UNSW AUSTRALIA

Course Outline

Semester 2 2015

Never Stand Still | Engineering | Mechanical and Manufacturing Engineering

MTRN 4030

OPTIMISATION METHODS FOR ENGINEERING SYSTEMS

Contents

1. Staff Contact Details

Contact details and consultation times for course convenor

Dr Ngai Ming Kwok
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Consultation concerning this course is available by appointments made through email.

Contact details and consultation times for additional lecturers/demonstrators/lab staff

TBA

2. Course details

Credit Points

This is a 6 unit-of-credit (UoC) course, and involves <insert hours> hours per week (h/w) of face-to-face contact.

The UNSW website states “The normal workload expectations of a student are approximately 25 hours per semester for each UoC, including class contact hours, other learning activities, preparation and time spent on all assessable work. Thus, for a full-time enrolled student, the normal workload, averaged across the 16 weeks of teaching, study and examination periods, is about 37.5 hours per week.”

This means that you should aim to spend about 9 h/w on this course. The additional time should be spent in making sure that you understand the lecture material, completing the set assignments, further reading, and revising for any examinations.

There is no parallel teaching in this course.

Contact Hours

All lectures in this course are given on Week 1 to Week 12, Tue 4pm – 6pm Colombo Theatre B (K-B16-LG04). Demonstrations and laboratory exercises are scheduled on Week 2 to week 13, Wed 9am – 11am MechEng 203/204 (room according to your enrolled lab class).

	Day	**Time**	**Location**
Lectures (week 1 – 12)	Tuesday	4pm – 6pm	Colombo Theatre B (K-B16-LG04)
Demonstrations	Wednesday	9am – 11am	MechEng Room 203/204

(week 2 – 13)			(K-J17-203/204)

Summary of the Course

This course will enable students to acquire an understanding of optimisation concepts in engineering system designs and will explore these ideas of optimisation algorithms in mechanical, manufacturing, and mechatronic system.

Aims of the Course

This course aims to enables you to explore the theories and concepts from the viewpoint of the application of optimisation methods in engineering systems. The course will give you tools in the design of engineering systems for optimum characteristics. Example cases will be focused on mechanical system design, manufacturing task scheduling and robotics trajectory planning.

The course also provides you with the concepts employed in the development of classical optimisation methods and metaheuristic optimisation approaches. You will be provided with insights into the advantages and disadvantages of these methods when they are applied to solve engineering problems.

This course will further develop your computer based skills in implementing and developing algorithms to solve engineering optimisation problems. You will improve your Matlab programming techniques through laboratory based exercise. Your understanding of numerical methods, learned in MATH2089 (or equivalent), will be further enhanced. The assignments also build on the report-writing skills which you commenced in ENGG1000.

Student learning outcomes

This course is designed to address the below learning outcomes and the corresponding Engineers Australia Stage 1 Competency Standards for Professional Engineers as shown. The full list of Stage 1 Competency Standards may be found in Appendix A.

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

Learning Outcome		**EA Stage 1 Competencies**
1.	Master the theory and concept of optimisation techniques to engineering systems design, and to critically evaluate and apply for specific engineering problems.	PE1.1, 1.3, 1.5, 2.1, 2.2
2.	Understand the essences of classical optimisation methods, and metaheuristic optimisation algorithms. These include unconstrained and constrained optimisations, agent based and nature inspired approaches.	PE1.1, 1.3

3.	Develop computer programs to implement and analyse optimisation approaches in the engineering context. Apply learned programming skills to develop computer programs for optimisation.	PE1.1, 1.3, 1.5, 2.1, 2.2
4.	Apply numerical techniques to complete the design of engineering systems for optimum performances. Implement optimisation knowledge in the designs for mechanical, manufacturing and robotic systems.	PE1.1, 1.3, 1.5, 2.1, 2.2, 2.3

3. Teaching strategies

Lectures in the course are designed to cover the terminology, core concepts and theories in the optimum design of engineering systems. They do not simply reiterate the texts, but build on the lecture topics using examples to show how the theory is applied in practice and the details of when, where and how it should be applied.

The work in laboratory exercises involves self-directed work, in being theoretically sound in the design of your optimisation algorithms. It also allows you to integrate your theoretical basics into the construction of computer programs to solve optimisation problems. These include the optimisation of mechanical system designs, robotics motion/trajectory control optimisation, and the optimisation of manufacturing schedules.

Lectures and laboratory exercises are supported by current scientific publications as a means to let you explore the development in the field of engineering optimisation. Thus, literature readings and pre-laboratory preparations are strongly recommended.

Suggested approaches to learning in this course include:

- Careful reading, discussion and understanding of the material presented in lectures.
- Additional reading on and about the material presented in lectures to broaden the knowledge base.
- Paying attention throughout the lectures/demonstrations, and asking questions when anything is not understood.
- Conscientiously working through exercises/assignments.

4. Course schedule

Topic	**Date**	**Location**	**Lecture Content**	**Suggested Readings***
Introduction	28/07/15	Colombo Theatre B	Introduction to optimisation	Chp1, 2
Mathematical foundations	04/08/15	Colombo Theatre B	Mathematical foundations	Chp 3

Classic optimisation 1	11/08/15	Colombo Theatre B	Unconstrained. constrained, gradient-based optimisation, linear programming	Chp 4
Classic optimisation 2	18/08/15	Colombo Theatre B	Simplex, nonlinear, penalty, Lagrange multiplier, Karush-Kuhn-Tucker condition	Chp 4
Modern optimisation 1	25/08/15	Colombo Theatre B	Modern optimisation methods, optimal control	Chp 5, 7
Modern optimisation 2	01/09/15	Colombo Theatre B	Monte Carlo method, random walk	Chp 9
Metaheuristic 1	08/09/15	Colombo Theatre B	Markov chain, genetic algorithms	Chp 10, 11
Metaheuristic 2	15/09/15	Colombo Theatre B	Simulated annealing, ant algorithms	Chp 12, 13
Metaheuristic 3	22/09/15	Colombo Theatre B	Bee algorithm, particle swarm optimisation	Chp 14, 15
Metaheuristic 4	06/10/15	Colombo Theatre B	Harmony search, firefly algorithm	Chp 16, 17
Multi-objective optimisation	13/10/15	Colombo Theatre B	Multi-objective optimisation	Chp 18
Revision	20/10/15	Colombo Theatre B	Revision	

*Suggested Reading: X.S. Yang, “Engineering Optimisation: An Introduction with Metaheuristic Applications,” John Wiley & Sons, 2010. (available from UNSW library as ebook)

Topic	**Date**	**Location**	**Demonstration/Lab Content**	**Suggested Readings**
Exercise 1	05/08/15	MechEng 203/204	Matlab programming - review	Lab instructions
Exercise 1	12/08/15	MechEng 203/204	Matlab based optimisation programming	Lab instructions
Exercise 2	19/08/15	MechEng 203/204	Mechanical system optimisation – 1	Lab instructions
Exercise 2	26/08/15	MechEng 203/204	Mechanical system optimisation – 2	Lab instructions
Exercise 2	02/09/15	MechEng 203/204	Mechanical system optimisation – 3	Lab instructions
Exercise 3	08/09/15	MechEng 203/204	Robotic system optimisation – 1	Lab instructions
Exercise 3	16/09/15	MechEng 203/204	Robotic system optimisation – 2	Lab instructions
Exercise 3	23/09/15	MechEng 203/204	Robotic system optimisation – 3	Lab instructions
Exercise 4	07/10/15	MechEng 203/204	Production schedule optimisation – 1	Lab instructions
Exercise 4	14/10/15	MechEng 203/204	Production schedule optimisation – 2	Lab instructions
Exercise 4	21/10/15	MechEng 203/204	Production schedule optimisation – 3	Lab instructions
Revision	28/10/15	MechEng 203/204	Revision	

5. Assessment

The assessment of this course consists of two components: laboratory exercise/reports and examination. Laboratory instructions will be available on Moodle. There will be four laboratory exercises and two written reports. Exercises mark-off dates and laboratory report due dates are given in the table below. Reports are to be submitted to Moodle. You will be assessed on the basis of your understanding of the theories and your practical abilities to complete the tasks in the exercises/assignments. Exercise dependent assessment criteria will be given in the laboratory instructions.

Assessment task	**Length**	**Weight**	**Learning outcomes assessed**	**Assessment criteria**	**Due date, time, and submission requirements**
Lab practical work	2hr/week	20% (5% each for exercise 1, 2, 3, 4)	1, 2, 3 and 4	Understanding of lecture material	At end of laboratory meetings
Laboratory report	6 pages	20% (10% for exercise 2, 3)	1, 2, 3 and 4	Technical content, design capability and report writing skills	Exercise 2: midnight, Friday, 11/09/2015, submit via Moodle Exercise 3: midnight, Friday, 10/10/2015, submit via Moodle
Final exam	2 hours	60%	1, 2, 3 and 4	All course content from weeks 1-12	Exam period, date TBC

Assignments

Presentation

All submissions should have a standard School cover sheet which is available from this subject's Moodle page.
All submissions are expected to be neat, and clearly set out. Your results are the pinnacle of all your hard work. Presenting them clearly gives the marker the best chance of understanding your method; even if the numerical results are incorrect.

Submission

Late submissions will be penalised 5 marks per calendar day (including weekends). An extension may only be granted in exceptional circumstances. Where an assessment task is worth less than 20% of the total course mark and you have a compelling reason for being unable to submit your work on time, you must seek approval for an extension from the course convenor ***before the due date***. Special consideration for assessment tasks of 20% or greater must be processed through https://student.unsw.edu.au/special-consideration.

It is always worth submitting late assessment tasks when possible. Completion of the work, even late, may be taken into account in cases of special consideration.

Assessment Criteria

In general, the following criteria will be used to grade assignments. Specific requirements will be given in the laboratory instructions.

For reports:

- Identification of key facts and the integration of those facts in a logical development.
- Clarity of communication, this includes development of a clear and orderly structure and the highlighting of core arguments.
- Sentences in clear and plain English, this includes correct grammar, spelling and punctuation.
- Correct referencing in accordance with the prescribed citation and style guide.

For numerical calculations:

- Accuracy of numerical answers.
- All working shown.
- Use of diagrams, where appropriate, to support or illustrate the calculations.
- Use of graphs, were appropriate, to support or illustrate the calculations.
- Use of tables, where appropriate, to support or shorten the calculations.

Examinations

There will be a two hour examinations at the end of the semester. The paper will cover all materials in the whole semester.

You must be available for all tests and examinations. Final examinations for each course are held during the University examination periods, which are June for Semester 1 and November for Semester 2.

Provisional Examination timetables are generally published on myUNSW in May for Semester 1 and September for Semester 2

For further information on exams, please see Administrative Matters.

Calculators

You will need to provide your own calculator, of a make and model approved by UNSW, for the examinations. The list of approved calculators is shown at https://student.unsw.edu.au/exam-approved-calculators-and-computers

It is your responsibility to ensure that your calculator is of an approved make and model, and to obtain an "Approved" sticker for it from the School Office or the Engineering Student Centre prior to the examination. Calculators not bearing an "Approved" sticker will not be allowed into the examination room.

Special Consideration and Supplementary Assessment

For details of applying for special consideration and conditions for the award of supplementary assessment, see Administrative Matters, available on the School website and on Moodle, and the information on UNSW's Special Consideration page.

6. Expected Resources for students

Textbook

X.S. Yang, "Engineering Optimization: An Introduction with Metaheuristic Applications," John Wiley & Sons, 2010. (available from UNSW library as ebook)

Recommended Reading

S.S. Rao, "Engineering Optimization: Theory and Practice," John Wiley & Sons, 2009.
P. Venkataraman, "Applied Optimization with MATLAB Programming," John Wiley & Sons, 2009.

Additional materials provided in Moodle

This course has a website on Moodle which includes:

- lecture materials
- laboratory instructions
- selected scientific articles

Recommended Internet sites

For additional readings on scientific articles, accessible through UNSW library,
IEEE Xplore digital library http://ieeexplore.ieee.org/Xplore/home.jsp
SCOPUS (document search) http://www.scopus.com/

Other Resources

If you wish to explore any of the lecture topics in more depth, then other resources are available and assistance may be obtained from the UNSW Library. One starting point for assistance is: http://info.library.unsw.edu.au/web/services/services.html

7. Course evaluation and development

Feedback on the course is gathered periodically using various means, including the Course and Teaching Evaluation and Improvement (CATEI) 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.

8. 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: https://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: http://www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

Further information on School policy and procedures in the event of plagiarism is presented in a School handout, Administrative Matters, available on the School website.

9. Administrative Matters

You are expected to have read and be familiar with *Administrative Matters*, available on the School website: https://www.engineering.unsw.edu.au/mechanical-engineering/sites/mech/files/u41/S2-2015-Administrative-Matters_20150721.pdf

This document contains important information on student responsibilities and support, including special consideration, assessment, health and safety, and student equity and diversity.

N. M. Kwok
20 July 2015

Appendix A: Engineers Australia (EA) Professional Engineer Competency Standards

	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