ENGG9743

Fuel Cycle, Waste and Life Cycle Management

Term One // 2021

School of Mechanical and Manufacturing Engineering // UNSW Engineering

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

Course Details

Credit Points 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.

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 to storage and disposal. Fuel cycles vary with reactor technology and the course will review each of the existing processes in use. The course will also review improvements made in recycling processes, and how conventional processes need to be adapted for the requirements of the nuclear industry. The waste management aspects of this course focus on the growing need in the nuclear industry to understand the physics and engineering aspects of dealing with radiologically contaminated waste, including classification, processing, storage and disposal options.

A pre-requisite for this course is successful completion of Course 1 “Introduction to Nuclear Engineering”. Many of the fundamental nuclear engineering concepts introduced in Course 1 will be expanded upon in this course. Additionally, a grounding in chemistry, basic engineering principles and mathematical skills will be beneficial. A special tutorial on chemistry fundamentals will be provided if required.

Course Aims

This course is designed to give practical knowledge of the nuclear fuel cycle from the metallurgy of uranium to the disposition of used reactor fuel. It will provide details of current and future nuclear reactor designs for the generation of electricity and radioisotopes, their life cycle and decommissioning. 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 and nuclear technologies. The course also provides an insight into the principles and practices of waste management and 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

Learning Outcome	EA Stage 1 Competencies
5. Compare and contrast different reactor systems and different medical isotope production methods	PE1.4
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 will be delivered fully 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. Two main types of interactive activities will be used: self-moderated (tutor guided) asynchronous forum discussions, and online (synchronous) tutorials.

Assessment

Assessment Tasks

Assessment task	Weight	Due Date	Student Learning Outcomes Assessed
presentation	15%	by week 4	5
Self-moderated forum	10%	Not Applicable	4, 5, 6
quizzes	50%	test 1: between week 4-6, test 2: between week 7-10	1, 2, 3, 7, 8
assignment	25%	Week 11	4, 6

Assessment Details

Assessment 1: presentation

Start date: Not Applicable

Details:oral presentation of topic related to non-energy use of the nuclear fuel cycle

Additional details:

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 medical or engineering applications of radioisotopes, or about non-conventional reactor technology.

Individual assessment

Marks will be given for quality of content, quality of delivery, and level of interaction through Q&A and feedback.

Marks will be returned within 2 working days

Deadline for absolute fail: N/A

Assessment 2: Self-moderated forum

Start date: Not Applicable

Details:

A forum for discussion of controversial and topical issues related to the nuclear fuel cycles

Additional details:

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. The students are expected to provide a minimum of two interactions and 200 words per topic. The topic moderator will also be assessed on their ability to maintain a vibrant and respectful debate environment.

All marks are pass/fail and individual.

Marks will be returned at release of final results.

Deadline for absolute fail: N/A

Assessment 3: quizzes

Start date: Not Applicable

Details:two online quizzes

Additional details:

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.

These are individual tests

Marks will be returned within one week of each quiz completion.

Deadline for absolute fail: N/A

Assessment 4: assignment

Start date: Week 8

Details:take-home assignment

Additional details:

The final assignment with involve a case study and the students will need to provide their analysis in the form of an essay and/or by answering an online quiz. IT will involve both short and long answers. Mark will be assigned based on the completeness and correctness of the submission. Detailed instructions will be provide in the tutorials after week 6.

This is an individual assignment.

Marks will be returned with the release of final results.

Deadline for absolute fail: two weeks after the original deadline

Attendance Requirements

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

Course Schedule

View class timetable

Timetable

Date	Type	Content
O Week: 8 February - 12 February	Topic	Welcome, and administrative trouble-shooting
Week 1: 15 February - 19 February	Topic	Overview of the nuclear fuel cycle. Mining and milling
Week 2: 22 February - 26 February	Topic	Conversion to UF6 and enrichment
Week 3: 1 March - 5 February	Topic	Conversion to UO2 and nuclear fuel fabrication
Week 4: 8 March - 12 March	Topic	Current and future nuclear fuels.
Week 5: 15 March - 19 March	Topic	Used fuel storage and reprocessing
Week 6: 22 March - 26 March	Topic	Nuclearization of processes
Week 7: 29 March - 2 April	Topic	Separation of waste
Week 8: 5 April - 9 April	Topic	Wasteforms and storage
Week 9: 12 April - 16 April	Topic	Waste conditioning, storage and disposal
Week 10: 19 April - 23 April	Topic	Decommissioning, monitoring and remediation

Resources

Prescribed 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

Recommended Resources

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.

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.

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.

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

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. Class rosters will be attached to corresponding rooms and circulated among lab demonstrators. No over-enrolment is allowed in face-to-face class. 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

Important Links

- Moodle
- Lab Access
- Health and Safety
- Computing Facilities
- Student Resources
- Course Outlines
- Engineering Student Support Services Centre
- Makerspace
- UNSW Timetable
- UNSW Handbook
- UNSW Mechanical and Manufacturing Engineering
- Equitable Learning Services

Image Credit

Synergies in Sound 2016

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	