**SOLA 9104**

**Hybrid Renewable Energy SystemsContents**

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# Staff contact details

## Contact details and consultation times for course convener

Name: Dr Jose Bilbao

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Name: Dr Jessie Copper

Office location: Room 319, TETB

Email: [jessie.copper@unsw.edu.au](mailto:jessie.copper@unsw.edu.au)

**Consultation time:** Tuesdays from 16:00 to 18:00 via Microsoft Teams Video Chat (“open door”, no appointment needed). For all enquiries about the course please contact the course convener. For all other questions or enquiries, you are encouraged to ask the lecturer during lectorials and post your question on MS Teams.

**Keeping Informed**: All course material and announcements will be posted in MS Teams. Please note that it is your responsibility to check the site regularly for any updates and that you should take careful note of all announcements.

## Contact details for tutors

Tutor: Jose Ramon Martin-Sanz Garcia, [joseramonmartinsanzgarcia@gmail.com](mailto:joseramonmartinsanzgarcia@gmail.com)

# Important links

* [Microsoft Teams](https://student.unsw.edu.au/teams-students)
* [Moodle](https://moodle.telt.unsw.edu.au/login/index.php)
* [Health and Safety](https://www.engineering.unsw.edu.au/energy-engineering/student-resources/workplace-health-and-safety)
* [Student Resources](https://www.engineering.unsw.edu.au/energy-engineering/student-resources)
* [UNSW Timetable](http://timetable.unsw.edu.au/current/subjectSearch.html)
* [UNSW Handbook](https://www.handbook.unsw.edu.au/)
* [Engineering Student Support Services Centre](https://www.engineering.unsw.edu.au/study-with-us/current-students/student-resources/engineering-student-support-services)
* [UNSW Photovoltaic and Renewable Energy Engineering](https://www.engineering.unsw.edu.au/energy-engineering)

# Course details

## Credit points

This is a 6 unit-of-credit (UoC) course with a total workload equivalent to 150 hours for the term, including all contact hours, learning activities and assessments. Hence, you should aim to spend around 15 h/w on this course. This course involves around four to five hours per week (h/w) of scheduled online contact. 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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Day** | **Weeks** | **Time** | **Delivery Mode** |
| **Lectorials** | Tuesday | All weeks except 3 and 6 | 10:00 - 11:00 | Online |
| **Studios\*** | Fridays | All weeks except 3 and 6 | 13:00 - 17:00 | Online |
| **Lab** | Flexible | Week 3 | Flexible | Online |

\* Studios are shown as LAB in the timetable.

All classes in T3 2020 will be online. Please consult this course’s MS Teams module for details about delivery. Moodle will be used for online quizzes and the submission of assignments.

## Pre-requisites and Assumed Knowledge

SOLA9104 students should have a good working knowledge of university level physics, circuit theory and mathematics. Furthermore, it is expected that students understand the technical components of PV systems and have already completed the courses SOLA2504/9001 AND SOLA4012/9007.

## Summary and Aims of the course

Energy services are critical for health, livelihoods, and enabling productive activities. However, more than a billion people around the world in rural areas and urban slums do not have access to modern energy. Hybrid renewable energy systems can deliver these energy services in a sustainable and cost-effectively way, but there are several challenges related to their design, and the integration of high penetration of renewables. During this course students will develop the skills and knowledge required for designing, sizing, and specifying hybrid renewable energy systems, and to develop control strategies to optimise their operation, with an emphasis on delivering designs based on understanding context, appropriate design and technology selection, implementation of models, and capacity building for sustainable projects.

This course uses project-based learning to develop skills and knowledge for designing and specifying hybrid renewable energy projects, by working with a real target community and local partners. In this opportunity, the activities of the course will be focus on islands in the south pacific, and the development of projects for delivering energy services to the local community.

## Student learning outcomes

This course is designed to address the learning outcomes below and the corresponding Engineers Australia Stage 1 Competency Standards for Professional Engineers. The full list of Stage 1 Competency Standards may be found in Appendix A. After successfully completing this course, you should be able to:

|  |  |  |
| --- | --- | --- |
| **Learning Domain** | **Learning Outcomes** | **EA Stage 1 competencies** |
| Understanding | 1. Understand the technical characteristics of components in hybrid renewable energy systems, including loads, storage, and generation technologies | PE1.3 |
| Applying | 1. Interpret a brief, present proposals for feedback and assessment in a range of written, oral, and visual formats individually and as part of a team. | PE1.6, PE3.2., PE3.6 |
| Analysing | 1. Compare and prioritise energy access options according to the local context and energy service requirements. | PE1.5, PE1.6, PE2.2, |
| Creating | 1. Design, size and specify hybrid renewable energy systems using first principles and advanced simulations tools | PE1.5, PE2.2, PE2.3 |
| Creating | 1. Optimise a hybrid renewable energy system and its control strategy using appropriate dispatchability principles and techno-economic analysis | PE2.1, PE2.2, PE2.3 |

# Teaching strategies

The teaching strategy for this course comprises online work plus a series of online studio sessions in Microsoft Teams. The online lessons will present most of the theory related to Hybrid RE systems and minigrids and will be available in Microsoft OneNote. There will be weekly online quizzes in Moodle about the theory presented in the online lessons before the online studios.

Once per week the course Lecturer will be available for an online Lectorial in Microsoft Teams. A Lectorial is a combination of a lecture and a tutorial. You will have the chance to ask any question to the Lecturer regarding the material of the course or the application of what you are learning. Kind of like an “Ask Me Anything” (AMA) session but for course material.

Studio sessions will involve a combination of individual work, teamwork, and computer-based activities (using design programs such as Homer Pro or general software like Excel). The course lecturer and tutors will be present during the online studio to facilitate your learning process.

# Course schedule

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Week** | **Content** | **Studio** | **Delivery Mode** | **Suggested Readings** |
| 1 | Course outline, energy & sustainable livelihoods. | Project context and Team building | Online | OneNote online lesson |
| 2 | Electricity access and intro to Hybrid Renewable Energy Systems (HRES) | Human-Centered Design and needs assessment | Online | OneNote online lesson |
| 3 | HRES Laboratory | | Online | OneNote online lesson |
| 4 | Assessing and understanding loads for HRES | Load curve and HOMER | Online | OneNote online lesson |
| 5 | Dispatchable energy for HRES | Generators and HOMER | Online | OneNote online lesson |
| 6 | Flexibility week (Optional RE economics review) | | Online | OneNote online lesson |
| 7 | RE resources for HRES | RE systems and HOMER | Online | OneNote online lesson |
| 8 | Project planning and Storage for HRES | Storage and HOMER | Online | OneNote online lesson |
| 9 | Control and optimisation of HRES | Techno-Economic optimization and Excel/VBA | Online | OneNote online lesson |
| 10 | Energy transmission, distribution and monitoring with HRES | Minigrid design | Online | OneNote online lesson |

# Assessment

## Assessment overview

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Assessment** | **Group Project?** (group size) | **Length** | **Weight** | **Learning outcomes assessed** | **Assessment criteria** | **Due date and submission requirements** | **Deadline for absolute fail** | **Marks returned** |
| Online quizzes (x7) and video interview (x1) | No | Quizzes: 10 questions  Interviews: 10 minutes | 15% | 1 to 3 | Lecture material from weeks 2 to 9. | Quizzes: Fridays 12pm  Interview: week 10 | N/A | Quizzes: One hour after the quiz due date |
| Deliverable 1 -Laboratory report | No | 4-page report including drawings | 15% | 1 | Laboratory activity in week 3 | Saturday week 3 | One week after due date | Two weeks after submission |
| Deliverable 2 - Case study | No | 6-page report, plus attachments | 40% | 1 to 4 | Lecture material and studio activities from weeks 1 to 7 | Monday week 8 | One week after due date | Two weeks after submission |
| Deliverable 3 - Team project | Yes (4) | 10-page report plus attachments | 30% | 1 to 5 | All course content from weeks 1-10 inclusive. | Friday Week 11 (Exam Period) | One week after due date | Upon release of final results |

## Assignments

*Online quizzes (Total 15%)*

You will have to complete seven online quizzes, from weeks 2 to 5 and weeks 7 to 9. The quizzes will test your learning from the content in the online lessons. The quizzes are strictly individual and can be done online at any time after you have completed the online lessons. The online quiz of a respective week will be open in Moodle until Friday 12 pm (i.e. one hour before the studio starts) **after this time the quiz cannot be attempted**.

In addition, one video interview will be carried out in week 10. This interview is strictly individual between the student and the course coordinator or tutor. The interviews will check that you have learned the content of the course as demonstrated by the results in the online quizzes. **The mark obtained in the interview will be used to adjust your final quiz mark.**

*Deliverable 1 – Laboratory Report (15%)*

The laboratory will be based on the minigrid in the TETB. You will have to study the system configuration, examine the design, and produce a complete Single Line Diagram (SLD) of the system. You will also be provided with data from the system that must be analysed and presented in graphical form. A lab report must be submitted containing all the information required.

*Deliverable 2 – Case Study (40%)*

For this assignment you will be working on a case study of a hybrid RE system. With the data available, you must assess the energy services required for the local community and identify potential solutions, which will allow you to carry out a high-level system design using HOMER Pro®. The deliverable will include the load assessment and the load curves used to design the hybrid RE system and you must present the economic assessment of your energy system design using HOMER Pro®. The purpose of this assignment is to go from theory to the design of the whole system and reflect on the energy access options for the particular case study.

*Deliverable 3 – Team project (30%)*

The major project is designed to give you a chance to apply your knowledge to real-world problems relating to the design of a sustainable hybrid minigrid. Details of assessment criteria and expectations for the project will be provided separately in the project brief. Students will work in teams of four on the project. The outcome of this project is a detailed system design of a hybrid RE system using Australian Standards as a reference, including an optimised dispatch schedule using Excel/VBA. Team evaluation will be used to allocate marks based on contributions to the final report.

### 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 work and the method you have used; even if the numerical results are incorrect.

### 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 for the assessment item submitted after the due date, plus 10 percent (10%) of the maximum mark possible per 24 hour period after the due date (including weekends and public holidays). These penalties are applied to the mark received for the assessed item.

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 assessed 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:

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

### Marking

Marking guidelines (i.e. rubrics) 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 and the video interview. There will be no final examination for this course.

## 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](https://student.unsw.edu.au/sites/all/files/uploads/group271/fit-to-sit-guide.pdf), which means that if you attempt 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](https://student.unsw.edu.au/special-consideration).

## Workload

It is recommended you design a study plan for the term, based on the learning activities and assignments of each of your courses, detailing the number of hours you will spend on each learning task. A simple study guide for SOLA9104 is shown in the table below (e.g. the work related to the Case Study should take you around 30 hours, while the Major Project should take around 20 hours per team member or around 80 hours in total).

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Period** | **Self-**  **Study** | **Online**  **Activities** | **Online**  **Quizzes** | **Lab report** | **Case Study** | **Major Project** | **Total**  **Hours** |
| Week 01 | 3 | 5 |  |  | 5 |  | 13 |
| Week 02 | 3 | 5 | 2 |  | 5 |  | 15 |
| Week 03 | 3 | 1 | 2 | 8 |  |  | 14 |
| Week 04 | 3 | 5 | 2 |  | 5 |  | 15 |
| Week 05 | 3 | 5 | 2 |  | 5 |  | 15 |
| Week 06 | 8 |  |  |  | 5 |  | 13 |
| Week 07 | 3 | 5 | 2 |  | 5 |  | 15 |
| Week 08 | 3 | 5 | 2 |  |  | 5 | 15 |
| Week 09 | 3 | 5 | 2 |  |  | 5 | 15 |
| Week 10 | 3 | 5 | 2 |  |  | 5 | 15 |
| Week 11 |  |  |  |  |  | 5 | 5 |
| **Total Hours** | **35** | **41** | **16** | **8** | **30** | **20** | **150** |

# Expected resources for students

*Reference Books*

* Stand Alone Power Systems, Design and Installation – GSES
* Solar/Diesel Minigrid Handbook – PowerWater Corportation

*Online resources*

* UNSW Library website - <https://www.library.unsw.edu.au/>
* Australian Bureau of Meteorology - <http://www.bom.gov.au/climate/>
* NASA (weather data) - <https://power.larc.nasa.gov/>
* NREL National Solar Radiation Database (weather data) - <https://nsrdb.nrel.gov/>
* Renewables Ninja - <https://www.renewables.ninja/>
* APVI Solar Maps - <http://pv-map.apvi.org.au/>
* Nearmap tool (via UNSW Network) - <http://au.nearmap.com/>
* Clean Energy Council - <http://www.cleanenergycouncil.org.au/>
* PVeducation - <http://www.pveducation.org/pvcdrom>

*Design Tools*

* HOMER Energy - Hybrid Renewable and Distributed Generation Power System Design and Optimization <http://www.homerenergy.com/>
* PVSYST - Software for photovoltaic Systems
* SAM - System Advisory Model
* RETScreen - Clean Energy Management Software system for energy efficiency

*Standards (via UNSW Library)*

* Building Code of Australia
* AS/NZS 1170.2:2011 - Structural design actions - Wind actions
* AS/NZS 1768:2007 - Lightning Protection
* AS/NZS 3000:2007 - Electrical Wiring Rules
* AS/NZS 3008.1.1:2017 - Electrical installations - Selection of cables
* AS/NZS 4777.1:2016 - Grid connection of energy systems via inverters - Installation requirements
* AS/NZS 4777.2:2015 - Grid Connections of Energy Systems via Inverters - Inverter requirements
* AS/NZS 5033:2014 - Installation and safety requirements for photovoltaic (PV) arrays

# 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 changes in the assessment tasks and the online content.

# 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](https://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](http://www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf)

# 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](https://student.unsw.edu.au/attendance)
* [UNSW Email Address](https://www.myit.unsw.edu.au/services/students/email-students-and-staff)
* [Special Consideration](https://student.unsw.edu.au/special-consideration)
* [Exams](https://student.unsw.edu.au/exams)
* [Academic Honesty and Plagiarism](https://student.unsw.edu.au/plagiarism)
* [Equitable Learning Services](https://student.unsw.edu.au/els)

# 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 |