THE UNIVERSITY OF WINNIPEG

APPLIED COMPUTER SCIENCE

Course Number: GACS-7401-003
Course Name: Introduction to Operations Research

Instructor Information

Professor:	Talal Halabi	**Office:**	3D19
E-mail:	t.halabi@uwinnipeg.ca	**Office Hours**: Mon/Wed: 9:00 – 10:00	
Class Meeting Time:	Mon/Wed: 10:00 – 11:15	**Room No:** 3D03	

Course Web Page: https://sites.google.com/view/talalhalabi/teaching/gacs-7401

Important Dates

First Class:	January 6th, 2020
Proposal Submission:	January 19th, 2020
Reading Week (No Classes):	February 16th-22nd, 2020
Final Withdrawal Date w/o academic penalty:	March 13th, 2020

(A minimum of 20% of the work on which the final grade is based will be evaluated and available to the student before the voluntary withdrawal date)

Projects Presentation:	March 30th and April 1st, 2020
Last Class:	April 1st, 2020
Submission of term papers:	April 12th, 2020

Course Objectives/Learning Outcomes

This course provides a broad focus on algorithmic and practical implementation of Operations Research (OR) techniques, using theory, applications, and computations to teach students the basics of both deterministic and probabilistic decision-making. It introduces linear programming and emphasizes its underlying mathematical structures, algorithms, and solutions of practical programs. Topics covered include: formulations and relaxations, the geometry of linear optimization, convexity analysis, duality theory, the simplex method, sensitivity analysis, constrained and unconstrained optimization methods, robust optimization, network flows, semidefinite optimization, nonlinear optimization, heuristic programming, game and decision theory, Markov chains and queuing systems. At the end of the course, students will be able to

solve real world problems using optimization software tools. Students will also take on insightful reading activities on interesting applications of integer programming in computer science. The course involves a group project in which students apply the acquired knowledge in OR in the field of computer science. The course is a great asset for students willing to pursue research in computer science.

Evaluation Criteria

Assignments: 48%
- There are 4 assignments worth 12% each.
- Due at 11:59:59 pm on due day.
- No late assignment will be accepted, or under special circumstances accepted with 10% off for each late day.
- Assignments are only submitted by email as PDF (Portable Document Format) files to my University of Winnipeg email account – t.halabi@uwinnipeg.ca.
- Multiple submissions are not permitted. Students may submit a partially completed assignment and will receive credit for those attempted problems.
- Assignments will be written individually.

Term project: 52%
- Students are required to conduct a comprehensive research project involving the application of Operations Research in Computer Science. Examples and more details will be discussed in class.
- The project must present an innovative idea and a critical comparative analysis with the literature.
- The project may lead to the publication of a scientific paper.
- Depending on the class size, students may be assigned into groups, and then the project will be done as a group project. In this case, there will be additional evaluation criteria on each individual student on their contribution to the overall project in the group.
- Proposals must be submitted on the due day no later than 11:59:59 pm. They must be submitted by email as PDF (Portable Document Format) files to my University of Winnipeg email account – t.halabi@uwinnipeg.ca
- Proposals may be up to two pages, including a brief introduction, a discussion of related work in the literature, a description of the research objective(s), and the prospective methodology. Proposals must be typed. No handwritten proposals will be accepted.
- Research projects are evaluated based on originality, technical soundness, realization of declared objectives, outcomes or results, and the quality of the presentation. For group projects, individual contribution will be part of the evaluation (more details will be provided in class and on the course website).
- The final research paper must be formatted as a scientific publication of minimum five pages and maximum eight pages (two columns in 10-point font). More information about paper format will be given in class. Papers must be typed. No handwritten papers will be accepted. Papers must be written using the Latex editor.

- The final research paper must be submitted on the due day no later than 11:59:59 pm. It must be submitted by email as PDF (Portable Document Format) files to my University of Winnipeg email account – t.halabi@uwinnipeg.ca
- Students are required to present their projects in class at the end of term.

Final Letter Grade Assignment

Historically, numerical percentages have been converted to letter grades using the following scale. However, instructors can deviate from these values based on pedagogical nuances of a particular class, and final grades are subject to approval by the Department Review Committee.

A+	90+ - 100%	B+	75 - 79%	C	60 - 64%
A	85 - 90%	B	70 - 74%	D	50 - 59%
A-	80 - 84%	C+	65 - 69%	F	below 50%

Test/Exam Requirements

- Photo ID at exam is required.
- You are expected to write the test/exam on its given day.
- No electronic devices (e.g. cell/smart phone, laptop, scientific calculators, translators, etc.) are permitted.
- Midterm and final exams are closed book.
- Simple calculators can be used though. Simple calculators are subjected to test and can be denied use at mid-term test and final examination times.
- Unless a medical certificate is provided, no accommodation is made for missed exams.

Prerequisite and Restriction Information[*]

(This information can be found in the UW General calendar)
- Consent of Department Graduate Studies Committee Chair (or research supervisor)

Email Communication Requirements

- Emails from accounts at uwinnipeg.ca are usually not filtered by the UofW email filter. Thereby it is recommended electronic communication used for the course utilize a UofW email account to minimize the risk of filtering.
- Use 'GACS-7401' as subject in email communication related to the course.

Services for Students

Students with documented disabilities, temporary or chronic medical conditions, requiring academic accommodations for tests/exams (e.g., private space) or during lectures/laboratories (e.g., note-takers) are encouraged to contact Accessibility Services (AS) at 786-9771 or

accessibilityservices@uwinnipeg.ca to discuss appropriate options. All information about a student's disability or medical condition remains confidential:
http://www.uwinnipeg.ca/accessibility.

Students may choose not to attend classes or write examinations on holy days of their religion, but they must notify their instructors at least two weeks in advance. Instructors will then provide opportunity for students to make up work examinations without penalty. A list of religious holidays can be found in the 2019-20 Undergraduate Academic Calendar.

All students, faculty and staff have the right to participate, learn, and work in an environment that is free of harassment and discrimination. The UW Respectful Working and Learning Environment Policy may be found online at www.uwinnipeg.ca/respect .

Misuse of Computer Facilities, Plagiarism, and Cheating

Avoiding Academic and Non-academic Misconduct. Students are encouraged to familiarize themselves with the Academic Regulations and Policies found in the University Academic Calendar at:
https://uwinnipeg.ca/academics/calendar/docs/regulationsandpolicies.pdf
Particular attention should be given to subsections 8 (Student Discipline), 9 (Senate Appeals), and 10 (Grade Appeals). Please note, in particular, the subsection of Student Discipline pertaining to plagiarism and other forms of cheating. Detailed information can be found at the following:
Academic Misconduct Policy and Procedures:
https://www.uwinnipeg.ca/institutionalanalysis/docs/policies/academic-misconduct-policy.pdf
and
https://www.uwinnipeg.ca/institutionalanalysis/docs/policies/academic-misconduct-procedures.pdf
Non-Academic Misconduct Policy and Procedures:
https://www.uwinnipeg.ca/institutionalanalysis/docs/student-non-academic-misconduct-policy.pdf
and
https://www.uwinnipeg.ca/institutionalanalysis/docs/student-non-academic-misconduct-procedures.pdf
Additional information is available at University of Winnipeg library video tutorial "Avoiding Plagiarism" https://www.youtube.com/watch?v=UvFdxRU9a8g

Misuse of Filesharing Sites. Uploading essays and other assignments to essay vendor or trader sites (filesharing sites that are known providers of essays for use by others who submit them to instructors as their own work) involves "aiding and abetting" plagiarism. Students who do this can be charged with Academic Misconduct.

Avoiding Copyright Violation. Course materials are owned by the instructor who developed them. Examples of such materials are course outlines, assignment descriptions, lecture notes, test questions, and presentation slides. Students who upload these materials to filesharing

sites, or in any other way share these materials with others outside the class without prior permission of the instructor/presenter, are in violation of copyright law and University policy. Students must also seek prior permission of the instructor /presenter before photographing or recording slides, presentations, lectures, and notes on the board.

Required TextBook(s)/Reading List

The required textbook for this course is the following:

Operations Research: An Introduction, 10th edition
Author: Hamdy A. Taha
Publisher: Pearson
ISBN: 9780134444017, 0134444019
Supplementary scientific papers, and notices will be posted on the course website. Students are responsible for all material covered in class and posted on the website. Students are also responsible for announcements made in class and via email.

Course Outline (Tentative)

Week one
Introductory Concepts, Linear Programming Applications (LP), Convexity analysis, Graphical LP Solution, Computer Solution with Solver and AMPL, Binary Optimization.
Week two
Semidefinite programming, Simplex Method, Simplex Tableau Computations, Artificial Starting Solutions (M-Method and Two-Phase Method), Graphical and Algebraic Sensitivity Analysis, Duality, Post-Optimal Analysis, Feasibility and Optimality.
Week three
Transportation Model and Algorithm, Assignment Model, Hungarian Method, Advanced Linear Programming, Bounded-Variables Algorithm, Parametric Linear Programming
Week four
Network Model, Network Flow Problems and Solutions, Minimal Spanning Tree Algorithm, Shortest-Route Problem, Dijkstra's Algorithm, Floyd's Algorithm, Maximal Flow Model and Algorithm, Critical Path Method, LP Formulation
Week five
Goal Programming, Weights Method, Preemptive Method, Integer Linear Programming (ILP), Branch-and-Bound Algorithm, Cutting-Plane Algorithm.
Weeks six and seven
Heuristic Programming, Greedy (Local Search) Heuristics, Discrete/Continuous Variable Heuristic, Metaheuristics, Tabu Search, Simulated Annealing, Genetic Algorithm, Artificial Bee Colony, Metaheuristics Fine-Tuning, Metaheuristics Application to ILP, Constraint Programming, Constrained Optimization Methods.

Week eight

Traveling Salesperson Problem, Robust Modeling and Optimization, Nonlinear Programming Algorithms, Deterministic and Probabilistic Dynamic Programming.

Week nine and ten

Decision Analysis and Games, Analytic Hierarchy process (AHP), Decision under Uncertainty, Utilities and Payoffs, Zero-Sum Games, Pure and Mixed Strategy Games, Cooperative Game Theory, Coalition Formation, Hedonic Games.

Week eleven

Markov Chains, Queuing Systems, Pure Birth and Death Models, General Poisson Queuing Model, Single-Server and Multiple-Server Models.

Week twelve

Simulation Modeling, Monte Carlo Simulation, Discrete Event Simulation, Sampling, Simulation Languages, Classical Optimization Theory.

Note that all topics listed may not be covered and may be offered in a slightly different time order.

Additional Course Related Information

1. When it is necessary to cancel a class due to exceptional circumstances, instructors will make every effort to inform students via uwinnipeg email (and/or using the preferred form of communication, as designated in this outline), as well as the Departmental Assistant and Chair/Dean so that class cancellation forms can be posted outside classrooms

2. Students are reminded that they have a responsibility to regularly check their uwinnipeg e-mail addresses (and/or using the preferred form of communication, as designated in this outline) to ensure timely receipt of correspondence from the university and/or their course instructors

3. Please note that withdrawing before the VW date does not necessarily result in a fee refund (March 13th is VW date for classes that begin in September and end in December).

4. No classes:
   University closed from Dec 23, 2019 until January 1, 2020.
   February 16th-22nd, 2020 Mid-term reading week
   February 17th, LOUIS RIEL DAY
   April 10th, GOOD FRIDAY