

**Traffic Flow Theory**  
TTE 6267  
**Class Periods:** MWF 10:40-11:30 am  
**Location:** NEB 0201  
**Academic Term:** Fall 2023

**Instructor**

Dr. L. Elefteriadou  
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**Course Description**

Vehicle-roadway-infrastructure interactions, equations of motion, and car-following; microscopic and macroscopic traffic characteristics and traffic stream models; simulation, queueing theory and shockwave analysis (3 credits)

**Course Pre-Requisites / Co-Requisites**

TTE 4201/5256 Traffic Engineering, or equivalent; otherwise instructor permission required.

**Course Objectives**

When you complete this course you will be able to evaluate how a highway facility would operate under a given set of conditions (demand, traffic stream characteristics, highway environment, etc.) and to determine what changes can be made in those conditions to improve operations.

More specifically, you will be able to:

- List the fundamental microscopic and macroscopic traffic flow characteristics.
- Formulate and apply theories for describing and explaining the motion of a single vehicle and groups of vehicles (including conventional, connected, and autonomous vehicles); examine theories regarding the movement of pedestrians and bicycles.
- Compare and contrast several traffic analysis techniques such as shockwave analysis, queueing analysis, and microsimulation.
- Apply these techniques to a variety of highway facilities (for example, freeways, urban streets, roundabouts, pedestrian facilities, crosswalks, etc.)
- Review the state-of-the-art in traffic management techniques, autonomous and connected vehicle trajectory optimization, signal control optimization, and freeway management.

**Materials and Supply Fees**

N/A

**Required Textbooks and Software**

An Introduction to Traffic Flow Theory, L. Elefteriadou, Springer, 2014

**Statistics Videos and References**

<https://www.khanacademy.org/math/statistics-probability/modeling-distributions-of-data/more-on-normal-distributions/v/introduction-to-the-normal-distribution>  
<https://www.khanacademy.org/math/statistics-probability/significance-tests-one-sample/idea-of-significance-tests/v/simple-hypothesis-testing>  
<https://www.khanacademy.org/math/statistics-probability/inference-categorical-data-chi-square-tests/chi-square-goodness-of-fit-tests/v/pearson-s-chi-square-test-goodness-of-fit>

### **Other Recommended Materials and References**

Cyber Physical Systems in Transportation: Traffic Management With Connected and Autonomous Vehicles”, Chimay J. Anumba and Nazila Roofigari-Esfahan (Eds): Cyber-Physical Systems in the Built Environment, Springer, July 2020, <https://doi.org/10.1007/978-3-41560-0>  
Highway Capacity Manual 7th Edition (HCM7), Transportation Research Board, Washington DC, 2022  
Traffic Engineering, Roes, Prassas, McShane, 5th Edition, 2019  
Traffic Flow Theory, A monograph (Web Document: [www.tfhrc.gov/its/tft/tft.htm](http://www.tfhrc.gov/its/tft/tft.htm))  
Traffic Flow Fundamentals, Adolf D. May, 1990  
Introduction to the Theory of Traffic Flow, Wilhelm Leuzbach, 1988

### **Course Schedule**

#### Module 1

INTRODUCTION: Role of traffic flow theory in transportation, objectives of traffic flow theory, relationships to other areas of transportation; PART I, CHAPTER 1: Vehicle/driver/environment interactions, motion of a single vehicle, constant speed, constant acceleration; Varying acceleration, acceleration functions, vehicle trajectories; Vehicle, driver, environment considerations for equations of motion for a single vehicle.

#### Module 2

CHAPTER 2: Modeling vehicle interactions and the movement of groups of vehicles, car-following; Currently used car-following models; Car-following and automated vehicles; Lane changing and gap acceptance models.

#### Module 3

PART II, CHAPTER 3: The traffic stream, traffic flow performance, flow and time headways. *REVIEW: Distributions, hypothesis testing, comparing means*; Speed, space mean speed and time mean speed. *REVIEW: Comparing distributions, required sample size, chi-square hypothesis testing*; Density and space headway. *REVIEW: K-S test for comparing distributions*; *REVIEW: Hypothesis tests of means and variances for speeds and headways*; Traffic stream models, the Greenshields model, HCM traffic stream models; Mathematical expressions of traffic stream models, relationship between traffic stream and car-following models; Pedestrian and bicycle flow models.

#### Module 4

CHAPTER 4: Capacity and its definition, breakdown, breakdown probability distributions.

#### Module 5

CHAPTER 5: The four dimensions of mobility. Traffic operational performance measures, travel time and delay, travel time reliability, queue length and other mobility performance measures, MOEs in the HCM [**Material up to here for mid-term exam**].

#### Module 6

ON-LINE MATERIAL: Overview of the *Highway Capacity Manual, 7<sup>th</sup> Edition*.

#### Module 7

PART III, CHAPTER 6: Traffic operational analysis techniques, shock wave analysis, types of shockwaves; Cumulative plots, queuing analysis, deterministic queuing; Queue accumulation polygons in the HCM, stochastic queuing, applications of queuing analysis. Optimization techniques.

**Monday, Oct. 16 - REVIEW SESSION**

**Wednesday, Oct. 18 - MID-TERM EXAM**

## Module 8

CHAPTER 7: Simulation modeling, stochastic micro-simulation, Random Number Generators; Components of a traffic simulator, using an existing simulator; Hardware-in-the-loop, driving simulators, vehicle simulators; Traffic Operational Analysis Techniques – Which one to use when?

## Module 9

PART IV, CHAPTER 8: Highway facilities and principles for their analysis, freeway segments and systems, freeway merging, diverging, and weaving; CHAPTER 8: Advanced traffic management methods for freeway facilities, ramp metering; CHAPTER 8: Variable speed limits, HOV/HOT lanes, congestion pricing, HCM methods; Connected and autonomous vehicles, truck platooning, trajectory optimization for merging and weaving.

## Module 10

CHAPTER 9: Signalized intersections, signalization principles, lost time and saturation headway; Signalized intersections, cycle length estimation, delay estimation; Signalized intersections, pre-timed and actuated control, the dual ring; Signalized intersections in the HCM; Signal control for arterials and networks, offsets and coordination; Optimization of isolated intersection control for automated vehicles

## Module 11

CHAPTER 10: Unsignalized intersections and roundabouts, principles of gap acceptance. Optimization of roundabout operations with CAVs.

## Module 12

Interchange designs and operations. Innovative intersections and interchanges; Optimizing automated vehicle trajectories along arterials; Highway networks, interactions between freeways and arterials.

## Module 13

Two-lane highways. Design and operations. Design, passing maneuvers, density and related performance metrics.

## Lecture 42 Wednesday, Dec. 6 - CLOSING AND REVIEW SESSION

## FINAL EXAM Thursday, December 14, 5:30-7:30 pm

### ***Attendance Policy, Class Expectations, and Make-Up Policy***

#### a. Attendance:

For on-campus students, class attendance is encouraged and you are responsible for material assigned in the readings and covered in class. Any absence should be coordinated in advance, if possible. Late assignments (unless coordinated in advance) will have a 5% grade reduction per day. (Delay up to 24 hours will have a reduction of 5 %, etc.) Excused absences must be consistent with university policies in the Graduate Catalog (<https://catalog.ufl.edu/graduate/regulations>) and require appropriate documentation. Additional information can be found here: <https://gradcatalog.ufl.edu/graduate/regulations/> For EDGE/on-line students, you are responsible for keeping up with viewing the lectures and completing the assignments on-time. It is very important that you ask any questions you may have in a timely manner, so that you do not fall behind in the assignments and the lecture material.

#### b. Classroom Procedures:

Bring the book, course notes, any additional assigned reading material, a calculator, and note taking material to each class period. Cell phone use during class is strictly prohibited, and all cell phones should be turned off during class. If you know you will have to miss a lecture or have a conflict with an exam time please let me know as soon as possible.

#### c. Additional Instruction:

If you are having a difficult time understanding a concept, coordinate a time with me for additional instruction, as needed.

d. **Written Submissions:**

A significant part of engineering is written communication. Strong emphasis will be placed on the clarity, organization and readability of your work. It is preferable that the assignments and reports are typed, but in the event they are hand-written, they must be very neatly presented. All information extracted from external references (journals, books, etc.) must have appropriate notation and bibliographic citations. Assistance from other students or instructors must be properly acknowledged as a parenthetical note and a proper bibliographic citation.

**EDGE/On-line students:** Please contact me via e-mail (through the Canvas system) to ask questions and to resolve any issues that arise throughout the course. We can also arrange to meet over Zoom.

***Evaluation of Grades***

<b>Assignment</b>	<b>Total Points</b>	<b>Percentage of Final Grade</b>
Homework (7-8)	100 each	40%
Quizzes (13)	100 each	10%
Midterm Exam	100	25%
Final Exam	100	25%
		100%

***Grading Policy***

<b>Percent</b>	<b>Grade</b>	<b>Grade Points</b>
95.0 - 100.0	A	4.00
90.0 - 94.9	A-	3.67
85.0 - 89.9	B+	3.33
80.0 - 84.9	B	3.00
75.0 - 79.9	B-	2.67
70.0 - 74.9	C+	2.33
65.0 - 69.9	C	2.00
60.0 - 64.9	C-	1.67
55.0 - 59.9	D+	1.33
50.0 - 54.9	D	1.00
45.0 - 49.9	D-	0.67
0 - 44.9	E	0.00

More information on UF grading policy may be found at:

[UF Graduate Catalog](#)  
[Grades and Grading Policies](#)

***Students Requiring Accommodations***

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

***Course Evaluation***

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

## **In-Class Recording**

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

## **University Honesty Policy**

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://sccr.dso.ufl.edu/process/student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

## **Commitment to a Safe and Inclusive Learning Environment**

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Jennifer Nappo, Director of Human Resources, 352-392-0904, [jpennacc@ufl.edu](mailto:jpennacc@ufl.edu)
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, [taylor@eng.ufl.edu](mailto:taylor@eng.ufl.edu)
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, [nishida@eng.ufl.edu](mailto:nishida@eng.ufl.edu)

## **Software Use**

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

### ***Student Privacy***

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

### ***Campus Resources:***

#### ***Health and Wellness***

##### **U Matter, We Care:**

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact [umatter@ufl.edu](mailto:umatter@ufl.edu) so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

**Counseling and Wellness Center:** <https://counseling.ufl.edu>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

##### **Sexual Discrimination, Harassment, Assault, or Violence**

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, [title-ix@ufl.edu](mailto:title-ix@ufl.edu)

##### **Sexual Assault Recovery Services (SARS)**

Student Health Care Center, 392-1161.

**University Police Department** at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

#### ***Academic Resources***

**E-learning technical support**, 352-392-4357 (select option 2) or e-mail to [Learning-support@ufl.edu](mailto:Learning-support@ufl.edu).  
<https://lss.at.ufl.edu/help.shtml>.

**Career Connections Center**, Reitz Union, 392-1601. Career assistance and counseling; <https://career.ufl.edu>.

**Library Support**, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

**Teaching Center**, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.  
<https://teachingcenter.ufl.edu/>.

**Writing Studio, 302 Tigert Hall**, 846-1138. Help brainstorming, formatting, and writing papers.  
<https://writing.ufl.edu/writing-studio/>.

**Student Complaints Campus:** <https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>; <https://care.dso.ufl.edu>.

**On-Line Students Complaints:** <https://distance.ufl.edu/state-authorization-status/#student-complaint>.