School of Environmental and Life Sciences

CHEM3410: Energy and Materials

Callaghan
Semester 2 - 2023

COURSE OUTLINE

OVERVIEW

Course Description

This course explores the synthesis, characterisation and chemistry of materials and nanostructures relevant to energy conversion applications. Electrode dynamics, including the metal-solution interface and structure of the double layer, is examined, along with rates and mechanisms of charge transfer reactions, electrochemical techniques and corrosion. The synthesis, characterisation and electronic structure of nanomaterials is examined in the context of energy applications and catalysis. An introduction to modelling the electronic structure of solid state materials with computational chemistry is provided, and the fundamental nature and applications of semiconductor materials will also be discussed.

Requisites

Students must have successfully completed CHEM2410 to be enrolled in this course.

Assumed Knowledge

CHEM2410, CHEM2210, CHEM2110.

Contact Hours

Callaghan
Computer Lab *
Face to Face On Campus
3 hour(s) per Week for 4 Weeks

Laboratory *
Face to Face On Campus
3 hour(s) per Week for 8 Weeks

Lecture
Face to Face On Campus
2 hour(s) per Week for 12 Weeks

Tutorial
Face to Face On Campus
1 hour(s) per Week for 12 Weeks

* This contact type has a compulsory requirement.

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
Prof Scott Donne
Scott.Donne@newcastle.edu.au
(02) 4921 5477
Consultation: By appointment

Teaching Staff

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

School Office

School of Environmental and Life Sciences
Room C228 Chemistry Building
Callaghan
Science-SELS@newcastle.edu.au
+61 2 4921 5080
9am-5pm (Mon-Fri)

SYLLABUS

Course Content

The course involves study of:

- Solids and interfaces in energy production and conversion
- Semiconductor photo-electrochemistry
- Synthetic strategies and characterisation of nanomaterials
- Theories of bonding in solids and nanomaterials
- Electronic structure of semiconductor materials

Course Learning Outcomes

On successful completion of this course, students will be able to:

1. Apply concepts and solve problems of applied physical chemistry;

2. Relate electrode dynamics to the performance of electrochemical systems;

3. Describe the electronic structure, surface chemistry and morphology of nanomaterials, and apply this knowledge to synthesis, characterisation and energy-related applications;

4. Competently use instrumentation and methods employed in applied physical chemistry;

5. Competently use computational chemistry software to model the electronic structure of semiconductor materials and nanomaterials;

6. Apply the scientific process in the design, conduct, evaluation and reporting of experimental investigations;

7. Assess and mitigate risks when working with chemicals and hazardous substances;

8. Contribute to team and group work for scientific investigation and reporting.

COMPULSORY REQUIREMENTS

In order to pass this course, each student must complete ALL of the following compulsory requirements:

Contact Hour Requirements:

- Computer Lab There is a compulsory attendance requirement in this course. Students may only miss 1 laboratory session. Students who missed a laboratory with a recognised adverse circumstance will have the opportunity to complete that laboratory at a later date.
- Laboratory There is a compulsory attendance requirement in this course. Students may only miss 1 laboratory session. Students who missed a laboratory with a recognised adverse circumstance will have the opportunity to complete that laboratory at a later date.
- Laboratory Induction Requirement - Students must attend and pass the induction requirements before attending these sessions. In order to participate in this course, students must complete a compulsory safety induction.

Course Assessment Requirements:

- Assessment 1 - In Term Test: Minimum Grade / Mark Requirement - Students must obtain a specified minimum grade / mark in this assessment item to pass the course. Students must obtain a mark of at least 40% in each test to pass this course.

- Assessment 2 - Tutorial / Laboratory Exercises: Pass Requirement - Students must pass this assessment item to pass the course. Students must submit all reports and obtain an overall mark of at least 50% to pass the course.

- Assessment 2 - Tutorial / Laboratory Exercises: Attempt / Submission Requirement - Students must attempt/submit this assessment item to pass the course. Students must attempt/submit this assessment item to pass the course.

SCHEDULE

Week	Week Begins	Topic	Learning Activity	Assessment Due
1	17 Jul	Electronic theory of solids	Lectures Tutorial Laboratory experiments	None
2	24 Jul	Electronic theory of solids	Lectures Tutorial Laboratory experiments	None
3	31 Jul	Solid state solar energy conversion Semiconductor-solution interface	Lectures Tutorial Laboratory experiments	Lab report #1 (SD)
4	7 Aug	Semiconductor photo-electrochemistry	Lectures Tutorial Laboratory experiments	Lab report #2 (SD)
5	14 Aug	Background and basic concepts of nanomaterials and catalysis	Lectures Tutorial Laboratory experiments	Section assessment (SD)
6	21 Aug	Nanomaterials for electrocatalysis	Lectures Tutorial Laboratory experiments	Lab report #3 (SC)
7	28 Aug	Nanomaterials for electrocatalysis	Lectures Tutorial Laboratory experiments	Lab report #4 (SC)
8	4 Sep	Nanomaterials for photocatalysis	Lectures Tutorial Laboratory experiments	Lab report #5 (SC)
9	11 Sep	Revision of quantum mechanical principles	Lectures Tutorial Computer laboratory	Section assessment (SC)
10	18 Sep	Electronic structure of solids Molecular orbital band theory	Lectures Tutorial Computer laboratory	Lab report #6 (AP)
Mid Term Break				
Mid Term Break				
11	9 Oct	Electronic structure of solids Molecular orbital band theory	Lectures Tutorial Computer laboratory	Lab report #7 (AP)
12	16 Oct	Properties, growth and electronic structure of carbon nanomaterials	Lectures Tutorial Computer laboratory	Lab report #8 (AP)
13	23 Oct			Section assessment (AP)
Examination Period				
Examination Period				

ASSESSMENTS

This course has 2 assessments. Each assessment is described in more detail in the sections below.

	Assessment Name	Due Date	Involvement	Weighting	Learning Outcomes
1	In Term Tests*	Weeks 5, 9, 13	Individual	60%	1, 2, 3
2	Group or Individual Laboratory Exercises and Reports*	Weeks 3, 4, 6, 7, 8, 10, 11, 12	Combination	40%	1, 2, 3, 4, 5, 6, 7, 8

* This assessment has a compulsory requirement.

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 - In Term Tests

Assessment Type In Term Test
Description In term tests are designed to test the individual student's knowledge of the course material and their ability to describe, analyze and hypothesise from this material. They meet the course objectives of knowledge acquisition and demonstrated assimilation of data, upon reflection and analysis, to produce articulate and concise documents which convey evidence-based understanding of the concepts and topics. They provide the students with feedback on student learning for this section of the course. These tests highlight areas of concern and may stimulate discussion with lecturers.
Weighting 20% for each section (60% overall)
Compulsory Requirements Minimum Grade / Mark Requirement - Students must obtain a specified minimum grade / mark in this assessment item to pass the course.
Due Date Weeks 5, 9, 13
Submission Method Submission directly to the lecturer or via Canvas
Assessment Criteria Questions will require written answers, calculations where required, and will ideally be accompanied by relevant diagrams or chemical equations where necessary. Part marks will be awarded according to the level of completeness, understanding and accuracy of a response. While inaccurate or non-applicable responses will not attract specific demerits, unless it is explicitly stated to that effect in the question, they will be regarded as relevant to assessment of the student's understanding of the topic under test.
Return Method Via email or Canvas
Feedback Provided Upon request
Opportunity to Reattempt Students WILL be given the opportunity to reattempt this assessment.
Students who do not obtain 40% in their first attempt will be given the opportunity to re-attempt the test.

Assessment 2 - Group or Individual Laboratory Exercises and Reports

Assessment Type Tutorial / Laboratory Exercises
Description Laboratory work is the central component of chemistry by which knowledge is advanced and the means by which professional chemists contribute to an understanding of real-world problems. Here students will be required to demonstrate sufficient understanding regarding the applications of various electrochemical methods, particularly with relevance to photo-electrochemistry, as well as the synthesis, characterisation and computational simulation of nanomaterials.
Weighting 13.33% per section (Section 1: 6.67% each; Sections 2 and 3: 4.44% each; 40% overall)
Compulsory Requirements Pass Requirement - Students must pass this assessment item to pass the course..
Attempt / Submission Requirement - Students must attempt/submit this assessment item to pass the course.
Due Date Weeks 3, 4, 6, 7, 8, 10, 11, 12
Submission Method Submit to lecturer or in the report box outside the laboratory, via Canvas, or as an oral

	presentation.
Assessment Criteria	Assessment of performance in the laboratory, the quality of results and observational skills, and the ability to explain results together with the related theoretical background should stimulate discussion with demonstrators, lecturers and fellow students. In cases where an experimental value is determined or a product collected or synthesised, marks will be awarded according to the closeness of the result obtained against a pre-determined standard. These standard values are not made available to students in order to avoid bias in experimental work towards a preconceived conclusion. Marks will be awarded for the correct level of interpretation of data (e.g. spectra, electrochemical data, etc.) and incomplete interpretation will only receive marks according to the level of completeness of the interpretation. Questions posed throughout the laboratory notes, as well as those in the section entitled "Report", should be fully answered. Part answers will receive marks in proportion to the completeness of the answer. It is also important that students provide a detailed contextual statement concerning their experimental work, as describing why the laboratory work is done is also critical for learning.
Return Method	Laboratory report boxes / Canvas submission
Feedback Provided	Upon request
Opportunity to Reattempt	Students WILL be given the opportunity to reattempt this assessment. Students with valid adverse circumstance will be given the opportunity to re-attempt 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:

1. Canvas Site: Students will receive communications via posting of announcements or course content on the Canvas site.
2. Email: Students will receive communications via email accounts.
3. Face to Face: Students will receive communications via face-to-face meetings or supervision upon appointment

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.

	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.
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/no-room-for/policies-and-procedures that support a safe and respectful environment at the University.

This course outline was approved by the Head of School. 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.
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