ENGG9741
Introduction to Nuclear Eng

Course Outline – Semester 1, 2016

Never Stand Still | Faculty of Engineering | School of Electrical Engineering and Telecommunications

Course Staff

Course Convener: Prof. John Fletcher, Room 701 E10, john.fletcher@unsw.edu.au
Lecturers: Prof. Robin Grimes, Dr. Mark Wenman

Consultations: 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 will not be answered.

Keeping Informed: Announcements may be made during classes, via email (to your student email address) and/or via online learning and teaching platforms – in this course, we will use Moodle https://moodle.telt.unsw.edu.au/login/index.php. Please note that you will be deemed to have received this information, so you should take careful note of all announcements.

Course Summary

Contact Hours

The course will be delivered in **intensive mode** over two weeks of weekday evening lectures (6-9pm) March 7-11 (week 2) and March 14-18 (week 3) in NEWT307. The subject will be supported by tutorial sheets and coursework assignments with staff support from the School of Electrical Engineering and Telecommunications.

Context and Aims

This course provides students with an introduction to the key elements of nuclear engineering. It is aimed at giving students the basic background knowledge, understanding and vocabulary to demonstrate what differentiates nuclear engineering from other engineering disciplines, and to understand later courses on the Nuclear Engineering MEngSci stream.

The course will introduce a variety of themes including 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 policy.

The material will be presented by a team of leading researchers in nuclear engineering. The course material is advanced in nature, due to its interdisciplinary content, its delivery in an intensive mode, and the breadth of topics covered. Hence, students taking this course must have the skills of an Honours level graduate engineer such that they are capable of undertaking self-directed reading and learning in engineering systems, performing individual research, and have the required maths and engineering skills.

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.

Assessment

Assignments (x2)	50%
Final Exam (2 hours)	50%

Course Details

Credits

This is a 6 UoC course and the expected workload is 30 hours per week during the intensive mode period with 10 hours per week after the completion of the intensive mode period.

Relationship to Other Courses

This is a postgraduate course convened by School of Electrical Engineering and Telecommunications. It is a core class on the MEngSci Nuclear Engineering specialization and can be taken as an elective by 3rd or 4th year students from other schools and faculties on the approval of home school and the ENGG9741 course convener.

Pre-requisites and Assumed Knowledge

It is essential that you are familiar with basic engineering principles and mathematical skills before this course is attempted. Prior understanding of nuclear fission is useful as is a grounding in chemistry and physics.

Following Courses

The course is a pre-requisite for ENGG9742, ENGG9743 and ENGG9744.

Learning outcomes

After successful completion of this course, you should be able to:

1. Be capable of correctly using the units and nomenclature of nuclear engineering including radiation, radioactivity, particles and their interactions, radioactive decay.

2. Describe and perform basic calculations related to nuclear fissions including binding energy, the fission process and energy release and actinide yields.

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.

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.

5. Understand and describe basic reactor engineering concepts and designs.

6. Describe and compare the fundamental fuel cycles and fuel fabrication methods.

7. Define and classify nuclear waste and associated storage mechanisms.

8. Describe and discuss safety management and risk at nuclear sites.

9. Understand, analyse and differentiate the issues that led to past reactor accidents.

This course is designed to provide the above learning outcomes which arise from targeted graduate capabilities listed in ***Appendix A***. The targeted graduate capabilities broadly support the UNSW and Faculty of Engineering graduate capabilities (listed in ***Appendix B***). This course also addresses the Engineers Australia (National Accreditation Body) Stage I competency standard as outlined in ***Appendix C***.

Syllabus

1. Introduction and history of nuclear engineering
2. Radiation fundamentals
3. Radiation damage
4. Reactor designs
5. Nuclear fuel
6. Waste management
7. Basic reactor physics
8. Reactor engineering
9. Nuclear safety
10. Reactor safety and accidents

Lecturers

Prof Robin Grimes: Since 2002 Robin has been Professor of Materials Physics at Imperial College and in 2013 was appointed the Foreign and Commonwealth Office Chief Scientific Advisor. He joined the Materials Department at Imperial College in 1995. Robin has authored over 240 peer-reviewed publications. He is currently a member of the editorial boards for Journal of Materials Science and Journal of Nuclear Materials. In 2002 he was awarded the Rosenhain Medal and in 2010 the Griffith Medal of the IOM3, of which society he is a Fellow. From 2008 until 2013 he was Director of the Imperial Centre for Nuclear Engineering and from 2010 to 2013 he was Director of the Imperial College Rolls Royce University Technology Centre in Nuclear Engineering. He was appointed Principal Investigator of the Research Councils Nuclear Champion consortium in 2010. In 2011 he was Specialist Advisor to the House of Lords Select Committee on Science and Technology for their report on Nuclear Research and Development Capabilities.

Dr Mark Wenman: Mark Wenman started work at Imperial College as the British Energy (now EDF Energy) Research Fellow in Nuclear Fuels at the beginning of Nov 2008. He obtained a 1st class degree in Materials Science and Technology (BEng) from the University of Birmingham between 1996-1999 and stayed at Birmingham University to carry out a PhD on the micromechanisms of fracture in the ductile-to-brittle transition region of BCC alloys. Having completed his PhD, in 2003, Mark was appointed as a Lecturer in the Reactor Engineering Group at the Nuclear Department, HMS Sultan in Gosport.

Teaching Strategies

Delivery Mode

The teaching in this course aims at establishing a good fundamental understanding of the areas covered using:

- Formal face-to-face lectures, which provide you with a focus on the core analytical material in the course, together with qualitative, alternative explanations to aid your understanding;
- Tutorials, which allow for exercises in problem solving and allow time for you to resolve problems in understanding of lecture material;

Learning in this course

You are expected to attend all lectures, and tutorials 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.

Tutorial classes

You should attempt all of your problem sheet questions in advance of attending the tutorial classes. 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.

Assessment

The assessment scheme in this course reflects the intention to assess your learning progress through the semester. Ongoing assessment occurs through assignment checkpoints.

Assignments

The assignments allow self-directed study leading to the solution of partly structured problems, essays and presentations. Marks will be assigned according to how completely and correctly the assignments have been addressed, and the understanding of the course material demonstrated by the report.

Assignment deadlines will be confirmed during the first week of intensive mode lectures.

Final Exam

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. *Please note that you must pass the final exam in order to pass the course.*

Course Resources

Textbooks

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. Reactor Accidents

Author: David Mosey

ISBN 978-1903077450

Publisher Progressive Media Markets

Lecture Video Sample

Samples of Professor Grimes Lectures can be viewed here:

http://youtu.be/G3ol5o5726Y

and

http://youtu.be/LdYtVfHinX0

On-line resources

Moodle

As a part of the teaching component, Moodle will be used to disseminate teaching materials. Assessment marks will also be made available via Moodle: https://moodle.telt.unsw.edu.au/login/index.php.

Mailing list

Announcements concerning course information will be given in the lectures and/or on Moodle and/or via email (which will be sent to your student email address).

Other Matters

Academic Honesty and Plagiarism

Plagiarism is the unacknowledged use of other people's work, including the copying of assignment works and laboratory results from other students. Plagiarism is considered a form of academic misconduct, and the University has very strict rules that include some severe penalties. For UNSW policies, penalties and information to help you avoid plagiarism, see http://www.lc.unsw.edu.au/plagiarism. To find out if you understand plagiarism correctly, try this short quiz: https://student.unsw.edu.au/plagiarism-quiz.

Student Responsibilities and Conduct

Students are expected to be familiar with and adhere to all UNSW policies (see https://my.unsw.edu.au/student/atoz/ABC.html), and particular attention is drawn to the following:

Workload

Students need to actively manage their workload particularly given the intensive mode delivery of this class and the long time between the end of the lectures and the examination. It is typically expected that you will spend at least **ten to twelve hours per week** studying a 6 UoC course, from Week 1 until the final assessment, including both face-to-face classes and *independent, self-directed study*. In periods where you need to need to complete assignments or prepare for examinations, the workload may be greater. Over-commitment has been a common source of failure for many students. You should take the required workload into account when planning how to balance study with employment and other activities.

Attendance

Regular and punctual attendance at all classes is expected. UNSW regulations state that if students attend less than 80% of scheduled classes they may be refused final assessment.

General Conduct and Behaviour

Consideration and respect for the needs of your fellow students and teaching staff is an expectation. Conduct which unduly disrupts or interferes with a class is not acceptable and students may be asked to leave the class.

Work Health and Safety

UNSW policy requires each person to work safely and responsibly, in order to avoid personal injury and to protect the safety of others.

Special Consideration and Supplementary Examinations

You must submit all assignments and attend all examinations scheduled for your course. You should seek assistance early if you suffer illness or misadventure which affects your course progress. All applications for special consideration must be **lodged online through myUNSW within 3 working days of the assessment**, not to course or school staff. For more detail, consult https://student.unsw.edu.au/special-consideration.

Continual Course Improvement

This course is under constant revision in order to improve the learning outcomes for all students. Please forward any feedback (positive or negative) on the course to the course convener or via the Course and Teaching Evaluation and Improvement Process. You can

also provide feedback to ELSOC who will raise your concerns at student focus group meetings. As a result of previous feedback obtained for this course and in our efforts to provide a rich and meaningful learning experience, we have continued to evaluate and modify our delivery and assessment methods.

Administrative Matters

On issues and procedures regarding such matters as special needs, equity and diversity, occupational health and safety, enrolment, rights, and general expectations of students, please refer to the School and UNSW policies:
http://www.engineering.unsw.edu.au/electrical-engineering/policies-and-procedures
https://student.unsw.edu.au/guide.

Appendix A: Targeted Graduate Capabilities

Electrical Engineering and Telecommunications programs are designed to address the following targeted capabilities which were developed by the school in conjunction with the requirements of professional and industry bodies:

- The ability to apply knowledge of basic science and fundamental technologies;
- The skills to communicate effectively, not only with engineers but also with the wider community;
- The capability to undertake challenging analysis and design problems and find optimal solutions;
- Expertise in decomposing a problem into its constituent parts, and in defining the scope of each part;
- A working knowledge of how to locate required information and use information resources to their maximum advantage;
- Proficiency in developing and implementing project plans, investigating alternative solutions, and critically evaluating differing strategies;
- An understanding of the social, cultural and global responsibilities of the professional engineer;
- The ability to work effectively as an individual or in a team;
- An understanding of professional and ethical responsibilities;
- The ability to engage in lifelong independent and reflective learning.

Appendix B: UNSW Graduate Capabilities

The course delivery methods and course content directly or indirectly addresses a number of core UNSW graduate capabilities, as follows:

- Developing scholars who have a deep understanding of their discipline, through lectures and solution of analytical problems in tutorials and assessed by assignments and written examinations.
- Developing rigorous analysis, critique, and reflection, and ability to apply knowledge and skills to solving problems. These will be achieved by the interactive checkpoint assignments and exams.

- Developing capable independent and collaborative enquiry, through a series of tutorials spanning the duration of the course.

Appendix C: Engineers Australia (EA) Professional Engineer Competency Standard

	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	✓