School of Engineering

RENE4000: Energy Storage Systems

Callaghan
Semester 1 - 2024

COURSE OUTLINE

OVERVIEW

Course Description

This course introduces students to energy storage systems and provides a broad understanding and appreciation of the scientific principles that underpin the operation of such systems. The emphasis is on grid-scale (or utility-scale) energy storage as a means of addressing the intermittency of renewable energy components (e.g. solar or wind power systems) of modern electricity networks. Smaller energy storage systems are also discussed for benchmarking and comparisons. Topics covered include electrical, chemical, thermal, mechanical, electrochemical, thermochemical and thermomechanical energy storage systems as well as grid integration issues.

Academic Progress Requirements

Nil

Assumed Knowledge

First year of engineering calculus, physics, chemistry and general engineering courses or equivalent. Knowledge of thermodynamics, fluid mechanics and heat transfer or equivalent.

Contact Hours

Callaghan
Lecture
Face to Face On Campus
3 hour(s) per week(s) for 12 week(s) starting Week 1

Tutorial
Face to Face On Campus
2 hour(s) per week(s) for 11 week(s) starting Week 2

Unit Weighting

10

Workload

Students are required to spend on average 120-140 hours of effort (contact and non-contact) including assessments per 10 unit course.

CONTACTS

Course Coordinator

Callaghan
Dr Priscilla Tremain
Priscilla.Tremain@newcastle.edu.au
(02) 403 39347
Consultation: After classes or by appointment

Teaching Staff

Other teaching staff will be advised on the course Canvas site.

School Office

School of Engineering
EAG02
EA Building
Callaghan
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+61 2 4921 5798
9.00am-5.00pm (Monday to Friday)

SYLLABUS

Course Content

- Background
- Electrical Energy Storage
- Chemical Energy Storage
- Thermal Energy Storage
- Mechanical Energy Storage
- Electrochemical Energy Storage
- Thermochemical Energy Storage
- Thermomechanical Energy Storage
- Technology Status and Projected Demand and Cost
- Grid Integration

Course Learning Outcomes

On successful completion of this course, students will be able to:
1. Discuss the scientific principles underpinning the operation of energy storage systems.

2. Resolve the intermittency of renewable energy sources such as solar and wind by utilising problem solving skills in energy storage engineering and grid integration.

3. Work with a team to apply energy storage knowledge to develop and conduct a project.

Course Materials

Lecture Materials:

- - Lecture notes, directed readings, tutorials and assignments will be posted on Canvas.

SCHEDULE

Week	Week Begins	Lecture	Tutorial	Assessment Due
1	26 Feb	Module 1 – Background		
2	4 Mar	Module 2 - Electrical Energy Storage	Tutorial 1	
3	11 Mar	Module 3 - Chemical Energy Storage	Tutorial 2	
4	18 Mar	Module 4 - Thermal Energy Storage	Tutorial 3	Assignment 1 Due
5	25 Mar	Module 5 - Mechanical Energy Storage	Tutorial 4	

6	1 Apr	Module 6 - Electrochemical Energy Storage	Tutorial 5	Assignment 2 Due
7	8 Apr	Module 7 - Thermochemical Energy Storage	Tutorial 6	
Mid-Semester Recess				
Mid-Semester Recess				
8	29 Apr	Module 8 - Thermomechanical Energy Storage	Tutorial 7	Assignment 3 Due
9	6 May	Module 9 - Technology Status and Projected Cost	No tutorial In-class group work on Mini Project	
10	13 May	Module 10 - Grid Integration	No tutorial In-class group work on Mini Project	
11	20 May	No lecture In-class group work on Mini Project	No tutorial In-class group work on Mini Project	
12	27 May	Mini Projects Presentations	No tutorial	Mini Project Due
13	3 Jun			
Examination Period				
Examination Period				

ASSESSMENTS

This course has 5 assessments. Each assessment is described in more detail in the sections below.

	Assessment Name	Due Date	Involvement	Weighting	Learning Outcomes
1	Assignment 1	Week 4	Individual	10%	1, 2
2	Assignment 2	Week 6	Individual	10%	1, 2
3	Assignment 3	Week 8	Individual	10%	1, 2
4	Mini Project (Grid Energy Storage)	Week 12	Group	30%	1, 2, 3
5	Final Exam	During the formal exam period	Individual	40%	1, 2

Late Submissions The mark for an assessment item submitted after the designated time on the due date, without an approved extension of time, will be reduced by 10% of the possible maximum mark for that assessment item for each day or part day that the assessment item is late. Note: this applies equally to week and weekend days.

Assessment 1 - Assignment 1

Assessment Type Written Assignment
Purpose To reinforce learning outcomes 1 and 2
Description Assignment 1 covers questions from Modules 1 and 2 of the course
Weighting 10%
Due Date Week 4
Submission Method Online
Online via Canvas submission portal or hard copy submission in class.
Assessment Criteria * Methodology 80%
* Final answer 20%
Return Method In Class
Feedback Provided In Class - .
Opportunity to Reattempt Students WILL NOT be given the opportunity to reattempt this assessment.

Assessment 2 - Assignment 2

Assessment Type	Written Assignment
Purpose	To reinforce learning outcomes 1 and 2
Description	
Weighting	10%
Due Date	Week 6
Submission Method	Online Online via Canvas submission portal or hard copy submission in class.
Assessment Criteria	* Methodology 80% * Final answer 20%
Return Method	In Class
Feedback Provided	In Class - .
Opportunity to Reattempt	Students WILL NOT be given the opportunity to reattempt this assessment.

Assessment 3 - Assignment 3

Assessment Type	Written Assignment
Purpose	To reinforce learning outcomes 1 and 2
Description	
Weighting	10%
Due Date	Week 8
Submission Method	Online Online via Canvas submission portal or hard copy submission in class.
Assessment Criteria	* Methodology 80% * Final answer 20%
Return Method	In Class
Feedback Provided	In Class - .
Opportunity to Reattempt	Students WILL NOT be given the opportunity to reattempt this assessment.

Assessment 4 - Mini Project (Grid Energy Storage)

Assessment Type	Project
Purpose	To reinforce learning outcomes 1, 2 and 3
Description	
Weighting	30%
Due Date	Week 12
Submission Method	Online Online via Canvas submission portal or hard copy submission in class.
Assessment Criteria	* Presentation 30% * Final report 70%
Return Method	In Class
Feedback Provided	In Class - .
Opportunity to Reattempt	Students WILL NOT be given the opportunity to reattempt this assessment.

Assessment 5 - Final Exam

Assessment Type	Formal Examination
Purpose	To assess students' knowledge of course content / material
Description	A combination of multiple choice and numerical questions
Weighting	40%
Length	2 hours
Due Date	During the formal exam period
Submission Method	Formal Exam
Assessment Criteria	* For multiple choice question (full mark if correct and zero if incorrect) * For numerical questions: # Methodology 70% # Final answer 30%
Return Method	Not Returned
Feedback Provided	No Feedback - .

Opportunity to Reattempt	Students WILL NOT be given the opportunity to reattempt this assessment.

ADDITIONAL INFORMATION

Grading Scheme

This course is graded as follows:

Range of Marks	Grade	Description
85-100	High Distinction (HD)	Outstanding standard indicating comprehensive knowledge and understanding of the relevant materials; demonstration of an outstanding level of academic achievement; mastery of skills*; and achievement of all assessment objectives.
75-84	Distinction (D)	Excellent standard indicating a very high level of knowledge and understanding of the relevant materials; demonstration of a very high level of academic ability; sound development of skills*; and achievement of all assessment objectives.
65-74	Credit (C)	Good standard indicating a high level of knowledge and understanding of the relevant materials; demonstration of a high level of academic achievement; reasonable development of skills*; and achievement of all learning outcomes.
50-64	Pass (P)	Satisfactory standard indicating an adequate knowledge and understanding of the relevant materials; demonstration of an adequate level of academic achievement; satisfactory development of skills*; and achievement of all learning outcomes.
0-49	Fail (FF)	Failure to satisfactorily achieve learning outcomes. If all compulsory course components are not completed the mark will be zero. A fail grade may also be awarded following disciplinary action.

*Skills are those identified for the purposes of assessment task(s).

Communication Methods

Communication methods used in this course include:

- Canvas Course Site: Students will receive communications via the posting of content or announcements on the Canvas course site.
- Email: Students will receive communications via their student email account.
- Face to Face: Communication will be provided via face to face meetings or supervision.

Course Evaluation

Each year feedback is sought from students and other stakeholders about the courses offered in the University for the purposes of identifying areas of excellence and potential improvement.

Oral Interviews (Vivas)

As part of the evaluation process of any assessment item in this course an oral examination (viva) may be conducted. The purpose of the oral examination is to verify the authorship of the material submitted in response to the assessment task. The oral examination will be conducted in accordance with the principles set out in the Oral Examination (viva) Procedure. In cases where the oral examination reveals the assessment item may not be the student's own work the case will be dealt with under the Student Conduct Rule.

Academic Misconduct

All students are required to meet the academic integrity standards of the University. These standards reinforce the importance of integrity and honesty in an academic environment. Academic Integrity policies apply to all students of the University in all modes of study and in all locations. For the Student Academic Integrity Policy, refer to https://policies.newcastle.edu.au/document/view-current.php?id=35.

Adverse Circumstances

The University acknowledges the right of students to seek consideration for the impact of allowable adverse circumstances that may affect their performance in assessment item(s). Applications for special consideration due to adverse circumstances will be made using the

online Adverse Circumstances system where:

1. the assessment item is a major assessment item; or
2. the assessment item is a minor assessment item and the Course Co-ordinator has specified in the Course Outline that students may apply the online Adverse Circumstances system;
3. you are requesting a change of placement; or
4. the course has a compulsory attendance requirement.

Before applying you must refer to the Adverse Circumstance Affecting Assessment Items Procedure available at:
https://policies.newcastle.edu.au/document/view-current.php?id=236

Important Policy Information

The Help button in the Canvas Navigation menu contains helpful information for using the Learning Management System. Students should familiarise themselves with the policies and procedures at https://www.newcastle.edu.au/current-students/respect-at-uni/policies-and-procedures that support a safe and respectful environment at the University.

Graduate Profile Statements

This course builds students' capacity in the following University of Newcastle Bachelor of Engineering Graduate Profile Statements (based on 2011 Engineers Australia revised Stage 1 Competency Standards for Professional Engineers):

UON Att.	University of Newcastle Bachelor of Engineering Graduate Profile Statements/ Engineers Australia Stage 1 competency statements	Taught	Practised	Assessed	Skill Level (1-4)
	Professional Attributes				
11	3.1. Ethical conduct and professional accountability		X		4
12	3.2. Effective oral and written communication in professional and lay domains.		X	X	4
13	3.3. Creative, innovative and pro-active demeanour.		X	X	3-4
14	3.4. Professional use and management of information.		X	X	3-4
15	3.5. Orderly management of self, and professional conduct.		X	X	4
16	3.6. Effective team membership and team leadership.		X	X	4
	Engineering Ability				
7	2.1. Application of established engineering methods to complex engineering problem solving.	X	X	X	4
8	2.2. Fluent application of engineering techniques, tools and resources.	X	X	X	4
9	2.3. Application of systematic engineering synthesis and design processes.	x	X	X	4
10	2.4. Application of systematic approaches to the conduct and management of engineering projects.		X	X	4
	Knowledge Base				
1	1.1. Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline.	X	X	X	3-4
2	1.2. Conceptual understanding of the, mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline.	X	X	X	3-4
3	1.3. In-depth understanding of specialist bodies of knowledge within the engineering discipline.	X	X	X	3-4
4	1.4. Discernment of knowledge development and research directions within the engineering discipline.		X	X	4
5	1.5. Knowledge of contextual factors impacting the engineering discipline.		X		4
6	1.6. Understanding of the scope, principles, norms, accountabilities and bounds of contemporary engineering practice in the specific discipline.		X		3-4

This course outline was approved by the Head of School on 20/02/2024. No alteration of this course outline is permitted without Head of School approval. If a change is approved, students will be notified and an amended course outline will be provided in the same manner as the original.