MSCI 7140 (A01/G01) (3.0 CH)
QUANTITATIVE ANALYSIS FOR MANAGEMENT
WINTER 2024

TERRITORY ACKNOWLEDGEMENT

The University of Manitoba campuses are located on original lands of Anishinaabeg, Cree, Oji-Cree, Dakota and Dene peoples, and on the homeland of the Métis Nation. We respect the Treaties that were made on these territories, we acknowledge the harms and mistakes of the past, and we dedicate ourselves to move forward in partnership with Indigenous communities in a spirit of reconciliation and collaboration.

INSTRUCTOR

Name:	Dr. Yuvraj Gajpal	Office Location:	622 Drake
Phone:	204-474-7421	Office Hours:	Tuesday 11:30-12:30 am by appointment
Email:	Yuvraj.Gajpal@umanitoba.ca	Class Room:	Drake 115
		Class Time:	Wednesday 6.15 - 9.30p

COURSE DESCRIPTION

Introduction to the use of quantitative techniques, and computers to solve management problems. Mathematical optimization models, network analysis, and probability models.

BACKGROUND

A pre-requisite of course MSCI 5110 is required. This will provide a fundamental knowledge of college mathematics such as linear algebra, calculus, descriptive statistics and some probability. Also, the participants should have a basic knowledge of spreadsheets and Microsoft Excel.

COURSE OBJECTIVES

- To introduce students to the subject of Management Science, and a variety of management science models, methods and computational procedures that are helpful in solving management problems in Finance, P.O.M., Accounting, M.I.S., Marketing, Operational Research, Actuarial Science, etc. Emphasis is placed on models and their solutions.

- To give students a good foundation in basic problem solving as a preparation for upper level quantitative courses (Finance, Production/ Operations Management, Accounting, M.I.S., Marketing, Operational Research, Supply Chain Management etc.).

- To develop in students an appreciation of the management science approach to problem formulation and solution, so important in the modern business and industrial world with the increased use of computers. The students will learn to formulate the mathematical models in a variety of sectors, such as Finance, Production, Marketing, Insurance, and supply Chain Management etc., and solve them by a computational procedure or by computer.

- This course is designed to provide students with a conceptual understanding of the role that management science plays in the decision-making process. Quantitative methods will be discussed and there will be emphasis on modeling, problem solving, and showing how quantitative approaches can be used in decision making process.

- Upon completion of this course, students will be able to: Define and use Management Science terminology, formulate basic models for problem solving techniques, use quantitative methods to solve typical decision making problems that arise in business and industry and recognize applications of Management Science concepts and techniques.

COURSE MATERIALS

Bernard W. Taylor, Introduction to Management Science, 13th edition.

This is a required text book. You can use following link to facilitate direct purchase of either version through UM BookStore's digital platform, Campus eBookstore:

https://bit.ly/3UydthG.

Please respect copyright laws. Photocopying textbooks or other reading material is a violation of copyright laws and is unethical, unless permission to copy has been obtained.

The Introduction to Management Science is a well written book with lots of example questions. The modelling techniques presented in this book are explained with straightforward examples that avoid lengthy written explanations. The examples presented in the book are organized in a logical step-by-step fashion that the student can subsequently apply to the problems at the end of each chapter.

COURSE ASSESSMENT

- Assignment 1 (worth 5%)
- Assignment 2 (worth 5%)
- Assignment 3 (worth 5%)
- Class Exercise (worth 10%)
- Midterm (worth 15%)
- Project (worth 15%)
- Final (worth 45%)

Final grades will be assigned as follows;

Cumulative Marks	Grade	GPA	Performance
91-100	A+	4.5	Excellent
85-90	A	4.0	Very Good
78-84	B+	3.5	Good
71-77	B	3.0	Satisfactory
65-70	C+	2.5	Marginal
60-64	C	2.0	Unsatisfactory
50-59	D	1.0	Unsatisfactory
Below 50	F	0.0	Unsatisfactory

NOTE: Class attendance is required. Missing more than 20% of this course due to absence from lectures may result in a failing grade. It is your responsibility to inform your professor, in advance if possible, of your absence and the reason for it:

1) if **medical**, self-declaration form must be submitted for an illness lasting 5 consecutive days or less https://umanitoba.ca/governance/governing-documents-students#self-declaration-for-brief-or-temporary-student-absences, no later than 48 hours after the end of the brief absence; a medical note from your physician must be submitted for an illness lasting more than 5 days;
2) if a **work commitment**, a signed letter on letterhead from your supervisor is required in advance, noting clearly the date(s) you must be away for your work commitment(s);
3) if for **student competitions**, an email from your Asper team coach must be received in advance indicating the dates you are away at competition.

The professor will then decide how to deal with the impact of the missed classes on your final grade.

Late Assignment Submission Policy

Late submissions of assignments are penalized 10 % per day including weekends unless an extension has been arranged in advance for a legitimate reason.

Class Exercises

The "Class Exercise" are based on the lecture taught in that day. You need to finish these exercises in the class. There is no fixed schedule for class exercises; hence, your attendance is required to complete the class exercises. If you miss the class, you will miss the class exercise. There will be a total of 5 class exercises.

COURSE SCHEDULE

- **Chapter 1**, Components of Break-Even Analysis are presented. The three components of break-even analysis are volume, cost, and profit. Graphical illustration and profit analysis will be discussed.

- **Chapter 2**, Linear programming formulation and graphical approach to solve linear programming model. The graphical approach is limited to models with only two decision variables. The analysis of the graphical approach provides valuable insight into linear programming problems and their solutions. In the graphical approach, once the feasible solution

area and the optimal solution point have been determined from the graph, simultaneous equations are solved to determine the values of x1 and x2 at the solution point. We will also discussed slacks, surplus variables and standard form solution to a linear programming model. We will also learn how to write a linear programming model in standard form.

- **Chapter 3**, Sensitivity Analysis and Model Formulation. Chapter 3 demonstrated how a linear programming model is formulated and how a solution can be derived from a graph of the model. Graphing can provide valuable insight into linear programming and linear programming solutions in general. However, the fact that this solution method is limited to problems with only two decision variables restricts its usefulness as a general solution technique. In this chapter we will show how linear programming problems can be solved using Excel computer software packages. We will also describe how to use a computer solution result to experiment with a linear programming model to see what effect parameter changes have on the optimal solution, referred to as sensitivity analysis. Students are also exposed to Excel formulation to linear programming model.

- **Chapter 4,** Linear programming has proven to be one of the most successful quantitative approaches to decision making. Applications have been reported in almost every industry. These applications include production scheduling, media selection, financial planning, capital budgeting, transportation, distribution system design, product mix, staffing, and blending.

- **Chapter 6,** In this chapter we discuss a class of problems that are modeled as linear programs with the additional requirement that one or more variables must be integer. Such problems are called integer linear programs. If all variables must be integer, we have an all- integer linear program. If some, but not all, variables must be integer, we have a mixed-integer linear program. In many applications of integer linear programming, one or more integer variables are required to equal either 0 or 1. Such variables are called 0- 1 or binary variables. If all variables are 0-1 variables, we have a 0-1 integer linear program. We will show that simply rounding of non-integer simplex solution values for models requiring integer solutions is not always appropriate. Rounding can often lead to suboptimal results.

- **Chapter 5**, In this chapter, we examine three special types of linear programming model formulations transportation, transshipment, and assignment problems. They are part of a larger class of linear programming problems known as network flow problems. These problems have special mathematical characteristics that have enabled management scientists to develop very efficient, unique mathematical solution approaches to them. Given the supply at each origin, the demand at each destination, and unit shipping cost between each origin and each destination, the transportation model determines the optimal amounts to ship from each origin to each destination. The assignment problem is a special case of the transportation problem in which all supply and all demand values are 1. The transshipment problem is an extension of the transportation problem involving transfer points referred to as transshipment nodes. Excel formulation for transportation model and assignment model will also be discussed in class. Modified transportation model will also be discussed.

- **Chapter 8**, In this chapter we examined a class of models referred to as network flow models. These included the shortest route network, the minimal spanning tree network model. These network models are all concerned with the flow of an item (or items) through an arrangement of paths (or routes). The shortest-route problem find the shortest route or path between two nodes

of a network. Distance, time, and cost are often the criteria used for this model. The shortest-route problem can be expressed as a transshipment problem with one origin and one destination.

- **Chapter 9**, This chapter introduced the concept of making decisions when there is more than one objective or criterion to consider. Three specific modeling techniques will be presented to solve decision-making problems with multiple criteria: Goal programming, the Analytical hierarchy process (AHP), and Scoring methods. These techniques can be applied to a wide variety of decision-making situations when there are objectives besides just profit or cost. They are often applicable to decision-making problems in public or governmental organizations in which the levels of service or efficiency in carrying out numerous goals are more important than are profit or cost. In all the linear programming models presented in Chapters 2 through 8, a single objective was either maximized or minimized. However, a company or an organization often has more than one objective, which may relate to something other than profit or cost. In fact, a company may have several criteria, that is, multiple criteria that it will consider in making a decision instead of just a single objective. For example, in addition to maximizing profit, a company in danger of a labor strike might want to avoid employee layouts, or a company about to be defined for pollution infractions might want to minimize the emission of pollutants. The model solutions are very much like the solutions to linear programming models. The format for the analytical hierarchy process and scoring models, however, is quite different from that of linear programming. These methods are based on a comparison of decision alternatives for different criteria that reflects the decision maker's preferences. The result is a mathematical "score" for each alternative that helps the decision maker rank the alternatives in terms of preferability.

- **Chapter 12**, Decision Analysis In actual practice, however, many decision-making situations occur under conditions of uncertainty. Several decision-making techniques are available to aid the decision maker in dealing with this type of decision situation in which there is uncertainty. Decision situations can be categorized into two classes: situations in which probabilities cannot be assigned to future occurrences and situations in which probabilities can be assigned. In this chapter we will discuss each of these classes of decision situations separately and demonstrate the decision- making criterion most commonly associated with each. The purpose of this chapter is to demonstrate the concepts and fundamentals of decision making when uncertainty exists. Within this context, several decision-making criteria will be presented. The maximax, maximin, minimax regret, equal likelihood, and Hurwicz decision criteria were demonstrated for cases in which probabilities could not be attached to the occurrence of outcomes. The expected value criterion will be discussed for cases in which probabilities could be assigned to the states of nature of a decision situation.

- Additional Topic: Formulation of the data envelopment analysis problem as a linear programming model.

- Goal Programming Versus Linear Programming, Deviation Variables Model Formulation, Graphical Solutions Solving Goal Programming Problems Using Excel, Weighted Goals. More emphasis will be placed on model formulation.

(Due to time constraints, all topics may not be covered)

Tentative Course Schedule – Winter 2024

Date	Topics
Jan 24	Ch1: Introduction, Break Even Analysis (Brief discussion)
Jan 31	Ch2: Introduction to Linear Programming Model Formulation and Graphical Solution
Feb 07	Ch3: Linear Programming: Computer Solution and Sensitivity Analysis
Feb 14	Ch4: Linear Programming: Modelling Examples Applications in various business areas
Feb 21	Winter Break
Feb 28	Mid-Term Exam: Chapter 1, 2, 3, and 4; Duration : 2.5 hours Ch5: Integer Programming
Mar 06	Ch6: Transportation, Transshipment and Assignment Problems
Mar 13	Ch7: Network Flow Models. Shortest Route Problem, Minimal Spanning Tree Problem
Mar 20	Ch9: Multi criteria Decision Making
Mar 27	Ch12: Decision analysis
April 03	Project presentation

ACADEMIC REGULATIONS AND STUDENT SERVICES

HUMAN ETHICS APPROVAL FOR DATA COLLECTION

As part of coursework, if you will be collecting data from people who are not students in this class, you must obtain Human Ethics approval from the UofM's Research Ethics Board (REB) prior to data collection. This applies to data collection such as surveys, interviews, focus groups, experiments, video recording, etc., where a respondent is solicited for participation.

If the entire class will be working on the same project, your instructor will apply for human ethics approval from the REB. If individuals or small groups of students will be working on different projects, it is the responsibility of the students to obtain approval (only one group member needs to apply). Your instructor will tell you whether s/he will be or you need to. **When in doubt, please talk to your instructor.**

Instructions and forms to apply for human ethics approval can be found at:
http://umanitoba.ca/research/orec/ethics/guidelines.html

In most cases, you will be using the "Protocol Submission Form" which is under the "REB Forms - Fort Garry Campus" heading.

It can take up to six weeks to process human ethics applications and obtain approval. Therefore, plan early. Note that approval must be obtained prior to data collection and cannot be obtained during the data collection phase or retroactively. Violation can get you, your instructor, and the Asper School in serious trouble with the REB.

The following do not require REB approval:

a) Projects where students are conducting the research on themselves during class time;
b) Projects involving the use of records or information that is in the public domain, including the use of anonymous secondary data and surveys or questionnaires that have already been published;
c) Projects involving the use of naturalistic observation where there is no reasonable expectation of privacy (i.e. public park).
d) Practicum or job training projects where students are fully integrated into the organization's operational practices and are not conducting research;
e) Projects where the intent is to use the information to provide advice, diagnosis, identification of appropriate interventions or general advice for a client;
f) Projects where the intent is to develop skills which are standard practice within a profession (e.g. observation, assessment, intervention, evaluation, auditing); or
g) Projects where the information gathering processes are part of the normal professional relationship between the student and the participants.

If you have any questions, please contact humanethics@umanitoba.ca or your instructor.

UNCLAIMED ASSIGNMENT POLICY

Pursuant to the FIPPA Review Committee's approved recommendations of August 15, 2007, all unclaimed student assignments will become the property of the faculty and will be subject to destruction six months after the completion of any given academic term.

STUDENT SERVICES AND SUPPORTS

The University of Manitoba provides many different services that can enhance learning and provide support for a variety of academic and personal concerns. You are encouraged to visit the below websites to learn more about these services and supports. If you have any questions or concerns, please do not hesitate to contact your instructor or the Graduate Program Office.

For Information on…	**…follow this link**
Course Outlines, Year-at-a-Glance, Concentrations, Textbooks, VW Dates and Final Exams	Asper Graduate Student Resources
Exam Rescheduling Policy - *Please refer to Missing a Test/Exam on page 18 of the MBA Student Handbook*	MBA Student Handbook
Help with research needs such as books, journals, sources of data, how to cite, and writing	Library Resources
Tutors, workshops, and resources to help you improve your learning, writing, time management, and test-taking skills	Writing and Learning Support
Support and advocacy for students with disabilities to help them in their academic work and progress	Student Accessibility Services
Copyright-related questions and resources to help you avoid plagiarism or intellectual property violations	Copyright Office
Student discipline bylaws, policies and procedures on academic integrity and misconduct, appeal procedures	Academic Integrity
Policies & procedures with respect to student discipline or misconduct, including academic integrity violations	Student Discipline
Students' rights & responsibilities, policies & procedures, and support services for academic or discipline concerns	Student Advocacy
Your rights and responsibilities as a student, in both academic and non-academic contexts	Your rights and responsibilities
Full range of medical services for any physical or mental health issues	University Health Service
Information on health topics, including physical/mental health, alcohol/substance use harms, and sexual assault	Health and Wellness
Any aspect of mental health, including anxiety, stress, depression, help with relationships or other life concerns, crisis services, and counselling.	Student Counselling Centre
Support services available for help regarding any aspect of student and campus life, especially safety issues	Student Support Case Management
Resources available on campus, for environmental, mental, physical, socio-cultural, and spiritual well-being	Live Well @ UofM
Help with any concerns of harassment, discrimination, or sexual assault	Respectful Work and Learning Environment
Concerns involving violence or threats, protocols for reporting, and how the university addresses them	Violent or Threatening Behavior

ACADEMIC INTEGRITY

I.H. Asper School of Business, The University of Manitoba

It is critical to the reputation of the I. H. Asper School of Business and of our degrees that everyone associated with our faculty behaves with the highest academic integrity. As the faculty that helps create business and government leaders, we have a special obligation to ensure that our ethical standards are beyond reproach. Any misconduct in our academic transactions violates this trust. The University of Manitoba Graduate Calendar addresses the issue of academic misconduct under the heading "Plagiarism and Cheating." Specifically, acts of academic misconduct include, but are not limited to:

- using the exact words of a published or unpublished author without quotation marks and without referencing the source of these words
- duplicating a table, graph or diagram, in whole or in part, without referencing the source
- paraphrasing the conceptual framework, research design, interpretation, or any other ideas of another person, whether written or verbal (e.g., personal communications, ideas from a verbal presentation) without referencing the source
- copying the answers of another student in any test, examination, or take-home assignment
- providing answers to another student in any test, examination, or take-home assignment
- taking any unauthorized materials into an examination or term test (crib notes)
- impersonating another student or allowing another person to impersonate oneself for the purpose of submitting academic work or writing any test or examination
- stealing or mutilating library materials
- accessing tests prior to the time and date of the sitting
- changing name or answer(s) on a test after that test has been graded and returned
- submitting the same paper or portions thereof for more than one assignment, without discussions with the instructors involved.

Many courses in the I. H. Asper School of Business require group projects. Students should be aware that group projects are subject to the same rules regarding academic misconduct. Because of the unique nature of group projects, all group members must exercise extraordinary care to insure that the group project does not violate the policy on Academic Integrity. Should a violation occur on a group project, all group members will be held jointly accountable, no matter what their individual level of involvement in the specific violation.

Some courses, while not requiring group projects, encourage students to work together in groups (or at least do not prohibit it) before submitting individual assignments. Students are encouraged to discuss this issue as it relates to academic integrity with their instructor to avoid violating this policy.

In the I. H. Asper School of Business, all suspected cases of academic misconduct involving a graduate student (i.e. MBA, MFin, MSCM, MSc or PhD student) will be reported directly by the instructor to the Dean of the Faculty of Graduate Studies.

AI TOOLS

AI tools can be used to enhance learning and problem-solving skills, but they should not replace independent thinking and learning. Students must exercise critical thinking when using AI tools and acknowledge their use in academic work. Prohibited uses include generating or completing academic work with AI tools without appropriate acknowledgement. Academic honesty is paramount, and students should accurately represent their individual effort and knowledge. Faculty will provide guidance on AI tool usage and incorporate discussions on AI ethics and academic integrity. Violations may lead to disciplinary actions, including academic penalties or suspension.

Dr. Yuvraj Gajpal
Department of Supply Chain Management
I.H. Asper School of Business

Research Interests:

Application of heuristics and meta-heuristics on transportation and logistics management. Using different metaheuristics such as Ant colony optimization, tabu search, simulated annealing, genetic algorithm, adaptive large neighborhood search, particle swarm optimization and iterative local search to solve supply chain problems. Using linear and integer programming to formulate the problems arising in supply chain management. Scheduling issues in manufacturing industry, healthcare, cloud computing and project management. Vehicle route design for city delivery distribution such as parcel delivery, garbage collection and meal delivery distribution.

Background:

Yuvraj Gajpal is an Assistant Professor of Supply Chain Management at Asper School of Business, University of Manitoba Winnipeg, Canada. He holds a PhD in Management Science from DeGroote School of Business at McMaster University Hamilton, Canada and Master in Industrial Management from Indian Institute of Technology (IIT) Madras, India. Prior to joining University of Manitoba, he worked as an assistant professor at King Fahd University of Petroleum and Minerals (KFUPM), Saudi Arabia. He also taught courses at McMaster University as a sessional lecture. He has worked as a postdoctoral fellow at Interuniversity Research Center on Enterprise Networks, Logistics and Transportation (CIRRELT), University of Ontario Institute of Technology (UOIT) and McMaster University. He is a member of Institute for Operations Research and the Management Sciences (INFORMS); Canadian Operational Research Society (CORS); Administrative Sciences Association of Canada (ASAC); Society of Operations Management, India (SOM) and Soft Computing Research Society (SCRS).

He has published papers in leading research journals such as Computers and Operations Research, European Journal of Operations Research, International journal of Production Economics, annals of Operations Research, Reliability Engineering and Systems Safety, Construction Management and Economics and Journal of the Operational Research Society. He is a reviewer of many international journals such as Computers and Operations Research, European Journal of Operations Research, Computers and Industrial Engineering, Journal of Heuristics and Transportation Research Part E.

He has taught wide variety of courses in Engineering and Management. He has taught courses in Introduction to Management Science, Operations Management, Simulation, Mathematical Optimization Models, Statistics, Global Supply Chain Management, Engineering Economics, Cost accounting; and Methods engineering.