UNSW SYDNEY | Australia's Global University

Mechanical and Manufacturing Engineering

Course Outline

Term 1 2020

ENGG9741

Introduction to Nuclear Engineering

Contents

1. Staff contact details

Contact details and consultation times for course convenor

Name: Dr. Patrick Burr
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You are encouraged to ask questions on the course material after the lecture class times in the first instance, rather than via email. All email enquiries should be made from your student email address with ENGG9741 in the subject line, otherwise they may not be answered promptly.

Contact details and consultation times for additional lecturers/demonstrators/lab staff

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 4 hours per week (h/w) of face-to-face 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 10-11 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	Location
Lectures	Tuesday	5pm - 7pm	Ainsworth G02
Lectures, discussion, quizzes	Friday	5pm - 7pm	Ainsworth G01 (Week 11 – Ainsworth 102)
Video recording	Any	Any	Moodle

This course will be delivered through face-to-face lectures and discussion sessions. Please refer to your class timetable for the learning activities you are enrolled in and attend only those classes.

Summary and Aims of the course

The course aims to give students a firm grounding in subjects from radioactivity and nuclear fission to nuclear reactors, fuel production and processing through to nuclear materials, nuclear safety, socio-economic factors and future developments in nuclear engineering.

It is aimed at giving students the basic background knowledge, understanding and vocabulary that differentiates nuclear engineering from other engineering disciplines. In doing so, this course also provides the foundations for later courses on the Nuclear Engineering MEngSci stream.

The course will introduce a wide breadth of topics. These include nuclear fission, reactor physics and engineering, the historical context of nuclear engineering, the impact of radiation on matter, fuel fabrication and the fuel cycle, radioactive wastes and storage methods, reactor accidents, and nuclear safety and licensing.

Student learning outcomes

The high-level aims of the course are to enable you to

- Perform calculations related to nuclear reactions, reactor physics and nuclear safety.
- Evaluate real-world questions relating to nuclear engineering
- Deconstruct the issues that led to past reactor accidents and challenges of current new-build reactors

These high-level objectives will be achieved through the learning outcomes listed in the table below.

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	Understand the units and nomenclature used in nuclear engineering including radiation, radioactivity, particles and their interactions, radioactive decay.	PE1.1
2	Describe nuclear fissions including binding energy, the fission process and energy release and actinide yields.	PE1.1, PE1.2
3	Describe reactor physics and calculate fundamental parameters: the harnessing of energy, the roles of the moderator and the coolant, reactor dynamics, neutron life cycle, criticality and reactor transients.	PE1.1, PE1.2
4	Understand and describe the effects of radiation on matter including alpha, beta, gamma and neutrons, material defects, the origin of swelling and material degradation mechanisms.	PE1.1, PE1.2
5	Understand and describe basic reactor engineering concepts and designs.	PE1.1
6	Describe and compare the fundamental fuel cycles and fuel fabrication methods.	PE1.1
7	Define and classify nuclear waste and associated storage mechanisms.	PE1.1
8	Describe and discuss safety management and risk at nuclear sites.	PE1.1, PE1.5
9	Understand, analyze and differentiate the issues that led to past reactor accidents.	PE1.3, PE2.1

The learning outcomes of the course also address the following Competency Areas for a degree in Nuclear Technology Management, defined by the International Atomic Energy Agency (IAEA)'s International Nuclear Management Academy (INMA)*:

INMA Competency Area		Competency Level
1.1	Energy production, distribution and markets	1
1.8	Nuclear licensing, licensing basis and regulatory processes	1
2.1	Nuclear power plant and other facility design principles	1
2.2	Nuclear power plant/facility operational systems	1
2.6	Nuclear safety principles and analysis	1
2.7	Radiological safety and protection	1
2.8	Nuclear reactor physics and reactivity management	1
2.9	Nuclear fuel cycle technologies	1
3.17	Nuclear events and lessons learned	1
4.2	Ethics and values of a high standard	1

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

4. Teaching strategies

The main delivery mode will be face-to-face lectures and discussion sessions, augmented by video recording, reading material and exercises.

In the face-to-face lectures, the focus will chiefly be on delivery of the content, which is substantial and diverse.

The discussion session has a dual purpose: sometimes they will focus on applying the knowledge gained in the lectures to real-life nuclear engineering scenarios, as well as providing alternative explanations of key concepts introduced in the lectures. Other times they will be the means to introduce new examinable material that is best tackled through group discussion.

Prior to attending discussion sessions, it is important that you complete all reading material and/or attempt all problem sheets assigned for the discussion session. The importance of adequate preparation prior to each session cannot be overemphasized, as the effectiveness and usefulness of these classes depends to a large extent on this preparation.

You are expected to attend all lectures and discussion sessions in order 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.

5. Course schedule

Week	Day	Topic	Location	Time
1	Tue	Introduction, history, reactor fundamentals	AinswthG02	5-7 pm
1	Fri	Reactor designs	AinswthG01	5-7 pm
2	Tue	Guest lecture: Mark Ho (ANA), potential role for nuclear power in Australia	AinswthG02	5-7 pm
2	Wed	(Optional) Serhii Plokhy: Chernobyl and the Fall of the Soviet Union	Roundhouse 18:30-19:30	6:30 - 7:30 pm
3	Tue	Nuclear Fuel Cycle	AinswthG02	5-7 pm
3	Fri	Fuel in-reactor performance	AinswthG01	5-7 pm
4	Tue	Nuclear Physics	AinswthG02	5-7 pm
4	Fri	Radiation Fundamentals	AinswthG01	5-7 pm
5	Tue	Reactor Physics	AinswthG02	5-7 pm
5	Fri	Student Presentations	AinswthG01	5-7 pm
6	Tue	Reactor Kinetics	AinswthG02	5-7 pm
6	Fri	Thermo-hydraulics fundamentals	AinswthG01	5-7 pm
7	Tue	Nuclear Safety	AinswthG02	5-7 pm
7	Fri	Accidents: David Besse	AinswthG01	5-7 pm
8	Tue	Accidents: Chernobyl	AinswthG02	5-7 pm
9	Tue	Radiation Damage in Materials	AinswthG02	5-7 pm
9	Fri	Accidents: INES + TMI	AinswthG01	5-7 pm
10	Tue	Nuclear Waste and Waste Management	AinswthG02	5-7 pm
10	Fri	Accidents: Fukushima	AinswthG01	5-7 pm
11	Tue	Final revision tutorial	Ainswth102	5-7 pm

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
Group presentation	Yes (3-5)	15 min TBC in lectures	20%	5, 6	Presentation skills, teamwork, depth of understanding and level of engagement,	Friday 20th March	N/A	One week after submission
Quizzes	Yes (3-5)	20-30 min	30%	1-9	Lecture material from the preceding three weeks.	During class hours	N/A	One week after submission
Final exam	No	2 hours	50%	1-9	All course content from weeks 1-11 inclusive.	Exam period, date TBC	N/A	Upon release of final results

Examinations

You must be available for all quizzes, tests and examinations.

The exam in this course is a standard closed-book 2 hour written examination. The examination 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, unless specifically indicated otherwise by the lecturer. Marks will be assigned according to the correctness of the responses.

Final examinations for each course 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.

Calculators

You will need to provide your own calculator of a make and model approved by UNSW for the examinations. The list of approved calculators is available at student.unsw.edu.au/exam-approved-calculators-and-computers

It is your responsibility to ensure that your calculator is of an approved make and model, and to obtain an "Approved" sticker for it from the Engineering Student Supper Services Centre prior to the examination. Calculators not bearing an "Approved" sticker will not be allowed into the examination room.

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 sit 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

Video recording of lectures from the previous year are available on the course Moodle page.

Recommended reading material

Introduction to Nuclear Engineering
Author: Lamarsh and Baratta
ISBN 978-0201824988
Publisher Prentice Hall

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

Reactor Accidents
Author: David Mosey
ISBN 978-1903077450
Publisher Progressive Media Markets

Sustainable Energy, without the hot air
Author: Sir David CJ MacKay
ISBN: 978-0954452933
Publisher: Green Books
Digital version freely available from https://www.withouthotair.com/download.html

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

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 rescheduling classes to avoid 3-hour blocks ending at 9pm and increasing the number of questions and examples throughout the course. The syllabus and the learning outcomes have also been aligned with the IAEA International Nuclear Management Academy competency areas for masters' courses in Management of Nuclear Technology.

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