School of Civil and Environmental Engineering

UNSW Engineering

# ENGG1400

## Engineering Infrastructure Systems

Term 2, 2022

# Course Overview

## Staff Contact Details

### Convenors

| Name | Email | Availability | Location | Phone |
|---|---|---|---|---|
| Elnaz Irannezhad | e.irannezhad@unsw.edu.au | Weeks 1 - 5 & 7 – 10: Physics Theatre | H20, Room 105 | +61432712822 |

## School Contact Information

Engineering Student Support Services – The Nucleus - enrolment, progression checks, 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

### 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)

# Course Details

## Units of Credit 6

## Summary of the Course

A course in optimization and modelling for first year engineering students who desire a higher capability in the application of the modelling of engineering systems, and seek to acquire a set of optimization tools that can be applied to various engineering applications. The course will introduce fundamental engineering systems concepts and methods with real-world projects related to critical contemporary issues. The course includes lectures on the following topics: complex systems, network modelling, system dynamics, optimization methods, infrastructure system design and behaviour and decision making.

This course in intended for first year engineering students.

## Course Aims

The aims of the course are:

- To reinforce a studentâ??s capability in infrastructure modelling with a view to and apply the concepts learned to the analysis of engineering systems.
- To introduce students to the fundamental optimization tools and concepts applied by engineers in advanced systems modelling.
- To abstract a complex technical system into quantitative models and/or qualitative frameworks that represent that system
- To analyse and optimize various engineering systems with the abstracted models
- Provide a foundation in modelling and optimization tools needed for their studies in the field of Engineering.

## Course Learning Outcomes

1. Develop an integrative holistic approach to problem-solving through systems-thinking methodologies used by engineers.
2. Abstract a complex technical system into quantitative models that represent that system to evaluate and compare effective design decisions.
3. Implement optimization methods to improve the performance of various infrastructure systems
4. Create justified solutions to real-world optimisation engineering problems using methods from discrete mathematics and economics.
5. Communicate the fundamental concepts and principles applied by engineers in advanced systems modelling.

| | **Program Intended Learning Outcomes** |
|---|---|
| **PE1: Knowledge and** | PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals |

| | |
|---|---|
| **Skill Base** | 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 |

## Teaching Strategies

The teaching strategies are:

- **Lectures** will focus on the development and application of high-level understanding of system modelling as applied to engineering and analysis of infrastructure systems.
- **Workshops/Sample Problem Demonstration** classes will concentrate on strategies for solving such problems and application by example.
- **WebCT** resources such as lecture material, examples, workshops and assignment problems and solutions, and links to other websites.

As the course is intended to impart intensive high-level foundation knowledge from lectures to students, a hybrid (both face to face and online) delivery mode will be adopted.

The teaching/learning activities are summarized in the following table:

Lectures

- Cover material to be learned for assessment tasks
- Follow worked examples
- Hear announcements on course changes

Workshops

- Practice solving set problems
- Hand on exercises using commercial software
- Be guided by demonstrators

- Ask questions

Private Study

- Review lecture material
- Preparation for the workshops and do set problems
- Reflect on class problems
- Study relevant references

Assessments (online quizzes, assignment, examinations)

- Demonstrate your knowledge and skills
- Demonstrate higher understanding and problem solving

# Assessment

**All assessments must be submitted on Moodle**

Failure to attend the quizzes will result in a mark of zero. Students who miss the assessment as a result of illness or unforeseen circumstances must apply for special considerations through **https://student.unsw.edu.au/special-consideration** and contact the course coordinator.

Students who perform poorly in the assignment and workshops are recommended to discuss progress with the lecturer during the term. The lecturer reserves the right to adjust the final scores by scaling if agreed to by the Head of School.

**The pass mark in this course is 50% overall, however, students must score at least 40% in the final examination in order to qualify for a Pass in this course. If below a 40% is scored on the Final Exam, the final exam mark will replace your course mark.**

Supplementary Examinations for Term 2 2022 will be held on Monday 5th September – Friday 9th September 2022 (inclusive) should you be required to sit one. You are required to be available during these dates. Please do not to make any personal or travel arrangements during this period.

| Assessment task | Weight | Due Date | Course Learning Outcomes Assessed |
|---|---|---|---|
| 1. Final Examination | 50% | Not Applicable | 1, 2, 3, 4, 5 |
| 2. Assignment (Group Project) | 20% | 02/08/2022 04:00 PM | 1, 2, 3, 4, 5 |
| 3. Mid-term Exam | 20% | 30/06/2022 07:30 PM | 1, 2, 3, 4, 5 |
| 4. Quiz 1 | 2% | 09/06/2022 06:00 PM | 1, 2, 3, 4, 5 |
| 5. Quiz 2 | 2% | 23/06/2022 06:00 PM | 1, 2, 3, 4, 5 |
| 6. Quiz 3 | 2% | 14/07/2022 06:00 PM | 1, 2, 3, 4, 5 |
| 7. Quiz 4 | 2% | 21/07/2022 06:00 PM | 1, 2, 3, 4, 5 |
| 8. Quiz 5 | 2% | 04/08/2022 06:00 PM | 1, 2, 3, 4, 5 |

## Assessment 1: Final Examination

**Assessment length:** 2 hours

The final written examination will be in the conventional closed book format covering all topics introduced throughout the course. The final examination will consists of a series of problems and focus on theoretical and methodological concepts presented within the lectures as well as within previous assessments. The final examination will assess the expected learning outcomes and will be assessed based on technical accuracy, clarity in reporting and presentation.

## Assessment 2: Assignment (Group Project)

**Start date:** 23/06/2022 04:00 PM
**Assessment length:** 6 weeks
**Submission notes:** Digital copies are expected to be submitted online via Turnitin by the due date. The last date of submitting the assignment is 2nd August 2022 at 4PM (Week 10). A late penalty of 10% per day will apply for failure to submit the assignment by the stated due date. Any reports submitted 5 or more days after the deadline will receive a mark of zero. Any duplicate submissions (or parts within) will receive a mark of zero. Students who plagiarize are also liable to disciplinary action, including exclusion from enrolment.
**Due date:** 02/08/2022 04:00 PM
**Deadline for absolute fail:** 04/08/2022 09:00 AM
**Marks returned:** 12/08/2022

The Assignment will be released in Week 4 and will be due in Week 10. The assignment will consists of a series of problems and focus on students solving infrastructure systems decision problems in AMPL presented during the course. The questions will be based on the material covered in lectures and workshop. It is intended to build on the skills developed in workshop and help prepare the students for the final examination.

Students are expected to work in groups of 3 or 4, and apply the theoretical knowledge gained during lectures and workshops to real world engineering problems. The group assignment will assess the expected learning outcomes in a practical setting and their team membership and leadership capabilities. The assignment will be assessed based on technical accuracy, clarity in reporting and presentation.

This assignment is submitted through Turnitin and students do not see Turnitin similarity reports.

**Assessment criteria**

The assignment will be assessed based on technical accuracy, clarity in reporting and presentation. A late penalty of 10% per day will apply for failure to submit the assignment by the stated due date. Any reports submitted 5 or more days after the deadline will receive a mark of zero. Any duplicate submissions (or parts within) will receive a mark of zero. Students who plagiarize are also liable to disciplinary action, including exclusion from enrolment.

## Assessment 3: Mid-term Exam

**Start date:** 30/06/2022 05:30 PM
**Assessment length:** 2 hours
**Due date:** 30/06/2022 07:30 PM
**Deadline for absolute fail:** 30/06/2022 07:30 PM
**Marks returned:** 01/07/2022

A mid-session exam will be administered on 30th of June 2022, Thursday, between 5:30PM and 7:30PM (Week 5). The exam will be based on the material covered in Week 1 to Week 4 Lectures/Workshops and is intended to assess student's knowledge of the expected learning outcomes, prepare students for the final exam, and discourage last-minute cramming.

**Assessment criteria**

The exam will be assessed on the technical merit and consistency of the methodology followed, with consideration given to the clarity of presentation. Students who plagiarise are also liable to disciplinary

action, including exclusion from enrolment.

## Assessment 4: Quiz 1

**Start date:** 09/06/2022 04:00 PM
**Submission notes:** Online Moodle Quiz
**Due date:** 09/06/2022 06:00 PM
**Deadline for absolute fail:** 09/06/2022 06:00 PM
**Marks returned:** 09/06/2022 06:00 PM

This quiz provides 2% of the course mark and will consist of small, customized problems covering the material introduced during the current week.

The weekly quizzes will assess the expected learning outcomes and will be assessed based on technical accuracy and participation. The Moodle quizzes will be open book, and are intended to help prepare the students for the final examination. The weekly assessments also provide a means for continuous assessment and feedback for students throughout the course.

**Assessment criteria**

The questions will be marked based on technical accuracy. Failure to complete a quiz within the accessible time period will result in a mark of zero. Each quiz will contribute to 2% of the course grade.

## Assessment 5: Quiz 2

**Start date:** 23/06/2022 04:00 PM
**Assessment length:** 2 hours
**Submission notes:** Online Moodle Quiz
**Due date:** 23/06/2022 06:00 PM
**Deadline for absolute fail:** 23/06/2022 06:00 PM
**Marks returned:** 23/06/2022 06:00 PM

This quiz provides 2% of the course mark and will consist of small, customized problems covering the material introduced during the current week.

The weekly quizzes will assess the expected learning outcomes and will be assessed based on technical accuracy and participation. The Moodle quizzes will be open book, and are intended to help prepare the students for the final examination. The weekly assessments also provide a means for continuous assessment and feedback for students throughout the course.

**Assessment criteria**

The questions will be marked based on technical accuracy. Failure to complete a quiz within the accessible time period will result in a mark of zero. Each quiz will contribute to 2% of the course grade.

## Assessment 6: Quiz 3

**Start date:** 14/07/2022 04:00 PM
**Assessment length:** 2 hours
**Submission notes:** Online Moodle Quiz

**Due date:** 14/07/2022 06:00 PM
**Deadline for absolute fail:** 14/07/2022 06:00 PM
**Marks returned:** 14/07/2022 06:00 PM

This quiz provides 2% of the course mark and will consist of small, customized problems covering the material introduced during the current week.

The weekly quizzes will assess the expected learning outcomes and will be assessed based on technical accuracy and participation. The Moodle quizzes will be open book, and are intended to help prepare the students for the final examination. The weekly assessments also provide a means for continuous assessment and feedback for students throughout the course.

**Assessment criteria**

The questions will be marked based on technical accuracy. Failure to complete a quiz within the accessible time period will result in a mark of zero. Each quiz will contribute to 2% of the course grade.

## Assessment 7: Quiz 4

**Start date:** 21/07/2022 04:00 PM
**Assessment length:** 2 hours
**Submission notes:** Online Moodle Quiz
**Due date:** 21/07/2022 06:00 PM
**Deadline for absolute fail:** 21/07/2022 06:00 PM
**Marks returned:** 21/07/2022 06:00 PM

This quiz provides 2% of the course mark and will consist of small, customized problems covering the material introduced during the current week.

The weekly quizzes will assess the expected learning outcomes and will be assessed based on technical accuracy and participation. The Moodle quizzes will be open book, and are intended to help prepare the students for the final examination. The weekly assessments also provide a means for continuous assessment and feedback for students throughout the course.

## Assessment 8: Quiz 5

**Start date:** 04/08/2022 04:00 PM
**Assessment length:** 2 hours
**Submission notes:** Online Moodle Quiz
**Due date:** 04/08/2022 06:00 PM
**Deadline for absolute fail:** 04/08/2022 06:00 PM
**Marks returned:** 04/08/2022 06:00 PM

This quiz provides 2% of the course mark and will consist of small, customized problems covering the material introduced during the current week.

The weekly quizzes will assess the expected learning outcomes and will be assessed based on technical accuracy and participation. The Moodle quizzes will be open book, and are intended to help prepare the students for the final examination. The weekly assessments also provide a means for continuous assessment and feedback for students throughout the course.

**Assessment criteria**

The questions will be marked based on technical accuracy. Failure to complete a quiz within the accessible time period will result in a mark of zero. Each quiz will contribute to 2% of the course grade.

## 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 | Lecture | Introduction to optimization problems and applications in infrastructure system analysis |
| | Workshop | Formulating infrastructure optimisation problems / Introduction to AMPL and Excel Solver |
| Week 2: 6 June - 10 June | Lecture | Transportation and resource allocation |
| | Workshop | First steps in AMPL: practice problems |
| | Assessment | Quiz 1: Online Moodle Quiz |
| Week 3: 13 June - 17 June | Lecture | Network optimisation: shortest path, minimum cost flow and network design |
| | Workshop | Shortest path and network flow problems: practice |
| Week 4: 20 June - 24 June | Lecture | Packing the knapsack and portfolio optimisation |
| | Workshop | Knapsack problem: practice |
| | Assessment | Quiz 2: Online Moodle Quiz |
| Week 5: 27 June - 1 July | Lecture | Facility location problem & Group project briefing |
| | Workshop | Facility location problem: practice |
| | Assessment | Mid-term Exam |
| Week 7: 11 July - 15 July | Lecture | Travelling salesman problem & Group project Q&A |
| | Workshop | Travelling salesman problem: practice |
| | Assessment | Quiz 3: Online Moodle Quiz |
| Week 8: 18 July - 22 July | Lecture | Solving constraint optimisation problems – the Lagrange Multiplier Method & Group project Q&A |
| | | |

| | | |
|---|---|---|
| | Workshop | Solving constraint optimisation problems: practice |
| | Assessment | Quiz 4: Online Moodle Quiz |
| Week 9: 25 July - 29 July | Lecture | Project scheduling: time is money |
| | Workshop | Scheduling problems: practice |
| Week 10: 1 August - 5 August | Lecture | Introduction to multi-objective optimisation & Course review |
| | Workshop | Multi-objective optimisation problems: practice |
| | Assessment | Assignment (Group Project): Digital copies are expected to be submitted online via Turnitin by the due date. The last date of submitting the assignment is 2nd August 2022 at 4PM (Week 10). A late penalty of 10% per day will apply for failure to submit the assignment by the stated due date. Any reports submitted 5 or more days after the deadline will receive a mark of zero. Any duplicate submissions (or parts within) will receive a mark of zero. Students who plagiarize are also liable to disciplinary action, including exclusion from enrolment. |
| | Assessment | Quiz 5: Online Moodle Quiz |

# Resources

## Prescribed Resources

Lecture Notes

## Recommended Resources

- Fourer, Robert, Gay, David M. and Brian W. Kernighan. *AMPL: A Modeling Language for Mathematical Programming,* Second edition, ISBN 0-534-38809-4. AMPL Chapters freely available: https://ampl.com/resources/the-ampl-book/chapter-downloads/
- Penn, Michael R. and Philip J. Parker. *Introduction to Infrastructure – An Introduction to Civil and Environmental Engineering*. John Wiley & Sons, Inc. 2011. ISBN : 978-0-470-41191-9
- Ravindra K. Ahuja Thomas L. Magnanti James B. Orlin. *Network flows : theory, algorithms, and applications.* Pearson new international edition., Harlow, Essex Pearson, 2014.

## Course Evaluation and Development

Based on the MyExperience feedback in the previous years, the contents of this course was slightly modified.

Additionally, a Google Form survey will be provided at the end of each lecture to collect the students' feedback and the collected feedback will be presented in the next session.

## Submission of Assessment Tasks

Please refer to the Moodle page of the course for further guidance on assessment submission.

**UNSW has a standard late submission penalty of:**

- 5% per day, for all assessments where a penalty applies, capped at five days (120 hours), after which a student cannot submit an assessment, and no permitted variation.

## Academic Honesty and Plagiarism

Beware! An assignment that includes plagiarised material will receive a 0% Fail, and students who plagiarise may fail the course. Students who plagiarise are also liable to disciplinary action, including exclusion from enrolment.

Plagiarism is the use of another person's work or ideas as if they were your own. When it is necessary or desirable to use other people's material you should adequately acknowledge whose words or ideas they are and where you found them (giving the complete reference details, including page number(s)). The Learning Centre provides further information on what constitutes Plagiarism at:

https://student.unsw.edu.au/plagiarism

# Academic Information

**Final Examinations:**

Final exams in T2 2022 will be held online between 12th - 25th August 2022 inclusive, and supplementary exams between 5th - 9th September 2022 inclusive. You are required to be available on these dates. Please do not to make any personal or travel arrangements during this period.

**ACADEMIC ADVICE**

- Key Staff to Contact for Academic Advice (log in with your zID and password): https://intranet.civeng.unsw.edu.au/key-staff-to-contact-during-your-studies-at-unsw
- Key UNSW Dates - eg. Census Date, exam dates, last day to drop a course without academic/financial liability etc.
- CVEN Student Intranet (log in with your zID and password): https://intranet.civeng.unsw.edu.au/student-intranet
- Student Life at CVEN, including Student Societies: https://www.unsw.edu.au/engineering/civil-and-environmental-engineering/student-life
- Special Consideration: https://student.unsw.edu.au/special-consideration
- General and Program-Specific Questions: The Nucleus: Student Hub
- Book an Academic Advising session: https://app.acuityscheduling.com/schedule.php?owner=19024765

# Disclaimer

*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

Mike Gal.

## CRICOS

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## Acknowledgement of Country

We acknowledge the Bedegal people who are the traditional custodians of the lands on which UNSW Kensington campus is located.