solving problems;
3. Capable of effective communication;
4. Information literate.

This course is designed to address the learning outcomes below and the corresponding Engineers Australia Stage 1 Competency Standards for Professional Engineers as shown. The full list of Stage 1 Competency Standards may be found in Appendix A.

After successfully completing this course, you should be able to:
The Engineers Australia policy on Accreditation of Professional Engineering programs requires that all programs ensure that their engineering graduates develop Stage 1 elements of competency (see: http://www.engineersaustralia.org.au/membership/assessment/assessment_home.cfm). Listed below are the activities in this course that will help students to achieve at least some of these elements of competency.

Professional Engineering Stage 1 Elements of Competencies	Activities used to Develop Competency
Knowledge Base	
PE1.1 Knowledge of Science and Engineering Fundamentals	Lectures on theory underlying aerodynamic principles and energy conversion and generation.

PE1.2 In-depth technical competence in at least one engineering discipline	Lectures on wind farm design and turbine development.
PE1.3 Techniques and resources	Tutorial exercises which use actual weather data to determine wind characteristics. Assignment tasks which require understanding of the wind resource, turbine design specifications and techniques for siting wind farms.
Engineering Ability	
PE2.1 Ability to undertake problem identification, formulation, and solution	Assignment tasks requiring problem analysis. Understanding electrical aspects of energy conversion.
PE2.2 Understanding of social, cultural, global and environmental responsibilities and the need to employ principles of sustainable development	Lectures/discussions on future trends and environmental aspects and impacts of wind farm development.
PE2.3 Ability to utilise a systems approach to complex problems and to design and operational performance	Tutorial and major assignment tasks in which a methodical approach is needed in understanding the multidisciplinary area of wind farm assessment.
PE2.4 Proficiency in engineering design	Major assessment project designing the layout of a wind farm as part of a wind farm assessment
PE2.5 Ability to conduct and engineering project	Major group assessment – wind farm feasibility study. Working effectively as a team to choose a site, design the layout, investigate social, economic and environmental aspects. Choose turbines and address any integration issues.
PE2.6 Understanding of the business environment	Lectures on the economics of wind turbines and large scale wind farms, including economic analysis methods and market applications.
Professional Attributes	
PE3.1 Ability to communicate effectively, with the engineering team and with the community at large	Preparing written assignments. Major group work project requiring a team effort. Presentation of final report.
PE3.2 Ability to manage information and documentation	Tutorial and assignment tasks requiring effective representation of data. Manipulating and interpreting large data sets.
PE3.5 Ability to function effectively as an individual and in multidisciplinary and multicultural teams, as a team leader or manager as well as an effective team member	Team assignments which require group planning and effective communication between team members.

4. Teaching strategies

- Lectures – to provide fundamental knowledge relevant to wind energy systems
- Tutorials – to develop relevant problem solving techniques
- Assignments – to give practice in problem solving, and to assess your progress
- Group Assignment – to encourage broader interdisciplinary thinking and design in a group context
- Exam – final assessment of understanding

Undergraduate and postgraduate students will attend the same lectures and tutorial sessions. Students are also strongly encouraged to use the discussion group on Moodle to assist their learning. Tutors will monitor the discussions and help answer posted questions.

5. Course schedule

Week	***DATE***	***Lecture Syllabus***	***Tutorial Syllabus***	***Assessment Syllabus***
1	**15th February**	**Introduction Wind Turbine Components and concepts**	**Group Assignment Briefing (tutorial briefing sheet handed out)**	
2	**22nd February 24th February**	**The Wind Resource** **Wind Resource continued/wake effects**	**See Tutorial briefing sheet handed out week 1 for tutorial syllabus**	**Tutorial Assignment 1 uploaded to Moodle 26th February**
3	**1st March 3rd March**	**Generators** **Wind Resource continued/wake effects**		**Online quiz – you must bring a laptop to class as the quiz is done via moodle in your tutorial time**
4	**8th March**	**Aerodynamics/wake loss models**	**1 x 2 hour tutorial** – assignment/project help **1 x 1 hour tutorial**	
5	**15th March**	**Economics**	**1 x 2 hour tutorial** - aerodynamics **1 x 1 hour tutorial**	**Tutorial Assignment 1 due Tuesday 17th March 5pm**
6	**24th March 26th March**	**No lectures – special revision tutorial**	**1 x 3 hours - 1 x hours**	
7	**29th March**	**Wind Energy Integration I**	**1 x 2 hour tutorial** **1 x 1 hour tutorial - aerodynamics assessment revision**	Short aerodynamics open book assignment worth 5% - open for 24 hours. Opens 31st March at 10am

				closes 1st April 10am
8	**5th April**	**Wind Energy Integration II**		
9	**12th April** **14th April**	**Social/Environmental Context** **Social/Enviro continued and resources**		
10	**19th April** **21st April**	**Turbine Components/Materials and design - overview** **Forecasting and revision**		**Report due Friday week 10, 23rd April by 5pm**

6. Assessment

Assessment overview

The assessment of the course consists of one major group assignment, tutorial participation and quiz, two tutorial assignments and a final examination paper.

Assessment	Weight
Tutorial Quiz week 3	5%
Tutorial Assignment 1 handed out week 2 due week 5	15%
Tutorial Assignment/Quiz week 7	5%
Group Assignment – breakdown given on assignment sheet	45% (this includes a peer assessment component)
Final Exam	30%
Total	100%

The major group assignment is a wind farm feasibility study – more details will be given on the briefing sheet.

1. *All* material presented during the session on the *Moodle* site will be examinable unless otherwise noted.
2. Assignments are due as listed on the course syllabus.
3. All assignments must be submitted with a completed cover page. The sheet can be downloaded from the SPREE Undergraduate site on:
http://www.engineering.unsw.edu.au/energy-engineering/sites/photo/files/u12/forms/individualcoversheet.pdf
http://www.engineering.unsw.edu.au/energy-engineering/sites/photo/files/u12/forms/groupcoversheet.pdf

The major group assignment is intended to encourage interdisciplinary thinking and engineering design in a group context. The key to success is establishing and maintaining good group dynamics, initiative, research and presentation of your work.
This assignment will give you the opportunity to make use of what you have learnt in the lectures, as well as develop research skills to be able to put together a wind farm feasibility study for the design of a commercial wind farm. Assessment will focus on whether you have identified the

various considerations, and then how well you address them in your planning and design. More details given on assignment sheet with specific deliverables.

Assessment	**Group Project?** (# Students per group)	**Length**	**Weight**	**Learning outcomes assessed**	**Assessment criteria**	**Due date and submission requirements**	**Deadline for absolute fail**	**Marks returned**
Group assignment	Yes (4-5)	See details on project sheet for specific deliverables each week	45%	1,2,3	Specifics for criteria for each week detailed on project sheet	Note submission dates for each week based on your tutorial class time. Final executive summary due F*riday 23rd* April by 5pm	5pm M*onday* 26th April	Two weeks after submission
Quiz (week 3)	No	10 multiple choice	5%	1	Lecture material from weeks 1, 2 and part of 3.	During week 3 tutorial class	N/A	The class after assessment
T*utorial Assignment 1 – handed out end of week 2 due week 5*	No	5 questions – 9 pages	15%	1	Lecture material from weeks 1-3	17th March by 5pm to moodle	21st March by 5pm	Two weeks after submission
Tutorial Assignment 2 - aerodynamics	No	1 long question	5%	2	Lecture material from week 4 and 5	Opens 31st March 10am week 7, closes 1st April 10am	N/A	Two weeks after submission
Final exam	No	T*BC*	30%	1, 2 and 3	All course content from weeks 2-12 inclusive.	Exam period, date TBC	N/A	Upon release of final results

This course will include the following hurdle requirements that are closely linked to a set of learning outcomes which demonstrate that you have acquired the required skills and competencies within this discipline:

- Students must demonstrate understanding of *the key underlying science of wind energy, and engineering aspects of wind turbines and wind farms, and their integration into power systems*. A minimum mark of 50% must be obtained for the final exam in order to pass this subject. Failure to achieve this minimum mark will result in an unsatisfactory fail (UF) grade, regardless of the performance in the rest of the course.

Assignments
All assessment tasks will be uploaded to Moodle and found in the folder labelled Assessments with full instructions.
The group assignment briefing will be uploaded to moodle Monday 15th February and a briefing sheet handed out in the tutorial.
Tutorial Assignment 1 – uploaded to moodle 26th February.
Tutorial Assignment 2 – opens for 24 hours on 31st March at 10am

Presentation

All submissions are expected to be neat and clearly set out. Your results are the pinnacle of all your hard work and should be treated with due respect. Presenting results clearly gives the marker the best chance of understanding your method; even if the numerical results are incorrect. All submissions must be typed no handwritten assignments accepted. All submission must have a cover sheet, stating that the work is your own.
http://www.engineering.unsw.edu.au/energy-engineering/sites/photo/files/u12/forms/individualcoversheet.pdf
http://www.engineering.unsw.edu.au/energy-engineering/sites/photo/files/u12/forms/groupcoversheet.pdf

Submission

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of 30 percent (30%) of the maximum mark possible for that assessment item, for the first day and 10% per day thereafter.

The late penalty is applied per calendar day (including weekends and public holidays) that the assessment is overdue. There is no pro-rata of the late penalty for submissions made part way through a day.

Work submitted after the 'deadline for absolute fail' is not accepted and a mark of zero will be awarded for that assessment item.

For some assessment items, a late penalty may not be appropriate. These are clearly indicated in the course outline, and such assessments receive a mark of zero if not completed by the specified date. Examples include:

a. Weekly online tests or laboratory work worth a small proportion of the subject mark, or
b. Online quizzes where answers are released to students on completion, or
c. Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date, or
d. Pass/Fail assessment tasks.

Marking

Marking guidelines for assignment submissions will be provided at the same time as assignment details to assist with meeting assessable requirements. Submissions will be marked according to the marking guidelines provided.

Examinations

You must be available for all quizzes, tests and examinations.

Final examinations for each course are held during the University examination periods: February for Summer Term, May for T1, August for T2, and November/December for T3.

Please visit myUNSW for Provisional Examination timetable publish dates.

For further information on exams, please see the Exams webpage.

Calculators

You will need to provide your own calculator of a make and model approved by UNSW for the examinations. The list of approved calculators is available at student.unsw.edu.au/exam-approved-calculators-and-computers

It is your responsibility to ensure that your calculator is of an approved make and model, and to obtain an "Approved" sticker for it from the Engineering Student Supper Services Centre prior to the examination. Calculators not bearing an "Approved" sticker will not be allowed into the examination room.

Special consideration and supplementary assessment

If you have experienced an illness or misadventure beyond your control that will interfere with your assessment performance, you are eligible to apply for Special Consideration prior to submitting an assessment or sitting an exam.

Please note that UNSW now has a Fit to Sit / Submit rule, which means that if you sit an exam or submit a piece of assessment, you are declaring yourself fit enough to do so and cannot later apply for Special Consideration.

For details of applying for Special Consideration and conditions for the award of supplementary assessment, please see the information on UNSW's Special Consideration page.

7. Expected resources for students

1. Textbooks. A basic introduction to wind energy can be found in:
Godfrey Boyle, "Renewable Energy: Power for a Sustainable Future," Second edition, Oxford University Press, 2004.
The recommended text for this course is "Wind Energy Explained: Theory, Design and Application" by J.F. Manwell, J.G. McGowan and A.L. Rogers. Copies are available for

purchase from the University Bookshop, for loan from the UNSW library open reserve and physical sciences section.
Other suggested reading: “Renewable Electricity and the Grid, the challenge of variability” edited by Godfrey Boyle.

Other texts and relevant supplements for this course will be discussed within the relevant lectures

2. Lecture Notes. Lecture notes will be made available on the Moodle site shortly after they are covered.
3. Moodle Site. All handout materials, including lecture notes, tutorials and assignments, will be distributed via the official site for this course.

UNSW Library website: https://www.library.unsw.edu.au/
Moodle: https://moodle.telt.unsw.edu.au/login/index.php

8. Course evaluation and development

Feedback on the course is gathered periodically using various means, including the UNSW myExperience process, informal discussion in the final class for the course, and the School’s Student/Staff meetings. Your feedback is taken seriously, and continual improvements are made to the course based, in part, on such feedback.

In this course, recent improvements resulting from student feedback include:
More tutorial questions and revision session moved to mid-term.
Changing the format of the Major Project to deliverables every week as opposed to one large submission at the end of term.

9. Academic honesty and plagiarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW students have a responsibility to adhere to this principle of academic integrity. Plagiarism undermines academic integrity and is not tolerated at UNSW. *Plagiarism at UNSW is defined as using the words or ideas of others and passing them off as your own.*

Plagiarism is a type of intellectual theft. It can take many forms, from deliberate cheating to accidentally copying from a source without acknowledgement. UNSW has produced a website with a wealth of resources to support students to understand and avoid plagiarism, visit: student.unsw.edu.au/plagiarism. The Learning Centre assists students with understanding academic integrity and how not to plagiarise. They also hold workshops and can help students one-on-one.

You are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting and the proper referencing of sources in preparing all assessment tasks.

If plagiarism is found in your work when you are in first year, your lecturer will offer you assistance to improve your academic skills. They may ask you to look at some online resources, attend the Learning Centre, or sometimes resubmit your work with the problem fixed. However more serious instances in first year, such as stealing another student's work or paying someone to do your work, may be investigated under the Student Misconduct Procedures.

Repeated plagiarism (even in first year), plagiarism after first year, or serious instances, may also be investigated under the Student Misconduct Procedures. The penalties under the procedures can include a reduction in marks, failing a course or for the most serious matters (like plagiarism in an honours thesis) even suspension from the university. The Student Misconduct Procedures are available here:
www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

10. Administrative matters and links

All students are expected to read and be familiar with UNSW guidelines and polices. In particular, students should be familiar with the following:

- Attendance
- UNSW Email Address
- Special Consideration
- Exams
- Approved Calculators
- Academic Honesty and Plagiarism
- Equitable Learning Services

Appendix A: Engineers Australia (EA) Competencies

Stage 1 Competencies for Professional Engineers

	Program Intended Learning Outcomes
PE1: Knowledge and Skill Base	PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals
	PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing
	PE1.3 In-depth understanding of specialist bodies of knowledge
	PE1.4 Discernment of knowledge development and research directions
	PE1.5 Knowledge of engineering design practice
	PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice
PE2: Engineering Application Ability	PE2.1 Application of established engineering methods to complex problem solving
	PE2.2 Fluent application of engineering techniques, tools and resources
	PE2.3 Application of systematic engineering synthesis and design processes
	PE2.4 Application of systematic approaches to the conduct and management of engineering projects
PE3: Professional and Personal Attributes	PE3.1 Ethical conduct and professional accountability
	PE3.2 Effective oral and written communication (professional and lay domains)
	PE3.3 Creative, innovative and pro-active demeanour
	PE3.4 Professional use and management of information
	PE3.5 Orderly management of self, and professional conduct
	PE3.6 Effective team membership and team leadership