School of Civil and Environmental Engineering

Term 2, 2020

ENGG1400 ENGINEERING INFRASTRUCTURE SYSTEMS

COURSE DETAILS

Units of Credit	6
Contact hours	6 hours per week
Class	Tuesday, 11:00 – 13:00 Online
	Friday, 09:00 – 11:00 Online
Workshop	See http://timetable.unsw.edu.au/2020/ENGG1400.html

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INFORMATION ABOUT THE COURSE

This subject is targeted to students in the Faculty of Engineering desiring a greater understanding of how to model various complex systems, including critical infrastructure (e.g., telecommunications, water supply, and transport). This course will provide an introduction to the interdisciplinary concepts and approaches applied by engineers in advanced systems modelling. The expected outcomes of this course are reinforced capability in optimization theory with a view to apply the concepts learned to the analysis of engineering systems, the ability to implement mathematical models to represent, analyse and optimize various engineering systems, and gain the modelling and optimization tools needed for their studies in the field of Engineering.

HANDBOOK DESCRIPTION

A course in optimization and modelling for first year engineering students who desire a higher capability in the application of the mathematical modelling of engineering systems, and seek to acquire a set of optimization tools which 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, probability and statistics, optimization methods, infrastructure system design and behaviour and decision making. This course in intended for first year engineering students; it is available by application to the School of Civil and Environmental Engineering.
The URL of the course online handbook is:

https://www.handbook.unsw.edu.au/undergraduate/courses/2020/ENGG1400/

OBJECTIVES

Learning objectives of the course are:

1. To reinforce a student's capability in modelling and apply the concepts learned to the analysis of engineering systems.
2. To introduce students to the fundamental optimization tools and concepts applied by engineers in advanced systems modelling.
3. To abstract a complex technical system into quantitative models and/or qualitative frameworks that represent that system.
4. 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.

TEACHING STRATEGIES

The following teaching/learning strategies will be used the course.

Private Study	Review lecture material and textbook Do set problems and assignments Reflect on class problems and assignments
Lectures	Find out what you must learn See methods that are not in the textbook Follow worked examples
Workshops	Be guided by demonstrators Practice solving set problems Ask questions
Assessments (assignments)	Demonstrate your knowledge and skills Demonstrate higher understanding and problem solving

EXPECTED LEARNING OUTCOMES

By successfully completing this course you will be able to

Learning Outcomes		EA Stage 1 Competencies*
1.	Develop an integrative holistic approach to problem-solving through systems-thinking methodologies used by engineers	PE1.1, PE1.2, PE1.5.
2.	Abstract a complex technical system into quantitative models that represent that system to evaluate and compare effective design decisions	PE1.2, PE1.3, PE1.5, PE3.6.
3.	Implementing optimisation methods to improve the performance of various infrastructure systems	PE2.1, PE2.3, PE2.4, PE3.6.
4.	Create justified solutions to real-world optimisation engineering problems using methods from discrete mathematics and economics	PE2.1, PE2.3, PE2.4, PE3.3, PE3.4.
5.	Communicate the fundamental concepts and principles applied by engineers in advanced systems modelling	PE2.1, PE2.3, PE2.4, PE3.2, PE3.3, PE3.4

For each hour of contact it is expected that you will put in at least 1.5 hours of private study.

COURSE PROGRAM

Term 2 2020

Date	Lecture 1 Content	Lecture 2 Content	Demonstration Content
01/06/2020 (Week 1)	Introduction to infrastructure systems and optimization	Introduction to linear and integer programming	Linear and integer programming: practice
08/06/2020 (Week 2)	Introduction to AMPL: A Mathematical Modelling and Programming language	Transportation and Assignment Problems	First steps in AMPL: practice problems
15/06/2020 (Week 3)	Finding the best path: routing in networks	Network optimisation: minimum cost flow and network design	Shortest path and network flow problems: practice
22/06/2020 (Week 4)	Packing the knapsack	Portfolio optimisation	Knapsack problem: practice
29/06/2020 (Week 5)	Where should we open shop? Facility location	Group project introduction session	Facility location problem: practice
06/07/2020 (Week 6)		***Non-teaching week for all courses***	
13/07/2020 (Week 7)	Assignment 1 review	Group project Q&A	Group project catch-up
20/07/2020 (Week 8)	The travelling salesman problem	The vehicle routing problem	The vehicle routing problem: practice
27/07/2020 (Week 9)	Guest lecture	Time is money	Scheduling problems: practice
03/08/2020 (Week 10)	Introduction to multi-objective optimisation	Assignment 2 (group project) & course review	Multi-objective optimisation problems: practice
10/08/2020 (Week 11)		***Make up week for courses affected by Public Holidays***	

ASSESSMENT

The final grade for this course will be based on the sum of the scores from the assignments and the final examination. For the values of the single components see the table below:

Strand	Assessment	Weighting	Assessment Criteria
1	Moodle Quizzes (Weeks 1-10)	10%	Weekly online quizzes will be administered via Moodle. The Moodle quizzes will be based on the material covered in lectures and workshops. 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. The questions will be marked based on technical accuracy. There will be 10 quizzes in total, one administered every week which will be accessible on every Wednesday 4.00pm. Failure to complete a quiz within the accessible time period (2 days) will result in a mark of zero. Each quiz will contribute to 1% of the course grade.
1	Assignment 1	20%	The first assignment is worth 20% of the course grade. 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. The assignment will be assessed on the technical merit and consistency of the methodology followed, with consideration given to the clarity of presentation. Digital copies are expected to be submitted online via Turnitin by the due date. Students may discuss the problem set questions in general terms, and benefit from the insights of their peers; however each student must present their own solution. Assignment 1 will be released at 4:00pm on Friday 21 June (Week 3) and due by 4pm on Friday 12 July (Week 6) 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.
2	Assignment 2 (Group Project)	20%	The second assignment is a group project worth 20% of the course grade. 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. Digital copies are expected to be submitted online via Turnitin by the due date. 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. Assignment 2 will be released at 4pm on Friday 19 July (Week 7) and due by 4pm on Friday 9 August (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

Strand	Assessment	Weighting	Assessment Criteria
			submissions (or parts within) will receive a mark of zero. Students who plagiarize are also liable to disciplinary action, including exclusion from enrolment.
3	Final Examination	50%	The final written examination will be in the conventional closed book format covering all topic areas. The formal exam scripts will not be returned. The lecturer reserves the right to adjust the final scores. 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.

ASSESSMENT OVERVIEW

Item	Length	Weight	Learning outcomes assessed	Release Date	Due date	Deadline for absolute fail	Marks returned
Moodle Quizzes							
Quiz 1 (week 1)	1 day	1%	1,2,3,4	Fri, 5th June 11:00	Mon, 8th June 11:00	Mon, 8th June 11:00	Mon, 8th June 11:00
Quiz 2 (week 2)	1 day	1%	1,2,3,4	Fri, 12th June 11:00	Mon, 15th June 11:00	Mon, 15th June 11:00	Mon, 15th June 11:00
Quiz 3 (week 3)	1 day	1%	1,2,3,4	Fri, 19th June 11:00	Mon, 22nd June 11:00	Mon, 22nd June 11:00	Mon, 22nd June 11:00
Quiz 4 (week 4)	1 day	1%	1,2,3,4	Fri, 26th June 11:00	Mon, 29th June 11:00	Mon, 29th June 11:00	Mon, 29th June 11:00
Quiz 5 (week 5)	1 day	1%	1,2,3,4	Fri, 3rd July 11:00	Mon, 6th July 11:00	Mon, 6th July 11:00	Mon, 6th July 11:00
Quiz 6 (week 6)	1 day	1%	1,2,3,4	Fri, 10th July 11:00	Mon, 13th July 11:00	Mon, 13th July 11:00	Mon, 13th July 11:00
Quiz 7 (week 7)	1 day	1%	1,2,3,4	Fri, 17th July 11:00	Mon, 20th July 11:00	Mon, 20th July 11:00	Mon, 20th July 11:00
Quiz 8 (week 8)	1 day	1%	1,2,3,4	Fri, 24th July 11:00	Mon, 27th July 11:00	Mon, 27th July 11:00	Mon, 27th July 11:00
Quiz 9 (week 9)	1 day	1%	1,2,3,4	Fri, 31st July 11:00	Mon, 3rd Aug 11:00	Mon, 3rd Aug 11:00	Mon, 3rd Aug 11:00
Quiz 10 (week 10)	1 day	1%	1,2,3,4	Fri, 7th Aug 11:00	Mon, 10th Aug 11:00	Mon, 10th Aug 11:00	Mon, 10th Aug 11:00
Major Assessments							
Assignment 1	3 weeks	20%	1,2,3,4,5	Tue, 16th June 11:00	Tue, 7th July 11:00	Fri, 10th July 9:00	Tue, 14th July
Assignment 2 (group project)	3 weeks	20%	1,2,3,4,5	Tue, 14th July 11:00	Tue, 4th Aug 11:00	Fri, 7th Aug 9:00	Tue, 11th Aug
Final Exam	2 hours	50%	1,2,3,4,5		TBD (Refer to myUNSW)	N/A	N/A

All assessments must be submitted on Moodle

Supplementary Examinations for Term 2 2020 will be held 7th – 11th September 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.

PENALTIES

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.

RELEVANT RESOURCES

Textbooks (**recommended as reference**)

- Fourer, Robert, Gay, David M. and Brian W. Kernighan. *AMPL: A Modeling Language for Mathematical Programming,* Second edition, ISBN 0-534-38809-4.
- Larson, Richard C., and Amedeo R. Odoni. *Urban Operations Research*. Prentice Hall, 1981. Available at: http://web.mit.edu/urban_or_book/www/book/
- 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
- Sussman, Joseph. *Complex Sociotechnical Systems (CSS): Some Fundamental Concepts.*
- Sterman, John D. *Business Dynamics: Systems Thinking and Modeling for a Complex World.* Irwin/McGraw-Hill, 2000. ISBN: 9780072389159.
- Martland, Carl D. *Toward More Sustainable Infrastructure: Project Evaluation for Planners and Engineers*. 1st ed. Wiley, 2011. ISBN: 9780470448762.
- Churchman, Charles West. "Thinking." Chapter 1 in *The Systems Approach*. New York, NY: Delacorte Press, 1979. ISBN: 9780385289986.
- Perrow, Charles. "Complexity, Coupling, and Catastrophe." Chapter 3 in *Normal Accidents: Living with High-risk Technologies*. Princeton, NJ: Princeton University Press, 1999. ISBN: 9780691004129
- AMPL Chapters freely available: https://ampl.com/resources/the-ampl-book/chapter-downloads/

DATES TO NOTE

Refer to MyUNSW for Important Dates available at: https://student.unsw.edu.au/dates

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 ADVICE

(Formerly known as Common School Information)

For information about:

- Notes on assessments and plagiarism,
- School policy on Supplementary exams,
- Special Considerations: student.unsw.edu.au/special-consideration
- Solutions to Problems,
- Year Managers and Grievance Officer of Teaching and Learning Committee, and
- CEVSOC.

Refer to Academic Advice on the School website available at: https://www.engineering.unsw.edu.au/civil-engineering/student-resources/policies-procedures-and-forms/academic-advice

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