IE 7570: Operations Research (Deterministic Optimization) (2 Credits)

Description: The primary goal of the course is to develop the ability to formulate fairly complex optimization problems, provide an appreciation of the main classes of problems that are practically solvable, describe the available solution methods, and build an understanding of the qualitative properties of the solutions they provide. These models are used to find optimal or near optimal solutions to problems involving as many as tens of thousands of decision variables and thousands of constraints. The class participant will develop skills in recognizing and formulating deterministic optimization models and gain an appreciation for the role of sensitivity analysis in analyzing a problem. The course will discuss methods for quantifying the impact of specific constraints on the overall performance of the system. Production scheduling, product mix planning, manpower planning, routing and scheduling, financial planning, and prototype builds are some of the application areas to be discussed.

Course Objectives:

1. Understand the role of analytics and big data in developing a competitive strategy.
2. Recognize the major capabilities and limitations of deterministic operations research modeling as applied to problems in manufacturing industry.
3. Build skills in recognizing and formulating deterministic optimization models: Constraints, Objective function and Decision variables
4. Use optimization algorithms to find the optimal solutions.
5. Be able to perform sensitivity analysis in analyzing a system
6. Quantify the cost of constraints
7. Understand of the theory behind the models and the importance of simplifying assumptions. (Linear, integer, network & non linear)
8. Build a broader understanding of the types of mathematical models and their appropriate context.

Learning Outcomes:

- Select a OR tool for a particular production/operations management application
- Formulate deterministic optimization models
- Define objective, decisions and constraints
- Write symbolic models and implement them using optimization software,
- Use Excel data table functions to conduct sensitivity analysis
- Read and interpret sensitivity tables
- Generate simplex tableaus
- Do duality analysis
- Prepare a presentation for a typical application of OR methods
- Write a concise project report for project

Instructor: Dr. Leslie Monplaisir

TA: Mahyar Movahednejad ed3506@wayne.edu

Classroom: Th 5:00 to 8:00 pm
Class Hours: W 1:00 to 2:00 pm
Office Hours: Room 2163, 4815 Fourth Street, MEB, Detroit, MI 48202
Contact Info: e-mail: ad5365@wayne.edu; Tel: 313-577-1645; Fax: 313-577-8833
Course Website: http://blackboard.wayne.edu

Pre-requisite: Graduate Standing

Grading:

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<th>Percentage</th>
<th>Description</th>
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<tr>
<td>15</td>
<td>Homework Problems and in-class assignments</td>
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<td>15</td>
<td>Quiz (three)</td>
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<td>30</td>
<td>Case Studies</td>
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<td>15</td>
<td>Journal Article Review &amp; Discussion - Class Participation</td>
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<td>25</td>
<td>Class Project</td>
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Project reports and special assignment reports have to be typed.
Homework late by one class will be evaluated at 90% and more than one class at 70%.

Guidelines for assigning grades: A = 95%+, A– = 90%+, B+ = 87%+, B = 83%+, B– = 80%+, C+ = 77%+, C = 73%+, C– = 70%+, D+ = 65%+, D = 60%+, D– = 55%+, E = less than 55%

General Policy:

**Student Conduct:** It is the responsibility of each student to adhere to the principles of academic integrity. Academic integrity means that a student is honest with him/herself, fellow students, instructors, and the University in matters concerning his or her educational endeavors. Thus, a student should not falsely claim the work of another as his/her own, or misrepresent him/herself so that the measures of his/her academic performance do not reflect his/her own work or personal knowledge. In this regard, cheating will not be tolerated. Cheating includes (but is not limited to) any communication (written or oral) during examinations and sharing of work, such as using the same models or computer programs or copying work. All homework and projects must be an individual effort unless specifically noted. **STUDENTS WHO CHEAT ON ANY ASSIGNMENT OR DURING ANY EXAMINATION WILL BE ASSIGNED A FAILING GRADE FOR THE COURSE.** Therefore, avoid all appearance of improper behavior! Students who witness cheating should report the incident to the instructor as soon as possible. Students are also welcome to discuss any concerns related to cheating with the Chair of Industrial & Manufacturing Engineering.

**Educational Accessibility Services:** If you feel that you may need an accommodation based on the impact of a disability, please feel free to contact me privately to discuss your specific needs. Additionally, the Office of Educational Accessibility Services (EAS) coordinates reasonable accommodations for students with documented disabilities. The office is located in the Student Center Building, Room 583, Phone: 313-577-1851 (Voice)/577-3365 (TTY).

**Policy on Classroom Attendance:** All students are expected to attend all lectures, quizzes, and examinations with enthusiasm. Although classroom attendance does not mathematically contribute to the final course grade, active class participation is expected of all students and may help to boost up the course grade in those “borderline” cases” between failing and passing.

**Case Study and Homework**
Problems will be assigned each week. Several linear and integer program formulations which require the use of the computer software will be assigned. The formulation assignments and due dates will be provided during our class meetings. Case study write-ups are due on the dates provided during our class meetings.

**Article Review**
The objective of the article review presentations is to allow students to study a wide range of real world applications that rely on operations research and optimization techniques. Attached are abstracts of recent applications from a leading OR journal.

You will work in teams of three or four. Each team is required to select and analyze an article from a recent journal (last two years from preferably Interfaces) that describes a practical application of OR. Each team will make a fifteen-minute presentation at the beginning of class and submit overheads of presentation & names of team members. Every team member is required to have a one-page outline of comments, observations and lessons learned that are to be appended to the presentation material to be turned in.

**Presentation 5-8 Overheads**
1. Problem Context
2-3 Model Structure or Content in WORDS (NO MATHEMATICAL FORMULA)
   - Decision Variables,
   - Objectives,
   - Constraints,
• Planning Horizon,
• System Scope

4-5 Model Usage -
• What issues did it address?
• What was its impact?
• Who were the model users?

6. Implementation Issues & Concerns if discussed in paper
7-8. Your lessons learned & analogies
• The analogies could relate to potential use of model or to implementation issues

Course Outline/Schedule:

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<th>Topic</th>
<th>Article Presentation</th>
<th>Assignment</th>
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<td>1</td>
<td><strong>Chapter 1:</strong> Introduction: Models and Modeling</td>
<td>Introduction to Linear programming and Formulation</td>
<td>Analytics Chapters 1-3 Due 05/30</td>
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<td>2</td>
<td>05/09 Spreadsheet Modeling</td>
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<td>HW 1 - Due 05/23</td>
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<td>3</td>
<td><strong>Chapter 2:</strong> Linear Optimization: Linear Programming</td>
<td>Formulation and Graphical Solution</td>
<td>HW 2 – Due 05/30</td>
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<td>4</td>
<td>05/23 <strong>Chapter 3:</strong> Solving LP Problems using Solver and</td>
<td>Sensitivity Analysis</td>
<td>Quiz 1</td>
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<td>5</td>
<td>05/30 <strong>Chapter 4:</strong> Linear Programming Examples</td>
<td>INTERFACE 36:5 Amazon.com Customer Service Page 47</td>
<td>HW 3- Due 06/06 Mosaic Tiles, LTD. Case Study. Due on 06/13</td>
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<td>6</td>
<td>06/06 <strong>Chapter 5:</strong> Integer Programming</td>
<td>INTERFACE 34:5 Optimizing Production Quantities at GE Plastics</td>
<td>HW 4 – Due 06/13 Final Project one pager due.</td>
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<td>7</td>
<td>06/13 <strong>Chapter 6</strong>: LP Applications: Transportation Problem and</td>
<td>INTERFACE 32:2 Allocating Operating Room Time at Toronto’s Mount Sinai Hospital</td>
<td>HW 5 – Due 06/20 New Offices at Atlantic AMS. Due on 06/27</td>
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<td>8</td>
<td>Assignment Problem and Multi-period problems</td>
<td>INTERFACE 34:02 transportation Models at Nu-Kote International.</td>
<td>Quiz 2</td>
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<td>9</td>
<td>06/20 <strong>Chapter 7</strong>: Network Flow Models</td>
<td>INTERFACE 31:1 Ford Prototyping</td>
<td>HW 6 – Due 06/30</td>
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<td>10</td>
<td>06/27 <strong>Chapter 10</strong>: Non-Linear Optimization</td>
<td>INTERFACE 39:5 Supplier Decisions at Ford Pg 487</td>
<td>Quiz 3</td>
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<td>07/04</td>
<td><strong>July 04 break</strong></td>
<td>Final Presentations</td>
<td>Final reports due</td>
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<tr>
<td>07/11</td>
<td><strong>Chapter 10</strong>: Non-Linear Optimization</td>
<td>INTERFACE 31:1 Ford Prototyping</td>
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<td>07/18</td>
<td><strong>Final Presentations</strong></td>
<td>Final reports due</td>
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Final Project

Overview
Discuss the potential role of Mathematical Models in real world problem for which you can obtain data. You must clearly define a management situation that you think optimization methods can be used to bring about significant improvement.

• Purpose of Model
• Journal Literature that demonstrates the industrial use of this model to this type of problem (2-5 articles)
General Model Structure(s)
- Decision Variables or Decision alternatives
- Objective(s)
- Constraints
- Data Sources

You must apply optimization models to a representative data set. Use Solver to run your model. Make recommendations based on a thorough sensitivity analysis of the model output.

Written Project Requirements

The written project reports must be typed or computer printed (laser quality only). The length of the written report is strictly limited to 10 pages, but exhibits up to 5 additional pages may be appended. Each report must include the following information, but not necessarily in this order:

a. Executive summary, Project Description or Definition
b. Model Formulation and Solution
c. Model Analysis
d. Sensitivity Analysis
e. Recommendation
   1. potential impact of your model to a department or workgroup
   2. wider impact to the company
   3. how you project can be rolled up into a broader strategy to compete on analytics.
f. Lessons learned and scope for further development of model.