Lecture classes: T R 2:00-3:20 pm, NSC 228  
Recitations or labs: N/A  
Instructor: Dr. Qing He, Bell 313 or Ketter 225, 645-3470, qinghe@buffalo.edu  
Office hours: Tuesday 3:30-4:00 pm and Thursday, 3:30 – 5:00 pm, Ketter 225  
Teaching assistant(s): Ramya Kamineni, rkaminen@buffalo.edu  
Prerequisite(s): CIE 439 or Graduate/ Senior standing  
Course web site: UB Learns  


Catalog Description: This course addresses the design, operation, control and management of transportation facilities. Topics covered include traffic stream characteristics, fundamentals of traffic flow theory, traffic studies, capacity analysis for freeway segments, signal timing and design, and intersection design and layout. Students will be introduced to a number of traffic analysis and traffic simulation software, including the SYNCHRO/SimTraffic model.

As a part of this course, students will be required to undertake a comprehensive term project that would involve detailed analysis and/or simulation of a given transportation facility. Graduate students may also be required to write a survey-type paper on a topic of recent interest that is related to traffic operations and design.

Course Objectives: The course addresses the design, operations, control and management of freeways and urban streets. Topics covered include traffic streams, traffic flow theory fundamentals, statistical applications in traffic engineering, data collection, volume studies, speed studies, safety studies, capacity analysis for freeway segments, and signal timing and design.

Course Learning Outcomes: Upon successful completion of the course, students will be able to:

<table>
<thead>
<tr>
<th>Course Learning Outcomes</th>
<th>SO</th>
<th>Assessment Tools</th>
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<tbody>
<tr>
<td>1. Understand the basics of traffic flow theory</td>
<td>a</td>
<td>HW; tests; final</td>
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<tr>
<td>2. Conduct several traffic studies including volume and speed studies</td>
<td>b, d</td>
<td>HW; tests; final</td>
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<tr>
<td>3. Determine the capacity &amp; level of service for basic freeway section</td>
<td>a, c</td>
<td>HW; tests; final</td>
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<tr>
<td>4. Determine the capacity &amp; level of service for weaving sections</td>
<td>a, c</td>
<td>HW; tests; final</td>
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<tr>
<td>5. Use SYNCHRO/SimTraffic to analyze and design signalized intersections and signalized corridors</td>
<td>d, f, h, g, k</td>
<td>Term-project</td>
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<td>6. Appreciate the fundamentals of traffic signal design and control</td>
<td>a, c</td>
<td>HW; tests; final</td>
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<tr>
<td>7. Design both pre-timed as well as actuated signals</td>
<td>a, c</td>
<td>HW; tests; final</td>
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Contribution of CIE 436 towards fulfillment of Student Outcomes (SO):

(a) An ability to apply knowledge of science, mathematics, and engineering. This course builds upon the students’ background knowledge of mathematics, statistics, and probability theory to address traffic-related problems. Many of the analysis tools have their foundation in science and mathematics.

(b) An ability to design and conduct experiments, as well as to analyze and interpret data. CIE 436/536 teaches students how to conduct several traffic studies, and how to design an effective plan for data collection and extrapolation.

(c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability. CIE 436/536 includes several design elements such as the design of basic freeway sections and weaving sections, and the design of signalized intersections.

(d) An ability to function on multi-disciplinary teams. In CIE 436/536, students work in teams to conduct various traffic studies, collect traffic data, and to analyze and simulate a signalized corridor.

(e) An ability to identify, formulate, and solve engineering problems. CIE 436/536 abounds with example problems and homework assignments designed to train students on how to identify, formulate and solve engineering problems.

(f) An understanding of professional and ethical responsibility. CIE 436/536 includes a very brief introduction to the professional and ethical responsibilities of traffic engineers.

(g) An ability to communicate effectively. CIE 436/536 includes a term-project where students will be required to write a comprehensive and professionally-looking report documenting their findings.

(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. CIE 436/536 includes several examples where the impact of traffic facilities and traffic design decisions on the environmental and societal systems are illustrated.

(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. CIE 436/536 teaches students how to use computer simulation software for the analysis and design of signalized intersections and corridors. In addition, many example problems and homework assignments require the student to use spreadsheets to organize the calculations.

Relationship of Course to Student Outcomes (Course Assessment Matrix):

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<tr>
<th>a</th>
<th>b</th>
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Contribution Level: Substantial = 3, Moderate = 2, and Limited = 1
Course Requirements: There will be one mid-term, in-class quizzes, several homework assignments, a term project (with labs) and a final. Graduate students will be required to write a research paper on a topic of interest.

Homework: Homework problems are due one week after the date of assignment. It is expected that each student will do all homework individually, although general discussion amongst colleagues is encouraged. Late homework will receive penalty.

Group Project: Group project involves a series of labs. Some of labs require outdoor traffic studies (including volume and travel time studies). Some of labs use the traffic analysis and simulation software (SYCHRO/SimTraffic) to model and analyze performance on signalized intersections. For these labs, you will work in groups of around 3~4 people.

Exams: There will be one mid-term exam and a final exam. No make-up examinations are allowed except for extreme cases. However, arrangements can be made for taking a test before the scheduled time if the excuse is reasonable.

Attendance: Attendance is expected at all classes since education involves the two-way interchange between student and teacher. Attendance will be recorded by random in-class quizzes.

Grading Policy: Your final grade for this course will be based on the following components:

- Homework Assignments: 13%
- Mid-term: 25%
- Project: 30%
- Final: 30%
- In-class Quizzes: 2%
- A Survey Paper (grad only).
  - The survey paper accounts for 10% of course average for graduate students.

To qualify for a particular letter grade, the minimum course average shown after that grade will be needed:
A: 90+; A-: 86-89; B+: 82-85; B: 78-81; B-: 74-77; C+: 70-73; C: 66-69; C-: 62-65; D+:58-61; D: 54-57; F: < 54.

I reserve the right to lower these cutoffs (i.e., give higher grades than indicated) under some circumstances (e.g., if one of the exams turns out much too difficult). However, I will not raise the cutoffs.

Grade ‘I’ will be strictly limited to the circumstances for which the incomplete is intended; namely, satisfactory work to date and legitimate inability to complete the work within the semester. See UB policy (http://undergrad-catalog.buffalo.edu/policies/grading/explanation.shtml).
**Academic Integrity:** The University at Buffalo takes very seriously its commitment to principles of academic integrity. Please review the UB policies regarding academic integrity regularly (http://academicintegrity.buffalo.edu/policies/index.php).

As an engineer, you have special ethical obligations. As per the NSPE Code of Ethics, “engineers shall avoid deceptive acts” and “shall conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.” For additional information about the procedures in place within the CSEE department, see the academic integrity section of the departmental website (http://www.csee.buffalo.edu/undergraduate/current-students/academic-integrity/).

**Accessibility Resources:** If you require classroom or testing accommodations due to a disability, please contact Accessibility Resources, located at 25 Capen Hall. Accessibility Resources can be reached by phone at (716) 645-2608 or by email at stu-accessibility@buffalo.edu. Please inform me as soon as possible about your needs so that we can coordinate your accommodations. For additional information, see http://www.buffalo.edu/accessibility/index.php.

**Course Outline:**

- Introduction to Traffic Engineering & Its Scope (Chapter 1)
- Traffic Stream Characteristics (Chapter 5)
  - Types of Facilities & Traffic Stream Parameters
  - Relationships among Flow Rate, Speed and Density
- Introduction to Traffic Flow Theory (Chapter 6)
  - Basic models of uninterrupted flow
  - Queueing Theory
  - Shock-wave Theory and Applications
- Statistical Applications in Traffic Engineering (Chapter 7)
  - Common Statistical Estimators
  - Confidence Bounds
  - Sample Size Computations
  - Addition of Random Variables
  - Hypothesis Testing
- Traffic Data Collection and Reduction Methodologies (Chapter 8)
- Volume Studies and Characteristics (Chapter 9)
- Speed, Travel Time and Delay Studies (Chapter 10)
- Capacity Analysis of Multi-lane Uninterrupted Flow Facilities (Chapter 14&15)
  - Capacity and Level of Service Concept
  - Analysis Methodology for Basic Freeway Sections
  - Analysis Methodology for Weaving Sections
  - Analysis Methodology for Merge and Diverge Sections
- The Hierarchy of Intersection Control (Chapter 18)

- Basic Principles of Intersection Signalization (Chapter 20)
  - Discharge Headway and Saturation Flow
  - Critical Lane and Time Budget Concepts
  - Delay as a Measure of Effectiveness

- Fundamentals of Signal Design and Timing (Chapter 21)
  - Development of Signal Phase Plans
  - Determining Vehicular Requirements
  - Determining Pedestrian Signal Requirements

- Actuated Signals and Detection (Chapter 22)
  - Detectors and Detection
  - Actuated Control Features
  - Actuated Signal Timing and Design