SOLA5051
Life Cycle Assessment

Course Outline – Term 3, 2019

1 Course Staff

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Consultation time: Wednesdays from 3 pm to 5 pm (open door, no appointment needed). For all enquiries about the course please contact the course convener. For all other questions, you are encouraged to ask the course lecturer after the studio or post your question in MS Teams.

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

2 Course Details

2.1 Credits

This is a 6 UoC course. The total workload is equivalent to 150 hours for the term, including all contact hours, learning activities and assessments.

2.2 Pre-requisites and Assumed Knowledge

In order to engage with the aspects of the course related to photovoltaic and renewable energy systems, students should have a basic understanding of the components, design and operation of such systems.

2.3 Relationship to Other Courses

SOLA5051 is a 4th year course in the School of Photovoltaic and Renewable Energy Engineering School. It is a compulsory course for the Renewable Energy Engineering (BE Hons) program and a professional elective for the Photovoltaics and Solar Energy (BE Hons) program. SOLA5051 is an Engineering and Technical Management Elective for the Master of Engineering Science in Photovoltaic and Solar Energy (SOLACS8338), and for the Master of Engineering Science in Renewable Energy (SOLADS8338).

2.4 Context and Aims

Life Cycle Assessment, or LCA, is a "cradle-to-cradle" approach for assessing products, processes or systems. This course will deal with the application of LCA on energy systems and its relevance. The broad aim of this course is to provide students with knowledge on the fundamentals of LCA, and an understanding of its relevance to the disciplines of PV and RE Engineering. More specifically the course aims to:

- Develop within students a solid understanding of the methodology and applications of LCA;
- Expose students to a range of examples and LCA case studies to demonstrate the process;
- Teach students to use available tools and techniques to conduct simple LCAs.

2.5 Learning Outcomes (LO)

Learning Domain	Learning Outcomes *After successful completion of this course, you should be able to:*
Understanding	1. Interpret and make use of completed LCAs
Applying	2. Determine whether it is worthwhile to commission an LCA for a particular scenario
Analysing	3. Recognise the breadth of LCA applications and the role of LCA in the overall process of environmental management.
Evaluating	4. Assess renewable energy technologies and systems using LCA theory.
Creating	5. Undertake simple LCAs of renewable energy systems, compliant with international norms.

This course is designed to achieve the above learning outcomes which address the specific UNSW and Faculty of Engineering graduate capabilities listed in ***Appendix A***. This course also addresses the Engineers Australia (National Accreditation Body) Stage I competency standard as outlined in ***Appendix B***.

2.6 Syllabus

This course will deal with LCA and its use for life cycle assessment of energy systems. Methodologies, boundary issues, data bases and applications will be studied. The uses of LCA will be illustrated with industrial case studies and with studies aimed at quantifying externalities associated with different electricity generation technologies.

2.7 Indicative Lecture Schedule

Period	Lectures	Book Chapter	Tutorials	Deadlines
Week 01 – 16 Sep	LCA M1 – Intro, Goal & Scope	6 to 8	Goal, scope & FU	
Week 02 – 23 Sep	LCA M2 – Inventory Analysis	9	Life cycle inventory	
Week 03 – 30 Sep	LCA M3 – Impact Assessment	10	LCA for a cup of tea	D1
Week 04 – 07 Oct	LCA M3 – Uncertainty Analysis	11	OpenLCA Bottles	
Week 05 – 14 Oct	LCA M4 – Interpretation	12	OpenLCA PV	
Week 06 – 21 Oct	Project presentations			D2.1
Week 07 – 28 Oct	LCA A1 – RE Systems & LCC	26	LCA of energy systems	
Week 08 – 04 Nov	LCA A2 – Buildings*	28	EPBT and energy yield	
Week 09 – 11 Nov	LCA A3 – Transport*	27	LCA of transport	
Week 10 – 18 Nov	LCA A4 – IO Analysis*	14	Project meetings	D2.2
Week 11 – 25 Nov				D2.3

* Guest lectures

2.8 Contact Hours

The course consists of 2 hours of lectures and 2 hours tutorial session each week as listed below plus online activities and self-study and reading time. This course requires you to use a number of software packages that will be available on student computers in LG34 and LG35 in TETB.

	Day	Time	Location	Delivered by
Lecture and tutorials	Tuesday Week 1-10	12 pm – 04 pm	TETB G16	Lecturer and tutors

3 Assessment

Assessment		Percentage of Total Mark	Date Due
Tutorial activities	Individual	10%	Week 01-10
Deliverable 1 (D1) – Article peer review	Individual	15%	Week 03
Deliverable 2 (D2) – Main project		40%	
D2.1 Presentation – LCA M1-M2 and planning	Team	(10%)	Week 06
D2.2 Final Report – LCA M1-M3	Team	(20%)	Week 10
D2.3 Final Report – LCA M4	Individual	(10%)	Week 11
Exam	Individual	35%	Exam period

The assessments in this course reflect the intention to assess your learning progress throughout the semester. The assignments submission will be via MS Teams or Moodle – **PDFs ONLY** – no hard copy submission. Requests for special consideration should be submitted, as for all other subjects, through the Registrar. An extension of time may only be granted under exceptional circumstances beyond the student's control.

Late submissions of any of the assessments will attract a penalty of 0.4% per hour (including weekends). No marks will be granted to a work submitted after the marks have been released.

3.1 Tutorial activities (Individual - 10%)

You will be required to carry out a set of activities during the tutorials, some of which will be marked. All tutorial activities must be documented in the OneNote Class Notebook. Activities include: definition of goal and scope, work on life cycle inventory, creation components in OpenLCA, and quizzes. This will give you a better understanding on how LCA works including the use of software.

3.2 Deliverable 1 – Article Peer Review (Individual - 15%)

This assignment is to be completed individually and will involve peer reviewing and analyzing a published LCA article on an energy system. This task includes answering questions related to the methodology followed by the article under review.

3.3 Deliverable 2 – Main Project (Team and individual - 40%)

This project involves completing an LCA in a specific renewable energy system, according to ISO standards. This project will run through the whole session, and the first activity will require the presentation of the LCA methodology proposed by the team. The final report will be divided

in two sections: team and individual. The team section must contain the main body of the LCA study, excluding for the interpretation section, which will be individual and submitted separately.

3.4 Final exam (Individual - 35%)

The final exam will be a digital exam of 2 hours duration, taken during the official exam period. Marks will be assigned according to the correctness of the responses.

3.5 Relationship of Assessment Methods to Learning Outcomes

	Learning Outcomes				
Assessment	**1**	**2**	**3**	**4**	**5**
Tutorial activities	✓	✓	✓	✓	
Deliverable 1	✓	✓			
Deliverable 2	✓		✓	✓	✓
Final exam		✓	✓	✓	

4 Teaching Strategies

4.1 Delivery mode

The teaching strategy for this course comprises a series of lectures and tutorial activities. The lecture series will present theory related to the methodology and applications of LCA, including various case studies throughout the course. Within each lecture, it is intended that a range of teaching formats will be employed. These will include: regular non-assessable quizzes on previous lecture content, class brainstorming sessions, and small-group and large group discussions. Students will be encouraged to actively engage with the topics via these lecture activities. It is expected that three to four topics will be covered by guest lecturers.

A set of tutorial questions or activities will be made available every week and students will be expected to work through the assigned activities in the tutorial session as directed by the tutor, sometimes working in small groups. In some cases, preparation such as reading prior to the tutorial class will be required. Students can also use their allocated tutorial session to ask tutors any questions they may have about the material taught in lectures.

Students are also strongly encouraged to use the discussion group to assist their learning. Tutors will monitor the discussions and help answer posted questions.

The course contains a component of self-learning through the experience gained via using the life cycle assessment software OpenLCA. The software will be used in tutorial sessions. Undergraduate and postgraduate students will attend the same lectures and tutorial sessions.

4.2 Learning in this course

You are expected to attend <u>all</u> lectures and tutorials in order to maximize learning. You will need to complete some pre-work for some of the lectures and tutorial classes. In addition to the lecture notes, you will be expected to read relevant papers and texts as required. Group learning is also encouraged but of course PLAGIARISM IS NOT. UNSW *assumes* that self-directed study of this kind is undertaken in addition to attending face-to-face classes throughout the course.

4.3 Tutorial classes

<u>Attendance at the tutorial classes is compulsory</u> from Week 1 to 10. If, for any reason you cannot attend your tutorial please contact the course convener.

5 Course Resources

5.1 Course official textbook

The course will use *Life Cycle Assessment: Theory and Practice* by *Michael Hauschild, Ralph Rosenbaum and Stig Irving Olsen (Springer International Publishing: Imprint: Springer, 2018)*, as the course textbook. The eBook version can be access via the UNSW library in the following link https://primoa.library.unsw.edu.au/permalink/f/1gq3lal/UNSW_ALMA51226734490001731

5.2 Software

Students must use the software OpenLCA to complete the project. This software can be downloaded in your personal computer, but it is also available on all computers in computer labs LG34 and LG35 in the TETB building.

5.3 MS Teams and Moodle

This course will use MS Teams as the main learning and communication platform. As such, it is expected that each student will get familiar with the use of teams and actively use the platform to interacts with the lecturer, tutors and peers.

Additionally, the Moodle course page will also be used for assignment submissions and marks.

5.4 Announcements and Discussion Board

Announcements concerning course information will be given in the lectures and/or via MS Teams and Moodle. A Discussion Board will also be established on the course page for you to post questions or initiate course-related discussions.

6 Other Matters

6.1 Academic Honesty and Plagiarism

Plagiarism is the unacknowledged use of other people's work, including the copying of assignment works and laboratory results from other students. Plagiarism is considered a form of academic misconduct, and the University has very strict rules that include some severe penalties. For UNSW policies, penalties and information to help you avoid plagiarism, see https://student.unsw.edu.au/plagiarism. To find out if you understand plagiarism correctly, try this short quiz: https://student.unsw.edu.au/plagiarism-quiz.

6.2 Student Responsibilities and Conduct

Students are expected to be familiar with and adhere to all UNSW policies (see https://student.unsw.edu.au/guide), and particular attention is drawn to the following:

6.3 Workload

You will spend around **twelve hours per week** studying a 6 UoC course, from Week 1 until the final assessment, including both face-to-face activities and *independent, self-directed study*. In periods where you need to complete assignments or prepare for examinations, the workload may be greater. Over-commitment has been a common source of failure for many students. You should take the required workload into account when planning how to balance study with employment and other activities.

It is recommended for you to design a study workload plan for the term based on the activities and assignments of each of your courses. An example of a simple weekly study plan for SOLA5051 is presented in the table below.

Period	Self-directed Study	Face to Face	D1	D2.1	D2.2	D2.3	Exam	Total Hours
Week 01	4	4	4					12
Week 02	4	4	4					12
Week 03	4	4	4					12
Week 04	4	4		4				12
Week 05	4	4		4				12
Week 06	4	4		2	4			14
Week 07	4	4			4			12
Week 08	4	4			4			12
Week 09	4	4			4	2		14
Week 10	4	4			4	2		14
Week 11						6	6	12
Exam weeks							12	12
Total Hours	**40**	**40**	**12**	**10**	**20**	**10**	**18**	**150**

6.4 Attendance

Regular and punctual attendance at all classes is expected. UNSW regulations state that if students attend less than 80% of scheduled classes they may be refused final assessment.

6.5 General Conduct and Behaviour

Consideration and respect for the needs of your fellow students and teaching staff is an expectation. Conduct which unduly disrupts or interferes with a class is not acceptable and students may be asked to leave the class.

6.6 Work Health and Safety

UNSW policy requires each person to work safely and responsibly, in order to avoid personal injury and to protect the safety of others.

6.7 Special Consideration and Supplementary Examinations

You must submit all assignments and attend all examinations scheduled for your course. You should seek assistance early if you suffer illness or misadventure which affects your course progress. All applications for special consideration must be **lodged online through myUNSW within 3 working days of the assessment**. For more detail, consult https://student.unsw.edu.au/special-consideration.

6.8 Continual Course Improvement

This course is under constant revision in order to improve the learning outcomes for all students. Please forward any feedback (positive or negative) on the course to the course convener or via the Course and Teaching Evaluation and Improvement Process. You can also provide feedback to RESOC who will raise your concerns at student focus group meetings. As a result of previous feedback obtained for this course and in our efforts to provide a rich and meaningful learning experience, we have continued to evaluate and modify our delivery and assessment methods.

6.9 Administrative Matters

On issues and procedures regarding such matters as special needs, equity and diversity, occupational health and safety, enrolment, rights, and general expectations of students, please refer to the School and UNSW policies:
http://www.engineering.unsw.edu.au/electrical-engineering/policies-and-procedures
https://my.unsw.edu.au/student/atoz/ABC.html

7 Appendix A: UNSW Graduate Capabilities

The course delivery methods and course content directly or indirectly addresses a number of core UNSW graduate capabilities, as follows:

- Developing scholars who have a deep understanding of their discipline, through lectures and solution of analytical problems in tutorials and assessed by assignments and written examinations.
- Developing rigorous analysis, critique, and reflection, and ability to apply knowledge and skills to solving problems. These will be achieved through students working through the Problem Sets and use of modelling software for the assignment.
- Developing independent, self-directed professionals who are enterprising, innovative, creative and responsive to change, through challenging design and project tasks.
- Developing citizens who can apply their discipline in other contexts, are culturally aware and environmentally responsible.

8 Appendix B: Engineers Australia (EA) Professional Engineer Competency Standard

	Program Intended Learning Outcomes		Relevant LO
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	✓	LO1, LO2
	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	✓	LO3, LO4
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	✓	LO5
PE3: Professional and Personal Attributes	PE3.1 Ethical conduct and professional accountability		
	PE3.2 Effective oral and written communication (professional and lay domains)	✓	LO5
	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		