School of Civil and Environmental Engineering

Term 2, 2021

ENGG1400 ENGINEERING INFRASTRUCTURE SYSTEMS

COURSE DETAILS

Units of Credit	6	
Contact hours	6 hours per week	
Class	Tuesday, 17:00 – 20:00	Weeks 1 - 5 & 7 – 10: Online through Blackboard Collaborate Ultra
Workshop	Thursday, 10:00 – 13:00 or 13:00 – 16:00	Weeks 1 - 5 & 7 – 10: Online through Blackboard Collaborate Ultra
Course Coordinator & Lecturer	Divya Jayakumar Nair email: divya.nair@unsw.edu.au office: Room 103, H20	
Lecturer	David Rey email: d.rey@unsw.edu.au office: Room 105, H20	

INFORMATION ABOUT THE COURSE

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.

This course 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

See link to virtual handbook:

https://www.handbook.unsw.edu.au/undergraduate/courses/2021/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 textbooks • Do set problems and assignments • Use Moodle for discussions • Download class notes from Moodle if not collected during classes • Reflect on class problems and assignments
Lectures	• Find out what you must learn • See methods that are not in the textbook • Follow worked examples • Hear announcements on course changes
Workshops	• Be guided by demonstrators • Practice solving set problems • Ask questions
Assessments	• 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 2021

Date	Lecture Content	Demonstration Content
01/06/2021 (Week 1)	Introduction to linear and integer programming	Linear and integer programming: practice / Introduction to AMPL
08/06/2021 (Week 2)	Transportation and assignment problems	First steps in AMPL: practice problems
15/06/2021 (Week 3)	Network optimisation: shortest path, minimum cost flow and network design	Shortest path and network flow problems: practice
22/06/2021 (Week 4)	Packing the knapsack and portfolio optimisation	Knapsack problem: practice
01/07/2021 (Week 5)	Facility location problem & Group project briefing	Facility location problem: practice
06/07/2021 (Week 6)	***Non-teaching week for all courses***	
13/07/2021 (Week 7)	Travelling salesman problem & Group project Q&A	Travelling salesman problem: practice
20/07/2021 (Week 8)	Vehicle routing problem & Group project Q&A	The vehicle routing problem: practice
27/07/2021 (Week 9)	Project scheduling: time is money	Scheduling problems: practice
03/08/2021 (Week 10)	Introduction to multi-objective optimisation: transit route design & Course review	Multi-objective optimisation problems: practice

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	10%	Weekly online quizzes will be administered via Moodle during weeks 2, 4, 7, 8 and 10. Moodle quiz will be available on Thursdays' between 4PM and 6PM. 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. 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.
2	Mid-term Exam	20%	A mid-session exam will be administered on 29th of June 2021, Tuesday, between 5:30PM and 7:30PM (Week 5- Lecture). 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. 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 plagiarize are also liable to disciplinary action, including exclusion from enrolment.
3	Assignment (Group Project)	20%	The 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. The last date of submitting the assignment is 3rd August 2021 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.
4	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 2 (week 2)	2 hours	2%	1,2,3,4	Thursday, 10th June 16:00	Thursday, 10th June 18:00	Thursday, 10th June 18:00	Thursday, 10th June 18:00
Quiz 4 (week 4)	2 hours	2%	1,2,3,4	Thursday, 24th June 16:00	Thursday, 24th June 18:00	Thursday, 24th June 18:00	Thursday, 24th June 18:00
Quiz 7 (week 7)	2 hours	2%	1,2,3,4	Thursday, 15th July 16:00	Thursday, 15th July 18:00	Thursday, 15th July 18:00	Thursday, 15th July 18:00
Quiz 8 (week 8)	2 hours	2%	1,2,3,4	Thursday, 22nd July 16:00	Thursday, 22nd July 18:00	Thursday, 22nd July 18:00	Thursday, 22nd July 18:00
Quiz 10 (week 10)	2 hours	2%	1,2,3,4	Thursday, 5th Aug 16:00	Thursday, 5th Aug 18:00	Thursday, 5th Aug 18:00	Thursday, 5th Aug 18:00
Major Assessments							
Mid-term Exam	2 hours	20%	1,2,3,4,5	Tuesday, 29th Jun 17:30	Tuesday, 29th Jun 19:30	Tuesday, 29th Jun 19:30	Friday, 9th July
Assignment (group project)	3 weeks	20%	1,2,3,4,5	Tuesday, 13th July 16:00	Tuesday, 3rd Aug 16:00	Thursday, 5th Aug 9:00	Friday, 13th 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

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 2021 will be held on Monday 6th September – Friday 10th September 2021 (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

For information about:

- Notes on assessments and plagiarism;
- Special Considerations: student.unsw.edu.au/special-consideration;
- General and Program-specific questions: The Nucleus: Student Hub
- Year Managers and Grievance Officer of Teaching and Learning Committee, and
- CEVSOC/SURVSOC/CEPCA

Refer to Key Contacts on the Faculty website available at:

https://www.unsw.edu.au/engineering/student-life/student-resources/key-contacts

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