INSY 4970/7970/7976
Vehicle Routing & Logistics
Spring 2014

Instructor: Dr. Chase Murray
E-mail: All e-mail communication will be handled via Canvas.
Office: 3301F Shelby
Office Hours: (See Canvas)

Teaching Assistant: Nader Al Theeb
Office Hours: (See Canvas)

- Credit Hours: 3
- Course Website: Canvas will be used for all course grades, for e-mail, material distribution, etc.
- Lecture Schedule: TR 11:00am – 12:15pm, (classroom to be determined).

Course Description:
The Council of Supply Chain Management Professionals defines logistics as:

The process of planning, implementing, and controlling procedures for the efficient and effective transportation and storage of goods including services, and related information from the point of origin to the point of consumption for the purpose of conforming to customer requirements. This definition includes inbound, outbound, internal, and external movements.¹

In this course, we will apply Operations Research techniques to model and solve problems related to vehicle routing in the context of logistics systems.

Prerequisites:
- INSY 3410 (Deterministic Operations Research), or equivalent
- INSY 3700 (Operation Planning), or equivalent
- Experience in (or a strong desire to learn) computer programming

Learning Objectives:
1. Understand the role of transportation in logistics systems and develop an appreciation for the unique challenges faced by decision makers for routing, scheduling, and dispatching vehicles.
2. Understand the classical traveling salesman problem (TSP) and vehicle routing problem (VRP), which form the foundations for many real-world transportation problems. What makes these problems difficult to solve? To what extent does the choice of a problem formulation impact solution difficulty?
3. Understand, and be able to classify, relevant extensions to the TSP and VRP.
4. Learn techniques for solving the vehicle routing problems defined in the course, including off-the-shelf general mixed integer solvers (e.g., CPLEX), vehicle routing software, and heuristics coded in MATLAB.

Course Topics:
1. Introduction
   - What is logistics? What activities comprise logistics management? What is the role of
     vehicle routing, scheduling, and fleet dispatching in logistics management?
2. Brief Review of Network Formulations and Solution Approaches
   - Transportation problem, minimum-cost network flow, shortest path, etc.
3. Traveling Salesman Problem (TSP)
   - Formal definition and mathematical formulations. Learn how to solve the TSP with
     commercial solvers (e.g., CPLEX, LINGO, or Gurobi) and understand how different
     problem formulations can improve the solvers’ efficiency. Investigate
     alternative/custom solvers (e.g., Tours) and code simple heuristics for solving the TSP
     in MATLAB.
4. Vehicle Routing Problem (VRP)
   - Formal definition and mathematical formulations. Learn how to solve the VRP with
     commercial solvers (e.g., CPLEX, LINGO, or Gurobi) and understand how different
     problem formulations can improve the solvers’ efficiency. Investigate
     alternative/custom solvers (e.g., Tours) and code simple heuristics for solving the VRP
     in MATLAB. Modify existing heuristics (e.g., by combining aspects from multiple
     approaches) to solve VRP instances.
5. Incorporating Realism into the VRP
   - Investigate problems that may be formed by adding new features to a baseline VRP
     model. Example extensions include heterogeneous capacitated vehicles, truck driver
     working hour restrictions, and customer time windows. These problems will motivate
     discussions on key logistics-related terminology and concepts.
   - Use IBM Transportation Analyst to solve and analyze solutions to these extended
     problems.
6. Investigate the Relationship between Inventory and Vehicle Routing
   - How do transportation costs affect inventory decisions?
7. Transportation Systems
   - Investigate distinguishing characteristics of common transportation modes (e.g., truck,
     rail, ship, air). Discuss multi-modal transportation systems.
8. Case Studies
   - Explore a variety of interesting problems from the literature. Examples include:
     o The dial-a-ride problem (a stochastic VRP)
     o Green logistics
     o Humanitarian logistics
     o Cross docking (vehicle routing with coordination constraints)
     o Delivery of perishable goods

Required Material:
- **Software:** CPLEX/Gurobi, IBM Transportation Analyst, LogicNetPlus, MATLAB, Tours
Supplementary Materials:
- A. McKinnon, S. Cullinane, A. Whiteing, and M. Browne, (2010), *Green Logistics: Improving the Environmental Sustainability of Logistics*, Kogan Page Limited
- Journal articles from *Transportation Science, Transportation Research*, and *Naval Research Logistics* (among others).

Course Requirements/Evaluation: Students will be evaluated based on the following:

<table>
<thead>
<tr>
<th>Item</th>
<th>Approximate Dates</th>
<th>Weight 4970</th>
<th>Weight 797x</th>
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</thead>
<tbody>
<tr>
<td>Homework Activities</td>
<td>Miscellaneous, approximately 4–6 throughout the semester.</td>
<td>35%</td>
<td>25%</td>
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<tr>
<td>Exam</td>
<td>Most likely in March.</td>
<td>25%</td>
<td>25%</td>
</tr>
<tr>
<td>Course Project</td>
<td>Deliverables throughout the latter part of the semester.</td>
<td>40%</td>
<td>40%</td>
</tr>
<tr>
<td>Survey Paper</td>
<td>Near the end of the semester.</td>
<td>-</td>
<td>10%</td>
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Final course grades will be determined based on the following scale:

- Student’s Final Average $\geq 90.0\%$ A
- Student’s Final Average $\geq 80.0\%$ B
- Student’s Final Average $\geq 70.0\%$ C
- Student’s Final Average $\geq 60.0\%$ D
- Student's Final Average $< 60.0\%$ F

*Do not expect your grade to be “rounded up.”*

Homework: Approximately four (4) to six (6) take-home assignments will be given throughout the semester. Unless stated otherwise, these assignments are to be performed individually. Strict adherence to the University’s academic honesty policies will be enforced. Late assignments will not be accepted.
Exam: The exam will be closed-book, closed-notes, and in-class, unless stated otherwise. A study guide will be provided to help you prepare for the exam.

Course Project: The team-based course project will focus on applying (and extending) the techniques learned in class to problems motivated by real-world challenges. The project will consist of multiple parts, with due dates throughout the semester:

- Preliminary Report (20%) – Submit a document that clearly describes the nature of the problem under consideration. The report should succinctly explain the importance of this problem, provide an overview of related problems (i.e., how can you leverage existing research to help you solve this problem?), and outline your course of action for modeling and solving this problem.
- Final Report (60%) – Submit a document that summarizes your model and solution approach to the problem. Experimental results should demonstrate the effectiveness of your approach and highlight important/interesting aspects of this problem.
- Final Presentation (20%) – Each team is expected to provide an in-class presentation of the research.

More details will be provided in class.

Survey Paper: Students enrolled in 7970/7976 (graduate) must complete a survey paper related to vehicle routing, scheduling, or fleet dispatching. Expectations for this paper will be provided in class.

Final Exam: There will be no “final exam” for this course.

Exam Makeup Policies: An exam missed due to authorized Tiger Cub absences will be made up as an oral exam. The exact day/time for the oral makeup will be decided by the instructor and the student. Proper documentation of the absence must be provided. Missing an exam due to an unexcused absence will result in a grade of zero (0) on the exam.

Policy for Off Campus Students: All individually-assigned homework assignments should be submitted electronically via Canvas within one (1) week of the due date given to the “local” students. In the case of group-based assignments, off-campus students will be expected to work with “local” students; as such, each of these assignments will have a common due date for both off campus and “local” students. The exam for off campus students will be handled through the Auburn University Graduate Outreach Program Director’s office, and will typically be given one (1) week after the “local” students take the exam.

Attendance: While attendance is highly recommended, it will not be a factor in the course grade.

Disabilities: Students who need accommodations are asked to arrange a meeting during office hours the first week of classes, or as soon as possible if accommodations are needed immediately. If you have a conflict with my office hours, an alternate time can be arranged. To set up this meeting, please contact me by e-mail. If you have not established accommodations through The Office of Accessibility, but need accommodations, make an appointment with The Office of Accessibility, 1228 Haley Center, 844-2096 (V/TT).
**Academic Honesty:** All portions of the Auburn University student academic honesty code (Title X11) found in the Tiger Cub will apply to this class. All academic honesty violations or alleged violations of the SGA Code of Laws will be reported to the Office of the Provost, which will then refer the case to the Academic Honesty Committee. Violations include, but are not limited to:

- **Cheating on an examination** – This includes such things as copying from another’s paper, using unauthorized notes, calculators, etc., or giving or receiving unauthorized aid, such as trading examinations, whispering answers, passing notes, or using electronic devices to transmit or receive information.

- **Plagiarism** – This is using someone else's work without giving credit. It is, for example, using ideas, phrases, papers, laboratory reports, computer programs, data - copied directly or paraphrased - that you did not arrive at on your own. Sources include published works such as book, movies, web sites, and unpublished works such as other students' papers or material from a research service. In brief, representing someone else's work as your own is academically dishonest. *The risk of plagiarism can be avoided in written work by clearly indicating, either in footnotes or in the paper itself, the source of any major or unique idea or wording that you did not arrive at on your own.* Sources must be given regardless of whether the material is quoted directly or paraphrased.

  *Copying another student's assignment and putting your name on it is plagiarism.*

- **Unauthorized collaboration** – This is working with or receiving help from others on graded assignments without the specific approval of the instructor. *If in doubt, seek permission from the instructor before working with others.* Students are encouraged to learn from one another: Form study groups and discuss assignments, but each assignment must be individual work unless specifically stated and turned in as a group assignment.

- You are encouraged to talk to one another about your assignments, however, all assignments must be done by the student(s) whose name is (are) on it!

- **Multiple submission** – This means using the same work to fulfill the academic requirements in more than one course. *Prior permission of the instructors is essential.*

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Syllabus prepared by C. Murray

*Revision History:*

  1/6/14 – Syllabus posted on Canvas.
  1/8/14 – Syllabus modified to include GLM textbook and exam date in March.