**SOLA5052**

**Bioenergy & Renewable FuelsContents**

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# Staff contact details

## Contact details and consultation times for course convenor

Name: Rob Patterson

Office location: Rm 246, Tyree Energy Technologies Building (TETB)

Tel: (02) 9385 0392

Email: robert.j.patterson@unsw.edu.au

Moodle: https://moodle.telt.unsw.edu.au/course/view.php?id=53928

It is best to email me (Rob) if you have a question or concern. After email, the best way to get in touch about the course is to message or call me on MS Teams. You are welcome to drop by my office anytime, of course maintaining physical distancing, with the understanding that if it is not a good time then any conversation we have might have to be kept brief, ok? Thanks.

## Contact details and consultation times for additional lecturers/demonstrators/lab staff

Tracey Yeung, [tracey.yeung@unsw.edu.au](mailto:tracey.yeung@unsw.edu.au)

Alexander Wotton, [a.wotton@unsw.edu.au](mailto:a.wotton@unsw.edu.au)

David Saldivia Salazar, [d.saldiviasalazar@student.unsw.edu.au](mailto:d.saldiviasalazar@student.unsw.edu.au)

If you are unsure who to talk to, you can email me (Rob) and I can forward your message on to the appropriate person. If you want to talk to Tracey, Alex or David outside of their contact hours (tutorial or lab demo) I suggest you email them and ask for an appointment.

Please see the course [Moodle](https://moodle.telt.unsw.edu.au/login/index.php).

# Important links

* [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 and involves 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 15 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

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Day** | **Time** | **Location** |
| **Lectures** | Wednesday | 9am – 11am | Online (MS Teams) |
| (Web stream) | Any | Any | Moodle |
|  |  |  |  |
| **Tutorials** | Thursday | 1pm – 3pm | Online (MS Teams) |
|  | Thursday | 3pm – 5pm | Online (MS Teams) |
|  |  |  |  |
| **Lab Demonstrations** | Monday | 10am – 12pm  Week 2, 3, 4, 5 | Online (MS Teams) |
|  |  |  |  |

Please refer to your class timetable for the learning activities you are enrolled in and attend only those classes.

## Summary and Aims of the course

The course aims to introduce biomass (i.e. material of recent biological origin) as an energy carrier and the technologies associated with its exploitation.

Several sources of raw biomass will be considered including forestry, wastes, energy crops, crop residues, and algae. Methods of production, collection, processing these different sources will be covered. Agriculture and silviculture are largely outside of the scope of the course and are only discussed as a means to estimate biomass production.

Several technologies for the conversion of raw biomass into heat, electricity and fuels will be considered. Specifically the following will be introduced:

• Combustion of raw biomass and biomass-derived liquid and gaseous fuels to produce heat and electricity.

• Thermochemical conversion technologies to produce gas fuels, including pyrolysis and gasification, and to produce liquid fuels such as methanol, biodiesel, or hydrocarbons similar to gasoline (petrol) or Diesel fuels.

• Biochemical conversion options to produce gaseous fuels including anaerobic digestion and to produce liquid fuels including via fermentation.

## Student learning outcomes

As can be seen in the previous section, a large breadth of topics will be considered. The aim is not to become an expert on all of these topics. Rather, the goal is to obtain a broad understanding of various types of biomass resource and various conversion technologies.

At the same time, in key areas, a basic level of understanding of underlying physical, chemical, and biological processes involved will be taught. This approach will enable both interactions with experts in the area and further learning at greater depth.

At the end of the course, students should:

* Explain how the characteristics of biomass resources determine the methods of production, collection, processing and potential conversion to energy or higher grade energy products (syn-gas, biogas).
* Compare and contrast the possible pathways for conversion of different biomass resources into heat, electricity and fuels.
* Solve quantitative engineering problems and perform algebraic derivations relevant to biomass conversion utilizing the governing and operating principles of biomass conversion.
* Evaluate business opportunities for biomass energy conversion using simple biomass resource assessments and fundamental engineering design and problem solving.

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:

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | | **EA Stage 1 Competencies** |
| 1. | Explain how the characteristics of biomass resources determine the methods of production, collection, processing and potential conversion to energy or higher grade energy products (syn-gas, biogas) | PE3.4 Professional use and management of information |
| 2. | Compare and contrast the possible pathways for conversion of different biomass resources into heat, electricity and fuels | PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing |
| 3. | Solve quantitative engineering problems and perform algebraic derivations relevant to biomass conversion utilizing the governing and operating principles of biomass conversion | PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals |
| 4. | Evaluate business opportunities for biomass energy conversion using simple biomass resource assessments and fundamental engineering design and problem solving | PE1.5 Knowledge of engineering design practice |

# Teaching strategies

Lectures will be used to introduce the factual information, theory, and methods of the course. Learning during lectures should be later reinforced by reading reference materials and working through the assignments.

Tutorials will be used to demonstrate how to apply the facts, theory and methods delivered in lectures to idealised problems, to work on assignments and exam practice questions, and for discussion of key points with demonstrators and/or lecturer.

Assignments then further develop (by calculation, critical analysis and discussion) and assess student learning by application to more complex and involved problems.

Laboratory activities will give “hands-on” experience making real biofuels and extracting energy from inexpensive, abundant and non-toxic bio-derived chemicals.

The final exam assesses student learning as a result of the course.

# Course schedule

(No significant modifications are expected as of the beginning of the course.)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Week:** | Date week starts: | Topic: | Major Assignment | Lab Demos: | Quiz | Lecture | Tutorial |
| **1** | 14-Sep-19 | Biomass Resources, Supply Chain | **Assignment 1: Thermochemical Gasification** |  | **1. Primer Quiz** | **As defined by the weekly topic** | **1** |
| **2** | 21-Sep-19 | Chemical Thermodynamics |  | **Biogas** | **2** |  | **2** |
| **3** | 28-Sep-19 | Gas and Steam Turbine, Power Cycles |  | **Biodiesel** | **3** |  | **3** |
| **4** | 5-Oct-19 | Gasification and Pyrolysis |  | **Sugar Fuel Cell** | **4** |  | **4** |
| **5** | 12-Oct-19 | Combusion of Solid Biomass Fuels |  | **\*Biogas Results\*** | **5** |  | **5** |
| **6** | 19-Oct-19 | Guest Lecture (Belinda Layson, Tony Esplin) | **1st ASSESSMENT**  **End of Week** |  | **6** |  | **6** |
| **7** | 26-Oct-19 | Guest Lecture (Earthpower) |  |  | **7** |  | **7** |
| **8** | 2-Nov-19 | Biochemical Gasification, Anaerobic Digestion |  |  | **8** |  | **8** |
| **9** | 9-Nov-19 | Liquid Biofuels for Transport | **FINAL ASSESSMENT, SOLVER** |  | **9** |  | **9** |
| **10** | 16-Nov-19 | Exam Preparation  {No Lecture} |  |  | **10** |  | **10** |

# Assessment

## Assessment overview

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Assessment** | **Group Project?** (# Students per group) | **Length** | **Weight** | **Learning outcomes assessed** | **Assessment criteria** | **Due date and submission requirements** | **Deadline for absolute fail** | **Marks returned** |
| Major Assignment | No | Answer document + spreadsheet | 20% | 3 | Lecture and tutorial material from weeks 2, 3, 4, 5, 6, 7 | Monday, 9am, Week 7  Sunday, midnight, End of Week 9 | N/A | Two weeks after submission |
| Weekly Quizzes | No | Mixed, depends on week | 20% | 1, 2, 3, 4 | Lecture and tutorial material from corresponding week | Tuesday, midnight, all weeks | N/A | Immediate feedback online |
| Lab submissions | Yes | Moodle Quiz & semi-formal report submission (2-5 pages) | 10% | 1, 2, 3 | Self-contained, all lecture material | Monday, 9am, Week 6 | N/A | Two weeks after submission |
| Final exam | No | 2 hours | 50% | 1, 2, 3 | All course content from weeks 1-10 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 both theory and practices relevant to bioenergy and renewable green fuels. A minimum mark of 50% must be obtained for both parts (Part A, qualitative and Part B, quantitative) of 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.

## Major Assignment

Worth 20% of the course.

* First Assessment due @ 9am Monday, week 7
* Final Assessment due @ 12am Sunday, end of week 9

On equilibrium products of biomass gasification (chemical thermodynamics)

Submission of assignments: can be done electronically/online through the Moodle page.

Late assignments will be penalized 30% plus 10% per day that the work is late (i.e. 40% if one day late), to a maximum penalty of 100%, except in highly exceptional and verifiable cases.

## Weekly Quizzes

Worth 20% of the marks in the course.

1. A ‘Primer Quiz’, will be given online in week 1. This quiz will provide a re-introduction to concepts necessary for the biomass course that should have been taught previously including dimensional reasoning, thermodynamics, fundamental chemistry and the basics of solving biomass questions.
2. Weekly quizzes (10 total) will be posted on Moodle just after the weekly lecture and will be due (e.g. set to close) just before the start of the next lecture.

**Important:** **No late quizzes will be accepted!**

## Laboratory Demonstration Submissions

Worth 10% of the marks on the course.

The laboratory activities are designed to convey real world experience making biofuels and extracting energy from biomass. There are three (3) laboratory activities. They are intended to show you how to:

1. **Biogas production:** make your own miniature marine bio-reactor and biologically gasify methanol, marine cyanobacterial feedstock (optional) as well as any other biomass feedstock of your choosing (optional). Analysis will be performed using gas chromatography (GC) and the final data will be used to determine the total methane yield from your bio-reactor. Biogas from marine digesters similar to these are attractive for massive-scale implementation since they have essentially no freshwater requirements and couple directly to fast growing marine plants that do not require arable land.
2. **Biodiesel production:** make your own biodiesel from waste vegetable oils, as well as new oils (optional, student may provide ~50 mL of oil). You will estimate the total energy in your product biodiesel after following an optimized synthesis recipe and so estimate an overall efficiency for the oil-to-biodiesel conversion process. The International Energy Agency (IEA) projects that advanced biodiesel will play a significant role in future sustainable transport fuels, growing in production out to 2050.
3. **Direct carbohydrate fuel cells:** Simple carbohydrates, or sugars, can be obtained from cellulose, which is the most abundant polymer on the planet and a major component of wood. In this lab you will obtain electricity directly from sugar in an electrochemical fuel cell. You will measure the characteristic “warm-up” time and the electrical power output. Electricity directly from sugar has significant potential to replace sugar fermentation to bio-ethanol, providing an energy dense fuel for future long-range electric vehicles.

During the first few weeks of the course 3 online lab demonstrations will be made available to you, for a maximum time commitment of 6 hours. Tutors will perform the labs and answer questions. The sessions will be recorded and made available on MS Teams as well as Moodle if necessary.

Lab submissions can be submitted through Moodle. **Though work may be done in groups, an individual lab submission is required from each student.**

## Final Exam

The exam will consist of written short answer questions, calculations and derivations. About half of the marks will be available for short answer written questions that mainly assess the breadth of your knowledge, while the other half will include more involved calculations that assess the depth of your ability to solve relevant engineering problems. All material presented in the course (including via Moodle) is examinable unless otherwise explicitly stated.

If you are ill on the day of the final exam, inform course staff immediately and bring a doctor’s certificate.

**Scaling**

If necessary, overall marks or marks from individual assessments may be scaled.

### 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.

### 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%) mark reduction on the first day and an additional 10% per day thereafter, consistent with other SPREE courses.

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:

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 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](https://student.unsw.edu.au/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](https://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](https://www.engineering.unsw.edu.au/study-with-us/current-students/student-resources/engineering-student-support-services) 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](https://student.unsw.edu.au/sites/all/files/uploads/group271/fit-to-sit-guide.pdf), 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](https://student.unsw.edu.au/special-consideration).

# Expected resources for students

Course resources:

* Essential course material will be made available on the course Moodle page.
* **Optional Textbook:** Ralph Sims, The Brilliance of Bioenergy in Business and in Practice, James & James, London, 2002, ISBN 1 902916 28 X.
* **Optional Textbook:** M.J. Moran and H.N. Shapiro, Fundamentals of Engineering Thermodynamics, John Wiley & Sons, Singapore, 1996, ISBN 0-471-07681-3

UNSW Library website:<https://www.library.unsw.edu.au/>

Moodle: <https://moodle.telt.unsw.edu.au/login/index.php>

# 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.

This course was redeveloped in 2019 and the response from students was overwhelmingly positive. The major change made to the course at that time was the inclusion of the laboratory component. This year that laboratory component has gone online due to the global pandemic. We are doing our utmost to retain that real-world, hands-on experience with real biofuels to ensure that your experience is still as industrially relevant as possible. This year the facts and figures in the lecture material have again been updated. A module on hydrogen production as an emerging green energy carrier has been added. Some sensible applications of this hydrogen have been suggested. We have learned from our experience in 2019 to continue to streamline the course delivery, submission and marking as well as improving lecturer/tutor-to-student feedback.

Please don’t hesitate to come and chat at the end of a lecture or with your demonstrators about any constructive and useful suggestions.

# 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)
* [Approved Calculators](https://student.unsw.edu.au/exam-approved-calculators-and-computers)
* [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 |