ENGG9743

Fuel Cycle, Waste and Life Cycle Management

Term 3, 2021

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Patrick Burr	p.burr@unsw.edu.au	9-5pm weekdays	402 Ainsworth building, Kensington campus, Sydney	0434483103

School Contact Information

Location

UNSW Mechanical and Manufacturing Engineering

Ainsworth building J17, Level 1

Above Coffee on Campus

Hours

9:00–5:00pm, Monday–Friday*

*Closed on public holidays, School scheduled events and University Shutdown

Web

School of Mechanical and Manufacturing Engineering

Engineering Student Support Services

Engineering Industrial Training

UNSW Study Abroad and Exchange (for inbound students)

UNSW Future Students

Phone

(+61 2) 9385 8500 – Nucleus Student Hub

(+61 2) 9385 7661 – Engineering Industrial Training

(+61 2) 9385 3179 – UNSW Study Abroad and UNSW Exchange (for inbound students)

(+61 2) 9385 4097 – School Office**

**Please note that the School Office will not know when/if your course convenor is on campus or available

Email

Engineering Student Support Services – current student enquiries

- e.g. enrolment, progression, clash requests, course issues or program-related queries

Engineering Industrial Training – Industrial training questions

UNSW Study Abroad – study abroad student enquiries (for inbound students)

UNSW Exchange – student exchange enquiries (for inbound students)

UNSW Future Students – potential student enquiries

- e.g. admissions, fees, programs, credit transfer

School Office – School general office administration enquiries

- NB: the relevant teams listed above must be contacted for all student enquiries. The School will only be able to refer students on to the relevant team if contacted

Important Links

- Student Wellbeing
- Urgent Mental Health & Support
- Equitable Learning Services
- Faculty Transitional Arrangements for COVID-19
- Moodle
- Lab Access
- Computing Facilities
- Student Resources
- Course Outlines
- Makerspace
- UNSW Timetable
- UNSW Handbook

Course Details

Units of Credit 6

Summary of the Course

This is a postgraduate course in the faculty of Engineering, convened by School of Mechanical and Manufacturing Engineering. It is a core class on the MEngSci Nuclear Engineering specialization, and associated GadDip and GradCert, and may be taken as an elective for most Engineering degrees.

The nuclear fuel cycle is a vital aspect of all nuclear technologies, from power reactors, to nuclear medicine, and this class covers the cycle from extraction of uranium from the ground, to fuel manufacture, in-reactor operation, to storage and finnal disposal. The fuel cycles vary with reactor technology and the course will review each of the existing processes in use. This course will not only provide a comprehensive study of the traditional fuel cycle (the uranium/plutonium once-through cycle), but it will also discuss the closure of the nuclear fuel cycle as well as fuel cycles that may be the future of nuclear power, such as the thorium fuel cycle. The course will review recent advances made in recycling processes, and how conventional processes need to be adapted for the requirements of the nuclear industry. The course also provides an introduction to the principles and practices of waste management and disposal. Case studies will be used to demonstrate the principles of life cycle management and decommissioning.

The prerequisite for this course is ENGG9741 Introduction to Nuclear Engineering.

Course Aims

The aim of the course is to provide in-depth, practical knowledge of the nuclear fuel cycle, including understanding of the front end aspects of mininng, conversiona dn fuel fabrication, considerations of in-reactor fuel utilisation, and understanding of the processes and principles of the back-end of the fuel cycle, inlcudinng reprocessing, waste mangment, and waste disposal.

Course Learning Outcomes

After successfully completing this course, you should be able to:

Learning Outcome	EA Stage 1 Competencies
1. Describe the fundamentals of Uranium mining, milling and conversions	PE1.3
2. Discuss fuel fabrication techniques and reprocessing routes	PE1.3
3. Calculate key parameters for enrichment, fabrication and reprocessing	PE1.3, PE2.1
4. Illustrate systems and processes required in nuclear engineering facilities beyond conventional engineering practice	PE1.5, PE2.4
5. Compare and contrast different reactor systems and different medical isotope production methods	PE1.4

Learning Outcome	EA Stage 1 Competencies
6. Describe technological challenges and regulatory aspects associated with decommissioning, environmental protection, monitoring and remediation	PE1.5
7. Identify options for processing high level waste for storage and disposal	PE1.3, PE1.5
8. Examine the key principles associated site selection, site characterization, waste acceptance criteria for near-surface and deep disposal of radioactive waste	PE1.5, PE2.3

This course also addresses the IAEA International Nuclear Management Academy (INMA) learning outcomes for masters' level course in Nuclear Technology Management:

INMA Competency Area*	INMA Competency Level
2.1 Nuclear power plant and other facility design principles	1
2.2 Nuclear power plant/facility operational systems	1
2.3 Nuclear power plant/facility life management	1
2.5 Systems engineering within nuclear facilities	1
2.9 Nuclear fuel cycle technologies	2
2.10 Nuclear waste management and disposal	2
2.11 Nuclear power plant/facility decommissioning	1
2.12 Nuclear environmental protection, monitoring and remediation	1
2.13 Nuclear R&D and innovation management	1
2.14 Application of nuclear science	2
3.1 Nuclear engineering project management	1

*Grosbois, J. de, F. Adachi, and H. Hirose. 2017. "International Nuclear Management Academy Master's Programmes in Nuclear Technology Management." IAEA.

Teaching Strategies

This course is delivered entirely online. A substantial portion of the content will be delivered via pre-recorded videos. These will extensively involve ANSTO staff, who will provide an industry perspective on the nuclear fuel cycle. These are designed to be supplemented by additional reading, and interactive activities. Knowledge will be consolidated through two self-moderated (tutor guided) asynchronous forum discussions, and online (synchronous) tutorials.

Assessment

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Presentation	15%	week 3 tutorial session	5
2. Self-moderated forum	10%	Not Applicable	4, 5, 6
3. Quizzes	65%	6pm Friday on week 4 (T1) week 7 (T2), week 10 (T3)	1, 2, 3, 6, 7, 8
4. Assignment	10%	Friday 6pm Week 11	4

Assessment 1: Presentation

Submission notes: Individual assessment
Due date: week 3 tutorial session
Deadline for absolute fail: N/A
Marks returned: Marks will be returned within 2 working days

Each student will be given one topic for which they will have to prepare an online presentation, which could be either synchronous (live presentation) or asynchronous (video recording). The topics will be related to non-energy use of the nuclear fuel cycle.

Presentation length will depend on number of students, in the class, and will range between 5 and 15 minutes. The presentation will be delivered on Teams, followed by a short Q&A.

Assessment criteria

Students will be assess on the quality of the presentation, the quality of the content, and the level of enngangement during the Q&A sessions (of their own presentation and that of their peers).

	Relative weight	*Marks will be awarded for*
Quality of presentation	33%	Presentation should be effective, clear, concise, engaging, timely (between 8 and 10 min).
Quality of content	33%	Content should be factually correct, show in-depth understanding, provide evidence of additional reading beyond common and/or superficial sources of information. Interesting.
Q&A engagement	33%	Ability to answer questions extensively, engaging comments, constructive criticism.

Assessment 2: Self-moderated forum

Submission notes: Individual Assessment
Deadline for absolute fail: N/A

Marks returned: Marks will be returned at release of final results.

Depending on student numbers, each week or fortnight a new controversial forum topic will be issued together with some reading material. A student (or group of students) will be nominated as the topic moderator(s). They will provide an initial summary of the topic, and ask provocative questions. The entire class will participate with their comments and opinions, maintaining a collegial and encouraging form for debate.

Assessment criteria

Assessment of contributions

Your contributions to the fortnightly discussions are assessed Pass/Fail (i.e. for that time period you either get full marks, or none), on the basis of satisfactory contribution to the asynchronous group discussion. You will be assessed exclusively on whether you participate constructively, not on the quality or content of your contributions. The expectation is a minimum of 200 words over multiple interactions.

Assessment of moderation

Every student will take turn to be a moderator. In this capacity, you will:

1. Initiate the discussion by providing a summary of the topic, together with some provoking questions.
2. moderate an asynchronous on-line discussion amongst your peer students over a two-week period;
3. synthesising the outcomes of the asynchronous discussion into a short summary that will wrap up and close the topic.

Your role is to provide some stimulating and provocative questions as well as to answer their questions or make other comments that would encourage a deep and critical your peer-experts engagement in this discussion. The goal is to make sure that the discussion is critical and based on facts.

You are encouraged to provide additional reading materials to aid the conversation. You should stimulate the conversation by playing “devil’s advocate”: if the conversation takes a one-sided approach to the problem, and all participants seems to agree on one view, it is your responsibility to highlight a different view point.

When participants mention facts, you should check the validity of these or request references/sources if you cannot validate the facts independently. Above all, it is your role to ensure a lively, open-minded and welcoming environment on which a productive and critical discussion can be had.

This component is also assessed Pass/Fail. It is expected that you actively prepare for discussion, moderate it, document and present the outcomes.

Additional details

Assessment 3: Quizzes

Due date: 6pm Friday on week 4 (T1) week 7 (T2), week 10 (T3)
Deadline for absolute fail: N/A
Marks returned: Marks will be returned within one week of each quiz completion.

Three online tests

Assessment criteria

The quizzes tests analytical and critical thinking and general understanding of the course material in a controlled fashion. Questions may be drawn from any aspect of the course covered until the week preceding the test, unless specifically indicated otherwise by the lecturer. Marks will be assigned according to the correctness of the responses.

The final quiz with involve a case study and the students will need to provide their analysis in the form of an essay and by answering an online quiz.

Assessment 4: Assignment

Assessment length: 2 A4 pages
Due date: Friday 6pm Week 11

A report on a topic of nuclearisation of engineering design processes

Assessment criteria

Aspect	Marks	What we are looking for
Technical correctness and historical accuracy.	10	Your knowledge of the science and engineering processes that underpin the project are evident. The important events are all listed, and dates are correct. The sequence of events is clear and not cluttered by un-important events.
Analytical skills	10	You can break down complex concepts. You can identify, in interconnected series of events, the root cause of the failure of a project.
Comprehensive risk assessment	10	You can correctly and comprehensively identify risk. You can accurately assess the likelihood and impact of each risk. You can identify appropriate mitigation strategies for the principal risk.
Ability to synthesise complex concepts into a coherent and succinct narrative	10	You can break down complex concepts. You can provide advice on solid, factual evidence. The

		executive summary is comprehensive, succinct and in plain English. The report conveys a coherent story, with no disconnections between the various sections.
Presentation	10	Well-structured. Within word limits. Proficient quality of English. Professional formatting. Appropriate use of graphs. Appropriate choice of references. Consistent citation format.

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

Course Schedule

View class timetable

Timetable

Date	Type	Content
Week 1: 13 September - 17 September	Topic	Overview of the nuclear fuel cycle. Mining and milling
Week 2: 20 September - 24 September	Topic	Conversion to UF6 and enrichment
Week 3: 27 September - 1 October	Topic	Conversion to UO2 and nuclear fuel fabrication
	Presentation	Individual presentations during tutorial session
Week 4: 4 October - 8 October	Topic	Current and future nuclear fuels.
	Assessment	Quiz 1 – assessing content of weeks 1-3
Week 5: 11 October - 15 October	Topic	Used fuel storage and reprocessing
Week 6: 18 October - 22 October	Topic	R&D status on advanced reprocessing techniques
Week 7: 25 October - 29 October	Topic	Wasteforms and High Level Waste
	Assessment	Quiz 2 – assessing content of weeks 4-6
Week 8: 1 November - 5 November	Topic	Overview of waste management, waste characterisation, and low level waste conditioning
Week 9: 8 November - 12 November	Topic	Overview of Decomissioning, and Mo-99 production
Week 10: 15 November - 19 November	Topic	Nuclearization of engineering processes and designs
	Assessment	Quiz 3 – assessing content of weeks 7-9

Resources

Recommended Resources

1. Basic Nuclear Engineering
Author: Foster and Wright
ISBN 978-0205078868
Publisher Allyn and Bacon

2. Nuclear Chemical Engineering
Author: Benedict, Pigford, Levi
ISBN 978-0070045316
Publisher McGraw-Hill

3. Comprehensive Nuclear Materials
Author: Rudy Konings
ISBN 978-0080560274
Year Published 2012

4. Nuclear Energy: Principles, practices and prospects
Author: David Bodansky
ISBN 978-0387207780
Year Published 2005

5. Geological Repository Systems for Safe Disposal of Spent Nuclear Fuels and Radioactive Waste
Author: Michael J. Apted and Joonhong Ahn
ISBN 978-0-08-100642-9
Year Published 2017

Course Evaluation and Development

Feedback on the course is gathered periodically using various means, including the UNSW myExperience process, informal discussion during the course (for on-the-fly changes), 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.

Recent improvements resulting from student feedback of this course include: providing a schedule for the tutorial times for the entire term; removing online video submissions to avoid potential IT complications; more time has been allocated for tutorials and practice questions; the self-moderated forum was a highly-appreciated feature of last year's delivery, thus it will be retained but with the discussion will be condensed into fewer days of the week, as per feedback of one alumni.

Submission of Assessment Tasks

Assessment submission and marking criteria

Should the course have any non-electronic assessment submission, these should have a standard School cover sheet.

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.

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.

Late policy

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of 20 percent (20%) of the maximum mark possible for that assessment item, per calendar day, for a minimum of zero marks.

The late penalty is applied per calendar day (or part thereof), including weekends and public holidays, that the assessment is overdue.

Work submitted after the ‘deadline for absolute fail’ is not accepted and a mark of zero will be awarded for that assessment item. For example:

- Your course has an assessment task worth a total of **30 marks (Max Possible Mark)**
- You submit the assessment **2 days after the due date**
- The assessment is marked as usual and achieves a score of **20 marks (Awarded Mark)**
- The late policy is applied using **Late Mark = Awarded Mark - (Days*Penalty per Day)*Max Possible Mark**. Your adjusted final score is **8 marks** (20 - ((2*0.2)*30)).

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.

Examinations

You must be available for all quizzes, tests and examinations. For courses that have final examinations, these 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 webpage.

Special Consideration

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.

UNSW now has a Fit to Sit / Submit rule, 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.

Please note that students will **not** be required to provide **any** documentary evidence to support absences from any classes missed **because of COVID-19 public health measures such as isolation**. UNSW will **not** be insisting on medical certificates from anyone deemed to be a positive case, or when they have recovered. Such certificates are difficult to obtain and put an unnecessary strain on students and medical staff.

Applications for special consideration **will** be required for assessment and participation absences – but no documentary evidence **for COVID-19 illness or isolation** will be required.

Special Consideration Outcomes

Assessments have default Special Consideration outcomes. The default outcome for the assessment will be advised when you apply for Special Consideration. Below is the list of possible outcomes:

Outcome	Explanation	Example
Time extension	Student provided more time to submit the assessment	e.g. 1 more week of time granted to submit a report
Supplementary assessment	Student provided an alternate assessment at a later date/time	e.g. a supplementary exam is scheduled during the supplementary exam period of the term
Substitute item	The mark for the missed assessment is substituted with the mark of another assessment	e.g. mark for Quiz 1 applied also applied as mark for Quiz 2, meaning if a student achieved a mark of 20/30 for Quiz 1 and was granted Special Consideration for Quiz 2, a mark of 20/30 would be applied for Quiz 2, etc
Exemption	All course marks are recalculated excluding this assessment and its weighting	e.g. The course has an assessment structure of: - Assignments 30%, - Lab report 30%, - Final Exam 40%. If the Lab report is missed and student is granted Special Consideration, then the assessment structure may be reweighted as follows: - Assignments 50% - Final Exam 50% as though the Lab report did not exist
Non-standard	Course Coordinator is contacted for the outcome when special consideration is granted as the outcome differs on a case-by-case basis	e.g. typical for group assessments where time extension supplementary assessment could be granted to the group member, time extension could be granted to the whole group, etc. Clarify with your Course Convenor for

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. 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

Academic Information

Credit points

Course credit is calculated in Units-Of-Credit (UOC). The normal workload expectation for one UOC is approximately 25 hours per term. This includes class contact hours, private study, other learning activities, preparation and time spent on all assessable work.

Most coursework courses at UNSW are 6 UOC and involve an estimated 150 hours to complete, for both regular and intensive terms. Each course includes a prescribed number of hours per week (h/w) of scheduled face-to-face and/or online contact. Any additional time beyond the prescribed contact hours should be spent in making sure that you understand the lecture material, completing the set assignments, further reading, and revising for any examinations.

On-campus class attendance

****T3-2021 UPDATE****
Classes will be entirely ONLINE until at least Week 6, after which we will receive further advice from UNSW about the return of face-to-face classes. Students who are enrolled in face-to-face classes will have access to the course's online content but NO classes will be changed to reflect online delivery until Week 6 due to uncertainty regarding delivery mode for the rest of the term. Please go to your course's Moodle modules and MS Teams sites for further information about accessing course resources and content.

- -

Public distancing conditions must be followed for all face-to-face classes. To ensure this, only students enrolled in those classes will be allowed in the room. No over-enrolment is allowed in face-to-face classes. Students enrolled in online classes can swap their enrolment from online to a **limited** number of on-campus classes by Sunday, Week 1. Please refer to your course's Microsoft Teams and Moodle sites for more information about class attendance for in-person and online class sections/activities.

Your health and the health of those in your class is critically important. You must stay at home if you are sick or have been advised to self-isolate by NSW health or government authorities. Current alerts and a list of hotspots can be found here. **You will not be penalised for missing a face-to-face activity due to illness or a requirement to self-isolate.** We will work with you to ensure continuity of learning during your isolation and have plans in place for you to catch up on any content or learning activities you may miss. Where this might not be possible, an application for fee remission may be discussed. Further information is available on any course Moodle or Teams site.

In certain classroom and laboratory situations where physical distancing cannot be maintained or there is a high risk that it cannot be maintained, face masks will be considered **mandatory PPE** for students and staff.

For more information, please refer to the
FAQs: https://www.covid-19.unsw.edu.au/safe-return-campus-faqs

Guidelines

All students are expected to read and be familiar with UNSW guidelines and polices. In particular,

students should be familiar with the following:

- Attendance
- UNSW Email Address
- Special Consideration
- Exams
- Approved Calculators
- Academic Honesty and Plagiarism

Image Credit

Photo by Stephen Blake March 2017, Willis Annexe (J18) Thermofluids lab

CRICOS

CRICOS Provider Code: 00098G

Acknowledgement of Country

We acknowledge the Bedegal people who are the traditional custodians of the lands on which UNSW Kensington campus is located.

Appendix: Engineers Australia (EA) Professional Engineer Competency Standard

Program Intended Learning Outcomes	
Knowledge and skill base	
PE1.1 Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline	
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	✓
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	✓
PE1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline	✓
PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline	
Engineering application ability	
PE2.1 Application of established engineering methods to complex engineering 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	✓
Professional and personal attributes	
PE3.1 Ethical conduct and professional accountability	
PE3.2 Effective oral and written communication in 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	