

**CEE 408 - Fall 2026
Railroad Transportation Engineering
Course Syllabus**

Instructor

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Francesco will be holding office hours online using Zoom at the following days and times:

- Day and time: Friday morning 8:00-9:00, Thursday morning 7:30-8:30
- Other times by appointment (make an appointment via email)

Course Web Site (Canvas): <https://canvas.illinois.edu/courses/72619>

PDFs of all reading assignments have been posted on the course Canvas page, and PDFs of the Lecture Notes will be posted before class. Students are encouraged to bring their laptops or tablets to class and follow along, taking digital notes or writing in a traditional notebook.

Lectures: The opening lecture will be provided live online. The first part of the course will be provided using pre-recorded lectures, and the remainder will be presented live in 2312 NCEL during the regular class periods. All lectures will be recorded, primarily for online and KTH students, but can also be watched by on-campus students if you need to miss a class. If I need to miss class due to travel, I will notify students and prerecord

the lecture.

Course Media Space Page: <https://mediaspace.illinois.edu/channel/2B2026/413509292>

Lecture recordings will generally be available within a few hours after they are recorded. Students should keep up to date by attending or watching all lectures, reading the assignments, and completing homework assignments.

Credit: 3 undergraduate or graduate hours.

Prerequisite: CEE 310. Students who have not taken CEE 310 or equivalent may wish to complete additional background reading in order to perform well on the exams and to be in a position to participate fully in class discussions. They should schedule a meeting with the instructor to discuss during the first week of the semester.

Course Description

Rail transportation requires infrastructure, vehicles, motive power, and energy to move goods and people. Each of these interacts to affect efficiency, service quality, energy requirements, economics, and environmental impact of railroad transport. Railroad technology spawned a transportation revolution that continues to substantially influence national and global markets. This course includes an introduction to the fundamental economics of transportation that shapes the role of the rail mode in freight and passenger transportation. This is followed by consideration of railroad rolling stock design, running gear and other mechanical components, train braking system design, function and dynamics, and locomotive design, operation and function. Quantitative analysis of train resistance and consequent power and train energy requirements, including effects of aerodynamics, grade, and curvature, is covered with consideration of train speed, power, and acceleration. Next is an introduction to railroad track system design, components, roadbeds, and maintenance required to support the movement of railway vehicles. The course concludes with a discussion of passenger rail transportation, high-speed rail, and the technical and operational challenges of increasing the speed and frequency of passenger rail service on existing freight rail corridors. There will possibly be a field trip to the Monticello Railway Museum to participate in infrastructure maintenance and inspect rolling stock characteristics.

Course Vision

To provide students with a complete picture of the railway transportation mode and its role in the overall freight and passenger transportation system. By giving students a knowledge of the economics, efficiencies, operations, and infrastructure requirements of railway transportation, they will be prepared to consider a proper balance between all modes and develop more effective solutions for the challenges facing civil engineers engaged in planning, design, construction, and operation of transportation systems.

Course Instructor's Mission

Encourage students to develop and/or refine their ability to critically evaluate transportation modes, encourage growth in communication skills, form lasting friendships amongst the class, and leave the class with a strong foundation in fundamental transportation economics that drive civil engineering projects. Encourage students to consider careers in railway engineering through increased exposure to the railway mode and the possible job opportunities.

Course Objectives

This course will provide you with foundational knowledge of the economics, efficiencies, operations, and infrastructure requirements of the railway transportation system and how these characteristics shape the role of the railway mode in the overall freight and passenger transportation system. The railcar portion of the class will allow the students to understand the optimization of the railcar structure and systems and how this leads to the shape and size of railcars and their subsequent space and clearance requirements. The train resistance, power, and acceleration portion of the class will provide the students with the tools required to perform basic train performance simulations to determine the running time over a particular railway route. An introduction to basic track design concepts is designed to provide the students who may be designing other civil engineering projects that interface with the railway mode in the future basic design tools and an understanding of the requirements and standards for railway infrastructure. Finally, the passenger rail portion of the class will allow you to be introduced to the issues, technical challenges, and operational obstacles required to implement high-speed rail in North America and higher-speed rail on existing freight corridors.

Required and Suggested Readings:

Chapters from the following three books, along with various other materials

- Armstrong, The Railroad; What it is, What it Does, 5th edition
- Hay, W. W., Railroad Engineering, 2nd edition
- Locklin, Economics of Transportation
- Other selected textbooks, magazines, and manuals (see course schedule and reading list for complete citations)

You are not required to purchase any of the above textbooks or reference materials. All relevant chapters will be provided on Canvas.

Class Sessions & Field Trip

Class sessions will include lectures, discussions of the readings, and small group activities. Please bring calculators and writing materials to all class meetings, as there may sometimes be problems that we will be working through individually or as a group. We plan to schedule one or more field trips to visit local rail facilities and/or the Monticello Railway Museum in Monticello, IL, at a date TBD. Field trips are required unless you are unable to attend due to a serious conflict. Please notify the instructor immediately if you will be unable to attend.

Course Content

TOPIC	CONTACT HOURS
Role of freight and passenger rail transport	4.5
Railroad efficiency and the transportation revolution	1.5
Railroad transportation economics	7.5
Transportation competition, regulation, and deregulation	3.0
Railcar design	4.5
Train braking system	3.0
Train resistance and energy	1.5
Motive power design and requirements	1.5
Train acceleration and performance simulation	1.5
Track system components, design, and maintenance	4.5

Geometric and bridge design considerations	1.5
High-speed rail and shared rail corridor challenges	3.0
Examinations	5.5
Total Contact Hours	43.0

Homework Assignments

Course assignments will help you achieve the objectives of the course that were described earlier. Unless otherwise specified, all written assignments must be submitted via Canvas. The filename for your assignments should be as follows:

“CEE_408_LastName_HomeworkNumber”.

Canvas submissions must be submitted by 11:59 PM US Central Time on the date they are due. (*see Late Submission Policy below*)

Assigned Reading and Discussion

To prepare for the classroom discussions and enhance your understanding of the subject, you are expected to complete the reading assignments prior to the beginning of each class period for which the reading is listed. Reading assignments are listed in the course schedule, and PDFs of all reading assignments can be found on Canvas in the “Reading Assignments” folder.

Examinations

There will be three closed-book exams in this course. All will be held in the regular classroom 2312 Yeh, NCEL:

- Exam 1 will be on October 7
- Exam 2 will be on November 16
- Exam 3 (non-cumulative Final Exam) will be on Monday, 14 December from 7:00-10:00 PM (*do not schedule departure from campus before this date and time*)

Online students will arrange scheduling of exams with their assigned proctor.

KTH Students will arrange the scheduling of exams with the KTH faculty or staff member managing the course in Stockholm.

Course Grading (3 Credit Hours – CEE 408)

Term Exam #1	25%
Term Exam #2	25%
Final Exam	25%
Homework Assignments	25%
Active Class Participation*	+++

Note: "Plus" and "Minus" Grading will be used in this class.

*Modified for online & KTH students

COURSE POLICIES

This course will follow all policies in the *Student Code* (<https://studentcode.illinois.edu/>). In addition to University Policies, we expect you all to show respect to your instructors and your classmates at all times, both in the classroom and on field trips. During field trips, you will be required to **strictly** follow individual railway safety procedures that will be discussed in greater depth prior to field trips. If you are unable or unwilling to abide by these procedures, you will not be allowed to attend the field trips.

Class Discussion and Participation

You are encouraged to actively participate in class by asking questions and responding to questions from the instructor. This will improve your understanding of the material, and it may also enhance your final course grade. If you have questions about this policy or would like interim feedback on your participation in class, please feel free to contact the instructor throughout the semester.

Attendance

Attendance in class is critical to your success, as discussions and presentation of lecture material will provide insights and knowledge that cannot be gained from the assigned reading and lecture materials alone.

Accommodations for Disabilities

If you require special accommodations, you should notify the instructor as soon as possible. In particular, you should contact the instructor if a disability might interfere with the successful completion of a course requirement. Accommodations will follow the procedures as stated in Article 1-110 of the *Student Code* <https://studentcode.illinois.edu/article1/part1/1-110/>.

Academic Integrity and Procedure

This course will follow Articles 1-401 through 1-406 of the *Student Code* beginning at <https://studentcode.illinois.edu/article1/part4/1-401/>. This rule defines infractions of academic integrity that include but are not limited to cheating, fabrication, and plagiarism. You are responsible for following these rules. If you have any questions about whether something would be an infraction, please consult with the instructor before proceeding.

Late Submission Policy

Unless otherwise specified, students shall submit assignments at or before 11:59 PM on the due dates. If you are unable to submit an assignment by this time, please contact the instructor or TA immediately, and an agreement will be reached that is fair to all parties involved. Ordinarily, 10% of the total value of the homework assignment will be subtracted for each day it is late.

Campus Syllabus Statements

Students should review information about campus policies at the following website at the beginning of the semester: <https://ae3.engineering.illinois.edu/syllabus-and-course-policy-statements-2/>

Classroom Health and Safety Policies and Procedures: Following University policy, all students are required to engage in appropriate behavior to protect the health and safety of the community. Students are also required to follow all campus COVID-19 protocols. Students who feel ill should not come to class, and students who test positive for COVID-19 or have had an exposure that requires testing and/or quarantine must not attend class. In these cases, you should watch the recorded lecture in order to keep up.