RAILROAD ENGINEERING CERTIFICATE

Curriculum Specifics

Program Description:

Railroad activity in the United States is flourishing, with expansion across the industry - in freight, passenger (inter-urban and commuter), transit, and emerging high-speed rail. With increased activity comes the need for highly trained professionals to ensure operating safety, efficiency, and cost-effective use of resources. Yet many of the most experienced engineers and supervisors are retiring, leaving a gap in knowledge, experience and capability. This certificate program can help fill that need, as indicated by a market research study conducted in 2013 by the Education Advisory Board, which noted that "Completion of several courses in railroad engineering adequately prepares students to compete for employment in the rail transportation industry." This graduate certificate is also designed for engineering professionals working in the area of railroad engineering or for those desiring to expand their knowledge of railroad engineering and related engineering disciplines, to thereby become viable candidates for advancement in the railroad industry. Certificate requirements are three 600 Level courses (9 credits) as defined below. All courses, to include all lectures, are available via internet on an off-line basis (24/7) using the University of Delaware's UD Capture and Canvas system. All course assignments are likewise accessible via remove access using the University of Delaware's UD Canvas system

Requirements for Admission:

Admissions and enrollment in railroad engineering certificate program courses are available to professionals and engineering graduates and does not require formal matriculation in a graduate engineering degree program. Admissions are managed through the Department of Civil and Environmental Engineering. GREs are not required for certificate program admission. The prospective student is required to submit a copy of his/her undergraduate transcript for review to ensure the necessary technical course background for success in the graduate railroad engineering courses. Those who hold an undergraduate degree in engineering should meet the criteria. Upon approval by the Director of Railroad Program, the student will be guided through the graduate admissions process. Part-time students are self- or industry-funded. Prospective students should contact Department of Civil and Environmental Engineering to begin the admission process at creoli@udel.edu. For further information contact the program director Professor Allan M Zarembski dramz@udel.edu.

Matriculated graduate students in civil or mechanical engineering are eligible to pursue the Graduate Certificate in Railroad Engineering, using their elective course options to focus on the field and earn the certificate. Students should discuss this with their faculty advisor and notify their department's Graduate or Undergraduate Academic Advisor.

Course Requirements

Required Courses:

Three courses, selected from the following (additional courses to be added to over time):

CIEG 614 - Railroad Geotechnical Engineering (3cr.)

CIEG 617 - Introduction to Railroad Safety and Derailment Engineering (3cr.)

CIEG 618 - Railroad Engineering (3cr.)

Note that any of the courses currently listed, or added later to the list of core course options, that are not used to fulfill the required core may be used as an elective course.

Elective Options:

As approved by the Railroad Engineering and Safety Program

Course Descriptions

INTRODUCTION TO RAILROAD ENGINEERING
CIEG-618
Fall Semester
Professor Allan M Zarembski

Objective: This course introduces railroad track structures and their major components; including functions and modes of degradation and failure. It addresses static and dynamic load environments and engineering design to effectively distribute loads throughout a structure. Additionally, the program provides both theoretical and practical approaches to track design as well as useful design, optimization and maintenance recommendations for key track components.

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Course description: This is the basic course in railroad and transit engineering required for the railroad engineering and safety program which introduces railroad engineering as part of the civil engineering curriculum. The proposed course provides the basics of railroad and transit engineering, provides students with the tools necessary to work in the railroad engineering field, as well as providing insight as to how engineering is applied on a practical basis in the railroad and transit industry.

Main Emphasis: This course addresses the fundamentals of railroad and transit engineering to include function and design of the railroad track structure, dynamic interaction with railway vehicles, and fundamentals of railroad systems, operations and component behavior. The major topics include the dynamic load environment of the railroad track (vertical, lateral and longitudinal), the analysis of the track as a Beam on Elastic Foundation, the analysis of the loading and stresses in each of the major track components (rails, ties, ballast, subgrade, slab, etc.), interaction between these major components, and integrated design of the track structure. Include wear and fatigue of rail, bending analysis of the cross-ties and/or slab track support, stress distribution in ballast and subgrade together with engineering techniques to determine allowable levels of stress and to reduce the stress levels through the track structure. Understand and apply basic railroad and transit engineering standards (AREMA, FRA, etc.).

This course addresses the application of engineering theory to specific problems and real-world issues and applications. It addresses basic problem-solving skills, by presenting students with real life problems to be encountered in the railroad or transit engineering areas and teaching students on how to solve these problems (Goal 2). The course presents real engineering situations encountered by railroad engineers and how to address them.

Course Outline: Introduction to Railroad Engineering

- Introduction to railroad operations
- Railroad alignment and its effects
    - Balance and unbalance on curves
        - Curvature and calculation of forces in curves
- Overview of the track structure
- Load Environment
    - Vehicle dynamic loading
        - Vertical
            - Quasi-static, dynamic impact equations (P1, P2),
        - Lateral
            - Curving forces
            - Angle of attack
            - Rolling radius differential effects
        - Longitudinal
            - Mechanical forces

        - Thermal forces in rail
- Beam of Elastic foundation theory
- Distribution of loading through the track structure
    - Rail to ties
    - Ties to ballast
    - Ballast to subgrade
- Rail
    - Analysis of rail loading and stresses
- Rail failure mechanism and development of defects
    - Rail stresses
    - Rail wear
    - Rail surface fatigue and failure
    - Rail internal fatigue and failure
    - Rail fracture and crack growth
- Ties and fasteners
    - Load transfer through ties
    - Tie bending moments and stresses
- Ballast and subballast
    - Load transfer through ballast
    - Ballast and subgrade stresses
- Subgrade
- Turnouts and Special trackwork
- Design of track section for
- Track Buckling
- Track Standards

Introduction to Railroad Safety and Derailment Prevention
CIEG-617
Spring Semester
Professor Allan M Zarembski

Objective: Explores the engineering issues associated with common types of derailments, including track, equipment and operator derailments. The specific failure mechanisms associated with key classes of derailments will be examined with the technologies available for reducing these types of derailments.

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Course Outline: Introduction to Railroad Safety and Derailment Prevention

1. Intro to railroads and railroad systems

    a. Track, Mechanical Signals and Operations
2. Overview of railroad safety
    a. Major categories of accidents and Derailments / FRA data base
    b. Derailment Investigation
    c. Example derailment Investigation
3. Rail Related derailments -1
    a. Rail fatigue (Hatfield), defect failure rates, risk, and UT
4. Rail Related Derailments- 2
    a. Wear, bolted rail derailments, welded failures
5. CWR related derailments
    a. Track buckles, buckling theory, installation temp
    b. CSX Amtrak buckle, Phoenix Light rail
6. Track Geometry related derailments-1
    a. Track standards, inspection, and safety
    b. Dynamic wheel rail forces
    c. Combined causes and vehicle/track interaction related derailments
7. Track Geometry related derailments-2
    a. Dynamic wheel/rail forces continued
    b. Wheel climb and derailments; L/V Nadal and related safety limits
    c. High c.g. loads
    d. Non-uniform –uneven loading
8. Turnout Related Derailments
9. Other track related derailment, causes, mechanisms and prevention
    a. Ties and Fasteners, GRMS
    b. Other
10. Wheel related derailments
    a. Overheated wheel and thermal cracks
    b. Fracture of wheel; US, ICE-DB
    c. Wheel inspection
11. Other Mechanical caused derailments; causes, mechanisms and prevention
    a. Axles and bearings (hot box and acoustic bearing detection)
    b. Trucks and truck components
    c. Brakes
    d. Other
12. Operating related accidents and derailments;
    a. Human factors (Amtrak NEC)
    b. Train makeup and operations
13. Signal and other accidents
    a. Human factor related (run through signal)
    b. Failed signals
14. Grade Crossing Accidents and personal protection

Railway Geotechnical Engineering
CIEG 614
Spring Semester
Dr. Steven Chrismer

Railway geotechnology is a relatively new field of study into the engineering behavior of track substructure. The performance and failure modes of the geotechnical layers under track are very distinct from those of the layers under a highway pavement, making railway geotechnology have a unique place in transportation engineering. The course will address the challenges associated with designing, constructing and maintaining a well-performing and long-lasting railway track from the ground up. The student will learn the methodologies and technologies needed to develop a state-of-art railway track substructure including aspects of materials, mechanics, drainage, loading, slopes, design, maintenance, measurements and management and case studies. The course will cover track substructure issues related to both heavy axle load freight and high-speed passenger rail traffic.

Course outline:

1. Intro to railroad geotechnology
2. Track Substructure Layers
3. Ballast and Sub-ballast
4. Subgrade
5. Track Substructure Loading
6. Track Substructure Mechanics
7. Track Analysis
    - GEOTRACK
    - Others
8. Track Design
9. Track Slopes
10. Track Substructure Measurements and Management
11. Track Dynamics
    - VAMPIRE
12. Train-Track Interactions
13. Case Studies