1 INSTRUCTOR

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2 LEARNING RESOURCES

2.1 Course Website
Course material, news, announcements, and grades will be regularly posted to the ENGG*6140 Courselink site. You are responsible for checking the site regularly.

2.2 Reference Materials

2.3 Recommended Resources
NA
2.4 **Additional Resources**

Selected Lecture notes will be posted on CourseLink.

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3 **ASSESSMENT**

3.1 **Mark Distribution and Tentative Due Dates**

**Assignments:** 10 %

1. Assignment 1: Week 3
2. Assignment 2: Week 5
3. Assignment 3: Week 8

**Mid-Term:** 20 %

Week 6 – in class

**Final Exam:** 40 %

April 6, 2015, Room TBA, Time TBA

**Project:** 30 %

1. **Project Proposal:** Week 7
2. **Project Presentation/Submission:** Week 12.

The project involves (1) a literature review on the application of operations research in a particular selected area (2) analysis and computer implementation of solution procedures for selected mathematical models.

3.2 **Course Grading Policies**

**When You Cannot Meet a Course Requirement:** When you find yourself unable to meet a course requirement because of illness or compassionate reasons, please advise the course in writing, with your name, id#, and e-mail contact. See the graduate calendar for information on regulations and procedures for Academic Consideration:

[https://www.uoguelph.ca/registrar/calendars/graduate/2014-2015/genreg/sec_d0e1498.shtml](https://www.uoguelph.ca/registrar/calendars/graduate/2014-2015/genreg/sec_d0e1498.shtml)

**Accommodation of Religious Obligations:** If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start of the semester to make alternate arrangements.

**Passing grade:** Students must obtain a grade of 65 % or higher to pass the course.

**Missed Mid-term:** If you miss a mid-term due to grounds for granting academic consideration or religious accommodation, you have to inform the instructor to arrange a make-up mid-term within a week from the date of the mid-term.
4 AIMS & OBJECTIVES

4.1 Calendar Description
This course serves as a graduate introduction into combinatorics and optimization. Optimization is the main pillar of Engineering and the performance of most systems can be improved through intelligent use of optimization algorithms. Topics to be covered: Complexity theory, Linear/Integer Programming techniques, Constrained/Unconstrained optimization and Nonlinear programming, Heuristic Search Techniques such as Tabu Search, Genetic Algorithms, Simulated Annealing and GRASP.

4.2 Course Aims
Same as calendar description.

4.3 Learning Objectives
In industry, commerce, government, indeed in all walks of life, one frequently needs answers to questions concerning operational efficiency. An industrial engineer may need to know how to lay out a factory floor so that the parts can be manufactured with less machine-to-machine movements. Engineers in many different areas (robotics, power, biological, environmental and water resources, image processing, VLSI design, etc.) typically develop methods for solving many hard problems. Several of these problems can be formulated as combinatorial optimization problems. Thus, the objective of this course is to serve as a graduate introduction into combinatorics and optimization.

By the end of this course, students should:
• Understand the concepts of optimization and how it is used as a tool for decision making
• Be able to formulate linear programming models and solve using methods including the simplex algorithm and duality techniques
• Be able to solve network optimization problems
• Be able to formulate integer and mixed-integer mathematical models for several engineering problems
• Understand the nature and importance of constrained/unconstrained optimization
• Understand the concept of computational complexity, heuristics and approximation algorithms and the difference between heuristic techniques and meta-heuristic algorithms
• Apply meta-heuristic algorithms such as Tabu Search, Simulated Annealing, Genetic Algorithm in order to solve engineering problems.
• Be familiar with tools for solving classical combinatorial optimization problems such as CPLEX, LINGO, EXCEL-Solver etc.

4.4 Instructor’s Role and Responsibility to Students
The instructor’s role is to develop and deliver course material in ways that facilitate the learning of students. Selected lecture notes will be made available to students on Courselink/D2L but these are not
intended to be stand-alone course notes. During the lecture, the instructor will present several examples of the application of optimization in Engineering.

4.5 Students’ Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures. The primary source of information is the lecture note and the recommended reference books and students are required to extensively read the various chapters and section of these reference books. Students are expected to actively participate both during lecture and laboratory hours.

E-mail Communication: As per university regulations, all students are required to check their <uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its students.

Recording of Materials: Presentations which are made in relation to course work—including lectures—cannot be recorded in any electronic media without the permission of the presenter, whether the instructor, a classmate or guest lecturer.

4.6 Relationships with other Courses

Previous Courses: NA
Follow-on Courses: NA
Basic knowledge of mathematics.

5 Teaching and Learning Activities

5.1 Timetable

Lectures:
TBA

5.2 Course Topics and Schedule

- Introduction and Overview (week 1)
- Linear Programming (weeks 1, 2, 3)
  - Linear Programming Examples
  - Setting Up the Simplex Method
  - The Simplex Method in Tabular Form
- Adapting to Other Model Forms
- Post-optimality Analysis
- Integer Programming (Weeks 4, 5)
  - Prototype Example
  - Some BIP Applications
  - Innovative Uses of Binary Variables in Model Formulation
  - Some Formulation Examples
  - Some Perspectives on Solving Integer Programming Problem
  - The Branch-and-Bound Technique and Its Application to Binary Integer Programming
  - The Branch-and-Bound Algorithm for Mixed Integer
- Metaheuristics (Weeks 6, 7)
  - The Nature of Metaheuristics
  - Tabu Search
  - Simulated Annealing
  - Genetic Algorithm
  - Other metaheuristic algorithms
- Transportation and Assignment Problems (Week 8)
  - The Transportation Problem
  - A Streamlined Simplex Method for the Transportation Problem
  - The Assignment Problem
  - A Special Algorithm for the Assignment Problem
- Network Optimization Model (Weeks 9, 10)
  - Prototype Example
  - Terminology of Networks
  - The Shortest Path Problem
  - The Minimum Spanning Tree Problem
  - The Maximum Flow Problem
  - The Minimum Cost Flow Problem
  - The Network Simplex Method
- Dynamic Programming (Week 10, 11)
  - A Prototype Example for Dynamic Problem
  - Characteristic of Dynamic Programming Problems
  - Deterministic Dynamic Programming
- Nonlinear Programming (Weeks 11, 12)
  - Sample Applications
Graphical Illustration of Nonlinear Programming Problems
- Types of Nonlinear Programming Problems
- One Variable Unconstrained Optimization
- Multivariable Unconstrained Optimization
- The Karush-Kuhn-Tucke (KKT) Conditions for Constrained Optimization
- Quadratic Programming
- Separable Programming

NOTE: Several of the above topics will be covered by a weekly reading assignment and problem solving.

5.3 Other Important Dates

Drop Date: The last date to drop one-semester courses, without academic penalty, is March 06, 2015. Refer to the Graduate Calendar for the schedule of dates:
https://www.uoguelph.ca/registrar/calendars/graduate/current/sched/sched-dates-w11.shtml

6 Lab Safety

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible. The laboratory sessions of this course are in a computer room. Hence, students are required to follow the safety sings posted at the entrance of this room.

7 Academic Misconduct

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community – faculty, staff, and students – to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University’s policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection. The Academic Misconduct Policy is detailed in the Graduate Calendar:
http://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/sec_d0e1687.shtml
7.1 Resources

A tutorial on Academic Misconduct produced by the Learning Commons can be found at:
http://www.academicintegrity.uoguelph.ca/

The School of Engineering has adopted a Code of Ethics that can be found at:
http://www.uoguelph.ca/engineering/undergrad-counselling-ethics

The Graduate Calendar is the source of information about the University of Guelph’s procedures, policies and regulations which apply to graduate programs:
http://www.uoguelph.ca/registrar/calendars/graduate/current/