MANF4611

Process Modelling and Simulation

Term 2, 2022

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Erik van Voorthuysen	erikv@unsw.edu.au		ME507	9385 4147

Lecturers

Name	Email	Availability	Location	Phone
Ron Chan	r.chan@unsw.edu.au		ME507	9385 1535

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

The following assumed knowledge is expected for postgraduate students undertaking this course: MATH2089.

Manufacturing engineers routinely solve complex problems involving resource allocation, process and supply chain optimization, work and activity flow and balancing, machine capacity analysis and the planning of capital expenditure. Since simulation (particularly discrete event simulation) is increasingly used in industry, this course will place heavy emphasis on simulation and the statistical analysis of results. Simulation software used is Rockwell Arena ®.

One of the important aims of the course is to teach, coach and develop the ability to analyse real world systems by understanding the nature of the underlying process, the ability to abstract its behaviour, and to select appropriate quantitative techniques for modeling this behaviour with the goal of improving it.

Course Aims

The course aims to develop you into a skilled and all-rounded design engineer and operational analyst, able to carry out and manage the key design, operations and decision-making processes. Operations and design are inherently complex and a systematic, yet a flexible, agile and interdisciplinary approach is required to manage and improve complex systems.

The course teaches this approach, at the system and managerial levels, based on global best-practice methodologies, and incorporates case studies and projects, to apply these methodologies and become proficient at them. Key factors for success in modern engineering systems include efficient and effective allocation of resources, infrastructure, capacity and capital investment. Depending on the characteristics of the system, for example a product and its market, appropriate processes, resources, entity flows, layouts and systems need to be designed. The aim of this course is precisely that: the understanding, analysis, design and, to some extent, the optimisation of resourcing and processes in line with practical requirements and a constantly evolving set of task and operational requirements.

This course focuses on analytical techniques for decision making and solving complex process and resource allocation problems. It includes statistical characterisation and analysis of systems as well as the theory and use of discrete event simulation. It covers the essential mathematical, statistical and computer simulation techniques for modelling and analysing complex systems involving multiple variables, internal, external and disturbances. Depending on the scope of the system to be analysed and the nature of its behaviour, different analytical techniques apply. Specific techniques discussed include statistical and regression analysis and simulation using Rockwell Arena ® software.

The course is focused on analysing, modelling and finally understanding and solving complex systems under multiple constraints. These may be manufacturing systems, but they can also be service systems, transportation systems, in fact any system involving multiple entities, processes, resources and constraints.

Topics include:
• Discrete event simulation and associated analysis techniques, using Rockwell Arena© simulation software

• Design of experiment techniques
• Regression analysis
• Decision analysis

The course will combine lectures with practical case studies that require the theory taught to be applied to actual manufacturing and industrial systems.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Formulate a real world system or problem and select an appropriate analytical technique for modelling and ultimately solving or optimizing it.	PE1.2, PE2.1, PE3.2, PE3.4
2. Characterize the behavior of a system in terms of the nature of its variables, interactions using regression methods.	PE1.3, PE1.4
3. Apply design of experiment techniques to solve complex system performance problems.	PE1.2, PE2.3
4. Apply simulation techniques to solve complex system issues and to select feasible, if not optimum, solutions and configurations amongst competing designs.	PE1.2, PE1.3, PE1.6, PE2.1

Teaching Strategies

The course material will be presented in the form of lectures and associated book chapters and readings. Understanding will be supplemented by case studies and examples discussed in class. Deeper understanding will be achieved during formal tutorial/lab sessions where students work with tutors and lecturer to implement theory on assigned problems and cases using Microsoft Excel, SAS, Matlab and Rockwell Arena. The mid-session examinations will test the understanding of basic theory.

Additional Course Information

The following assumed knowledge is expected for postgraduate students undertaking this course: MATH2089.

Assessment

Assignments

Each part of the Assignment (3 parts) will involve a written submission. Details will be posted on Moodle. The final part of the assignment requires a write-up and this is due at the end of Week 10.
You need to ensure that you use both an appropriate writing style as well as professional formatting and editing of style and content in your report.
The assignments will be posted on Moodle and discussed in class (as shown in the teaching schedule) and the due dates shown are firm. The final report will be submitted electronically on Moodle by the end of week 10. The assignments support the learning outcomes by incorporating an appropriate mix of analytical techniques, enabling software, and data analysis that supports achievement of appropriate solutions.

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.

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. The following criteria will be used to grade Viva examinations (Detailed instructions will be posted on Moodle):

- The level of progress achieved by the team at Stages 1 and 2 of the assignment. Stage 1 focuses on understanding the process flow and logic (flow charts and documentation) as well as identifying the issues, aims and scope of the model. Stage 2 needs to deliver a model, coded in Arena, appropriately verified, validated and documented that will be the engine for generating data from appropriate scenarios that the team will test and analyse (and ultimately submit as Part 3 of the assignment).
- The quality of work produced by the team at each of these stages. This includes the correctness of the work produced, an appropriate level of detail and documentation.
- The contribution of each team member to the efforts of the team. Each team member will be expected to present his or her part of the work and answer questions by the examiner(s).
- The following criteria will be used to grade written assignments:
- Analysis and evaluation of requirements by integrating knowledge and methods learned in lectures and demonstrations
- Sentences in clear and plain English—this includes correct grammar, spelling and punctuation
- Correct referencing in accordance with the prescribed citation and style guide
- Appropriateness of engineering techniques and methodologies used
- Accuracy of numerical answers and comprehensiveness of methods and techniques employed
- Evidence of quality data and analysis-based decision making
- All working shown
- Use of diagrams, where appropriate, to support or illustrate the calculations
- Use of graphs, where appropriate, to support or illustrate the calculations
- Use of tables, where appropriate, to support or shorten the calculations
- Neatness

Examinations

The end-of-session exam will cover all material including the simulation part of the course. It will specifically examine statistical analysis, simulation theory and design of experiment (DOE).

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Flow chart, identification of issues and definition of scope of the problem.	15%	Week 3	1, 2, 4
2. Simulation Model Development, Verification and Validation	25%	Week 7	1, 2, 4
3. Final exam	20%	During the examination period in August 2021	1, 2, 3, 4
4. Design of Experiment, simulation, statistical analysis, recommendations and documentation.	40%	Week 10	1, 2, 3, 4

Assessment 1: Flow chart, identification of issues and definition of scope of the problem.

Due date: Week 3

The purpose of the first part of the assignment is to demonstrate an understanding of the process and to formulate issues to be investigated as part of a simulation model.

Assessment criteria

Each part of the Assignment (3 parts) will involve a written submission. Details will be posted on Moodle. The final part of the assignment requires a write-up and this is due at the end of Week 10.
You need to ensure that you use both an appropriate writing style as well as professional formatting and editing of style and content in your report.

The assignments will be posted on Moodle and discussed in class (as shown in the teaching schedule) and the due dates shown are firm. The final report will be submitted electronically on Moodle by the end of week 10. The assignments support the learning outcomes by incorporating an appropriate mix of analytical techniques, enabling software, and data analysis that supports achievement of appropriate solutions.

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.

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. The following criteria will be used to grade:

The level of progress achieved by the team at Stages 1 and 2 of the assignment.

Stage 1 focuses on understanding the process flow and logic (flow charts and documentation) as well as identifying the issues, aims and scope of the model.

Stage 2 needs to deliver a model, coded in Arena, appropriately verified, validated and documented that will be the engine for generating
data from appropriate scenarios that the team will test and analyse (and ultimately submit as Part 3 of the assignment).

The quality of work produced by the team at each of these stages. This includes the correctness of the work produced, an appropriate level of detail and documentation.
The contribution of each team member to the efforts of the team. Each team member will be expected to present his or her part of the work and answer questions by the examiner(s).
The following criteria will be used to grade written assignments:

- Analysis and evaluation of requirements by integrating knowledge and methods learned in lectures and demonstrations
- Sentences in clear and plain English—this includes correct grammar, spelling and punctuation
- Correct referencing in accordance with the prescribed citation and style guide
- Appropriateness of engineering techniques and methodologies used
- Accuracy of numerical answers and comprehensiveness of methods and techniques employed
- Evidence of quality data and analysis-based decision making
- All working shown
- Use of diagrams, where appropriate, to support or illustrate the calculations
- Use of graphs, where appropriate, to support or illustrate the calculations
- Use of tables, where appropriate, to support or shorten the calculations
- Neatness

Assessment 2: Simulation Model Development, Verification and Validation

Due date: Week 7
Marks returned: within two weeks of submission

The purpose of the second part of the assignment is to design and develop a simulation model using the Rockwell Arena (c) simulation software platform.

Assessment 3: Final exam

Start date: During formal exams August 2021
Assessment length: 2 hours
Submission notes: Online exam
Due date: During the examination period in August 2021

Final Examination to cover all material taught in the course

This is not a Turnitin assignment

Assessment 4: Design of Experiment, simulation, statistical analysis,

recommendations and documentation.

Due date: Week 10
Marks returned: Upon release of final results

The third and last part of the assignment involves using the model designed in part 2 to simulate different scenarios for the purpose of improving the behaviour and performance of the process.

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: 23 May - 27 May		
Week 1: 30 May - 3 June	Blended	**Lecture: Introduction to Process and Operations Modeling** • Characteristics of Processes and Operations • Flow Systems, Manufacturing Systems, Business Systems, Engineering Systems • What are Models and why build them o Stochastic Processes o Dynamic Models o Continuous – Discrete Time Models o Input, Output and Disturbance Variables • The Process of Modeling – start with a flowchart • Model Characteristics, scope and detail • Introduction to Operations Research • Introduction to Simulation and Rockwell Arena – a step through model • The Arena environment • Basic Arena constructs: Entity, Process, Resource, Queue **Tutorial: Live demonstration of model building** • Discussion of the major Assignment • Homework: Start working on Tutorial Set 1
Week 2: 6 June - 10 June	Blended	**Lecture: Random Variables and Probability Distributions** • Observing, Measuring and Analysing Random Behaviour • Binomial, Poisson, Geometric, Exponential, Normal Distribution • Fitting a Distribution and Goodness of Fit • Random Number Generators • Generating Random Observations • Stationary – non-Stationary Processes • Introduction to Arena Input Analyzer

		Tutorial: Introduction to Arena Input Analyser • Introduction to Minitab • On-going Arena support for Assignments • Homework: Start working on Tutorial Set 2
Week 3: 13 June - 17 June	Blended	**Lecture: Model Design** • Modeling Operations and Processes in Arena • Essential modules, elements and blocks • Flow Control in Arena: Decisions, Queues, Hold, Signal • Arena variables, logic control and expressions: Variables (TNOW, MREP, NREP), Attributes, Record, Assign, Expressions • Data collection inside Arena **Tutorial: On-going Arena support for Assignments** • Homework: Start working on Tutorial Set 3
	Assessment	Flow chart, identification of issues and definition of scope of the problem.
Week 4: 20 June - 24 June	Blended	**Lecture: Data Manipulation in Arena** • Reading and Writing Data between Arena and the outside world • Interfacing to Excel, ASCII files • Data manipulation • Verification and Validation **Tutorial: On-going Arena support for Assignments** • Homework: Start working on Tutorial Set 4
Week 5: 27 June - 1 July	Blended	**Lecture: Creating Simulation Scenarios, Generating Data and Analysis of Output** • The Arena debugging environment • Finite – Infinite Horizon Simulations • Effect of Initial Conditions, Warming-up Period • Comparison of Different System Configurations and Designs • Types of Statistical Variables • Within – Across Replication Statistics • Reducing variance

		Tutorial: On-going Arena support for Assignments
Week 6: 4 July - 8 July	Tutorial	**Flexibility Week**: Assignment Support on Microsoft Teams Chat Online
Week 7: 11 July - 15 July	Blended	**Lecture: Reporting and Documentation** • Reporting Statistics • Model layout and presentation • Model Documentation **Tutorial: On-going Arena support for Assignments**
	Assessment	Simulation Model Development, Verification and Validation
Week 8: 18 July - 22 July	Blended	**Lecture: Design of Experiment Theory (DOE) Part I** • Single factor experiments • Introduction to factorial designs • Introduction to DOE in Minitab **Tutorial: On-going Arena support for Assignments**
Week 9: 25 July - 29 July	Blended	**Lecture: Design of Experiment Theory (DOE) Part II** • Blockings in factorial design • Screening and characterization of models • Best practice in DOE **Tutorial: Minitab Tutorial on DOE Set 1** • On-going Arena support for Assignments
Week 10: 1 August - 5 August	Blended	**Lecture: Decision Analysis** • Overcoming risk and uncertainty • Decision Trees • Decision tables • Decision methods: Maximax, Maximin, Equally Likely • Expected monetary value • Value of information **Tutorial: Minitab Tutorial on DOE Set 2**

		• On-going Arena support for Assignments
	Assessment	Design of Experiment, simulation, statistical analysis, recommendations and documentation.

Resources

Prescribed Resources

The student version of Arena may be downloaded from:
https://www.arenasimulation.com/academic/students

Recommended Resources

References

1. Simulation modeling and analysis with Arena, Tayfur. Altiok Benjamin Melamed, Warren, N.J. : Cyber Research and Enterprise Technology Solutions, 2001. UNSW Library – High Use Collection.
2. Design and Analysis of Experiments, Douglas C. Montgomery, Wiley, 8th Edition, ©2013
3. Introduction to Linear Regression Analysis, Douglas C. Montgomery, Wiley, 5th Edition, ©2013
4. Simulation with Arena, W.D. Kelton, R.P. Sadowski and N.P. Zupick, 6th edition, McGraw Hill.
5. Simulation Modeling and Arena, M.D. Rossetti, John Wiley & Sons, 2009.
6. UNSW Library website: https://www.library.unsw.edu.au/
7. Moodle: https://moodle.telt.unsw.edu.au/login/index.php

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 improved tutorial and example models that align better with the requirements of the assignment. This will allow for faster and more efficient model development for all teams.

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 five percent (5%) 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. This is for all assessments where a penalty applies.

Work submitted after five days (120 hours) will not be 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 100 marks.
- You submit the assessment 2 days (or part thereof) late (i.e. from 24-48 hours after the deadline).
- The submission is graded and awarded a mark of 65/100.
- A late penalty of 10 marks is deducted from your awarded mark (2 days @ 5% of 100 marks).
- Your adjusted final score is 55/100.

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

****T2-2022 UPDATE****
- -

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 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

Note: This course outline sets out description of classes at the date the Course Outline is published. The nature of classes may change during the Term after the Course Outline is published. Moodle should be consulted for the up-to-date class descriptions. If there is any inconsistency in the description of activities between the University timetable and the Course Outline (as updated in Moodle), the description in the Course Outline/Moodle applies.

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	