UNSW SYDNEY | Australia's Global University

Mechanical and Manufacturing Engineering

Course Outline

Term 2 2020

ENGG9743

Fuel Cycle, Waste and Life Cycle Management

Contents

1. Staff contact details

Contact details and consultation times for course convenor

Name: Dr. Patrick Burr
Office location: Room 402A, Ainsworth building (J17)
Email: p.burr@unsw.edu.au

The preferred point of contact is via Teams rather than via email, and whenever possible through the open class discussion forum – however private contact is also encouraged for sensitive matters. All email enquiries should be made from your student email address with ENGG9743 in the subject line; otherwise they may not be answered. Email queries may be answered in the learning platform to benefit all students.

Please see the course Moodle.

2. 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

3. Course details

Credit points

This is a 6 unit-of-credit (UoC) course and involves 3 hours per week (h/w) of scheduled online contact.

The normal workload expectations of a student are approximately 25 hours per term for each UOC, including class contact hours, other learning activities, preparation and time spent on all assessable work.

You should aim to spend about 10-12 h/w on this course. The additional time should be spent in making sure that you understand the lecture material, completing the set assignments, further reading, and revising for any examinations.

Contact hours

	Day	Time	Delivery Mode
Lectures	N/A	1-2 hrs/wk	Moodle Recorded Lectures
Tutorials	Wednesday weeks 1,3,5,7,9	5pm – 7pm	Teams video call
	asynchronous	1 hr/wk	Microsoft Teams Chat Channel

All classes in T2 2020 will be online. Please consult this course's Moodle module for details about delivery.

Summary and Aims 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 can be taken by students from Arizona State University via the PLuS Alliance scheme, and as an elective by 3rd or 4th year students from other schools and Faculties on the approval of home school and the ENGG9743 course convener.

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.

This course is designed to give in-depth, 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.

There is no mandatory pre-requisite for this course; however, it is essential that students are familiar with basic engineering principles and mathematical skills before this course is attempted. It is recommended that students take an introductory course to nuclear engineering (such as ENGG9741 or YENG9741) prior to taking this course to provide an understanding of nuclear fission. A grounding in chemistry and physics is also useful.

Student learning outcomes

This course is designed to address the learning outcomes below and the corresponding Engineers Australia Stage 1 Competency Standards for Professional Engineers as shown. The full list of Stage 1 Competency Standards may be found in Appendix A.

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	PE1.2, 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
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 (see Appendix B).

4. Teaching strategies

Delivery Mode

Fully online. The teaching in this course aims at establishing a good fundamental understanding of the areas covered using video recordings, reading materials, self-moderated (tutor guided) forum discussions, and online (synchronous) tutorials.

Learning in this course

You are expected to complete all online tasks, including watching videos, answering quizzes, attending tutorials, and engaging in forum discussions to maximise learning. In addition to the lecture notes/video, you should read relevant sections of the recommended text. Reading additional texts will further enhance your learning experience. Group learning

is also encouraged. UNSW assumes that self-directed study of this kind is undertaken in addition to attending face-to-face classes throughout the course. Learning materials and graded assessments will be paced throughout the duration of the course. As some of the assignments required group interaction, it is essential that you keep up with the pace of the course, and effectively manage your time in this course to view the material and complete the assignments on time.

Tutorial classes

You should attempt all of your problem sheet questions in advance of attending the synchronous tutorial sessions. The importance of adequate preparation prior to each tutorial cannot be overemphasized, as the effectiveness and usefulness of the tutorial depends to a large extent on this preparation. Group learning is encouraged. Answers for these questions will be discussed during the tutorial class and the tutor will cover the more complex questions in the tutorial class. In addition, during the tutorial class, 1-2 new questions that are not in your notes may be provided by the tutor, for you to try in class. These questions and solutions may not be made available on the web, so it is worthwhile for you to attend your tutorial classes to gain maximum benefit from this course.

5. Course schedule

Week	Topic	Delivery Mode	Suggested Readings
1	Overview of the nuclear fuel cycle. Mining and milling	Online	Class readings
2	Conversion to UF_6 and enrichment	Online	Class readings
3	Conversion to UO_2 and nuclear fuel manufacture	Online	Class readings
4	In-reactor fuel behaviour and future fuels	Online	Class readings
5	Used fuel reprocessing	Online	Class readings
6	Nuclearization of processes	Online	Class readings
7	Nuclear Wasteforms	Online	Class readings
8	Medical isotope production	Online	Class readings
9	Waste conditioning, storage and disposal	Online	Class readings
10	Decommissioning, monitoring and remediation	Online	Class readings

6. Assessment

Assessment overview

Assessment	Group Project? (# Students per group)	Length	Weight	Learning outcomes assessed	Assessment criteria	Due date and submission requirements	Deadline for absolute fail	Marks returned
Take-home test (2)	No	2 hours	60%	1, 2, 3, 5	Lecture material from weeks 1-3 (test 1) and weeks 4-7 (test 2)	Friday 5pm weeks 4 and 8	Wednesday weeks 5 and 9	One weeks after submission
Quiz	No	1 hour	15%	6, 7, 8	Lecture material from weeks 8-10 inclusive.	Friday 5pm week 10	N/A	Monday week 11
Final assignment	No	N/A	25%	2, 4, 5, 7	Completeness and correctness of response to problem, quality of report, understanding of course material from weeks 1-10.	Exam period, date TBC	N/A	Upon release of final results

Assignments

The assignments allow self-directed study leading to the solution of partly structured problems. The take-home tests will be made available 24 hours before submission is due, and will assess your understanding of the material presented in the 3-4 weeks immediately preceding the test, not including the week of the test itself. These will contain a few short (~ 10) answer questions and two problems that will test your ability to perform the relevant calculations, and provide critical analysis of their significance. The quiz will be assessible on the day it is due, and you will have 1 hour to complete it. The final assignment will be provided in weeks 9-10, and to be handed in during the exam period. The precise date will be confirmed in due course.

Presentation

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.

Submission

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:

a. Weekly online tests or laboratory work worth a small proportion of the subject mark, or
b. Online quizzes where answers are released to students on completion, or
c. Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date, or
d. Pass/Fail assessment tasks.

Marking

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.

Special consideration and supplementary assessment

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.

Please note that 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.

7. Expected resources for students

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

UNSW Library website: https://www.library.unsw.edu.au/
Moodle: https://moodle.telt.unsw.edu.au/login/index.php

8. Course evaluation and development

Feedback on the course is gathered periodically using various means, including the UNSW myExperience process, informal discussion in the final class for the course, 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.

In this course, recent improvements resulting from student feedback 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; diversity of guest lecturers from industry was retained; the self-moderated forum was a highly-appreciated feature of last year's delivery, thus it will be retained but with the following changes informed by student feedback: the discussion will be condensed into fewer days of the week and all marks associated with formative component have been removed in view of the small number of students this term.

9. 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

10. Administrative matters and links

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
- Equitable Learning Services

Appendix A: Engineers Australia (EA) Competencies

Stage 1 Competencies for Professional Engineers

	Program Intended Learning Outcomes
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
	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
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
PE3: Professional and Personal Attributes	PE3.1 Ethical conduct and professional accountability
	PE3.2 Effective oral and written communication (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

Appendix B: 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.