CVEEN 5580/ 6580: PUBLIC TRANSPORTATION

Department of Civil and Environmental Engineering, University of Utah

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Course Description

This course provides a systematic coverage of public transportation characteristics and operations. The course presents a history of transit development in the U.S., an overview of trends in transit ridership, a review of transit systems and their usage worldwide, the fundamentals of transit vehicle motion, bus operating and performance characteristics, and rail transit supply characteristics.

Goal

The goal of this course is to prepare the student for either employment or further study in public transportation. As urban growth and increasing motor vehicle usage force transportation agencies to develop alternative modes, there is a continuing need for engineers who are knowledgeable in the characteristics and operations of both bus and rail transit systems.

Modules

To reach the goal, this course is divided into four modules:

1. History of transit and transit system characteristics (Lessons 1-8)
2. Fundamentals of transit vehicle motion (Lessons 9-15)
3. Bus operation and performance characteristics (Lessons 16-23)
4. Rail transit supply characteristics (Lessons 24-29)

Because of the time limitations of a 3-credit hour, one-semester course, topics such as bus and rail network design, transit demand forecasting, fare-demand relationships, scheduling, transit service for the elderly and disabled, security and safety, rail transit operations, energy consumption, air quality impacts of buses, modal alternatives analysis, public transit finance and institutions, transit planning, automated transit, and transit management and labor will not receive in-depth attention. A separate course in public transportation planning, management and finance is both warranted and needed in today's political climate. Increasing attention to both heavy and light-rail transit development in many urban areas warrant an additional course in rail transit operations. The latter course might also include aspects of transit demand analysis, including fare policies, price elasticities, and forecasting.

Objectives

Upon the completion of this course's four modules, both the undergraduate and the graduate student should be able to:

Module 1:

- Describe the historical development of public transportation in the U.S.,
- Indicate an awareness of the current state of public transit in the U.S.,
- List the various transit modes and how each is used,

- Define various measures of transit system operations and service,
- Distinguish between low-capacity, medium-capacity, and high-performance modes of transit,
- Differentiate between the technical, operating and system characteristics of various transit modes,
- List and define the various commuter transit modes,
- Describe the historical and recent trends in transit ridership in the U.S.,
- Identify the largest and most heavily-used transit systems in the world, and
- Delineate the key differences between U.S. and non-U.S. transit systems.

Module 2:

- Apply the equations of kinematics to the movement of transit vehicles,
- Understand the notions of rolling, air, curvature and gradient resistance,
- Apply expressions for rolling, air, curvature and gradient resistance to the analysis of transit vehicle motion,
- Interpret diagrams and equations of speed-tractive effort,
- Develop a general understanding of electric traction,
- Understand the concept of speed regulation,
- Compute acceleration, braking and stopping distances for transit vehicles,
- Describe the importance of distance, speed, acceleration and jerk,
- Apply equations of acceleration, constant speed, and braking to the regimes of vehicle motion,
- Derive and apply equations of travel time to four general cases of transit vehicle motion,
- Display distance and speed versus time in a diagram of vehicle motion,
- Graph travel time versus transit stop spacing, and
- Develop relationships between travel time, speed, and stop spacing.

Module 3:

- List the types of buses that are regularly used in transit systems,
- Describe the various methods of bus propulsion,
- Interpret the multiple elements of bus size,
- Distinguish between the physical characteristics of minibuses, standard buses, and articulated buses,
- Apply equations for turning radii to the operation of buses of various sizes,
- Comprehend the elements of bus movement and performance,
- Assess bus vehicle interior characteristics regarding passenger flow and seating capacity,
- Describe the requirements associated with bus operations in mixed traffic,
- List and understand the traditional approaches to preferential treatment of buses,
- List and understand “intelligent” approaches to preferential treatment of buses,
- Evaluate the various bus transit preferential treatments,
- Determine the ideal bus stop spacing in a given situation,
- Indicate the preferred bus stop locations in various situations,
- Design an on-street, curbside bus stop,
- Perform a conceptual design of a freeway bus stop,

- ?? Demonstrate an understanding of the design characteristics of a bus station or terminal,
- ?? Compute various measures of bus performance and service quality, and
- ?? Given cost data, estimate bus investment and operating costs.

Module 4:

- ?? Understand the basic aspects of rail transit operations,
- ?? List and describe the various rail transit modes,
- ?? Distinguish between technical, operational and system characteristics of rail transit modes,
- ?? Define the elements of rail transit rolling stock,
- ?? Understand the physical components of rail transit vehicles,
- ?? Compute the turning radii of a rail transit vehicle,
- ?? Interpret the interior layout of various types of rail transit vehicles,
- ?? Distinguish between the technical data associated with different types of rail transit vehicles,
- ?? Explain the differences between the loading, floor areas, power-weight and dimensions of various LRT vehicles,
- ?? Interpret the factors that determine rail transit operating units,
- ?? Understand how curvature and gradient affect the operations of rail vehicles,
- ?? Design the basic elements of track structure, and
- ?? Demonstrate knowledge of the design aspects associated with shared rights of way.

In addition to the objectives listed above, the graduate student should be able to explain formulas, synthesize and integrate information from the four modules, apply the techniques and concepts learned to real-life situations, appraise methodologies, and be prepared to expand his or her knowledge into areas not specifically covered in this course.

Assessment
The following assessment techniques will be used in this course:

Homework assignments (weekly). The homework assignments will require the students to apply the techniques and consider the concerns covered in the lessons, the textbook, and supplemental reading materials. The completion of these problems will involve skills in mathematical computation, usage of spreadsheet software, preparing written summaries of results, preparing short essays, and graphically displaying data.

Minute papers (weekly). Minute papers will be required of the undergraduate students. These will be weekly summaries of the preceding week's lessons. The purposes of these papers will include getting the students to: regularly come to class, pay attention in class, regularly complete a writing exercise, and reveal (to both themselves and to the instructor) subjects in which there is a lack of clarity.

Examinations (two). The first exam will cover the first two modules of the course (roughly the first half of the course), while the second exam will cover the third and fourth modules. The purpose of these exams will be to evaluate the students' understanding

and mastery of the subject matter in a controlled environment. The format of the exams is under development.

Discussions (each lesson). A variety of questioning techniques will be used during the lesson to engage feedback from the students. The questions will be designed to incite discussion, get the students to think, get the students to participate, uncover unclear areas, and reveal a lack of preparation. The questioning techniques might include general questions, calling on students individually, getting the students to think first and then answer, and having pair or small-group discussions before requesting a response. Participation in the discussions will be graded, with a heavier portion of the graduate student's grade allocated to participation.

Term project (one). Each graduate student, instead of completing minute papers, will be required to complete a term project. Graduate students will be expected to display skills in analysis, synthesis and evaluation (the 4^{th}, 5^{th} and 6^{th} levels of Bloom's taxonomy) in their work. Each graduate student may be required to present his or work to the class.

CVEEN 5580/ 6580: TRANSPORTATION FACILITY PLANNING

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Prerequisites: CVEEN 3520 "Transportation Engineering" (or equivalent); advanced algebra and introductory physics.

Textbook: Vuchic, Vukan R., *Urban Public Transportation Systems and Technology*, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1981.

Course Outline

				Assignment[2]	
No.[1]	**Date**	**Topics**	**Reading**	**Undergraduate**	**Graduate**
1		History of U.S. Transit: 1800-1979	1.1-1.6		
2		History of U.S. Transit: 1980-2000	Handout		
3		Trends in Transit Ridership: U.S.	2.4 Handout		
4		World Public Transit Systems	Handout		
5		Transit Right-of-Way Categories Technology Concepts Transit Service Types and Modes	2.1.1-2.1.2		
6		Transit System Components Operating Characteristics	2.1.3-2.1.4		
7		Low and Medium-Capacity Modes High-Performance Transit Modes	2.3.1-2.3.4		
8		Commuter Transit Modes Alternative Technologies	2.3.5 Handout		
9		Kinematics of Vehicle Motion Rolling Resistance Air Resistance	3.1-3.2.1.2		
10		Total Resistance Gradient Resistance Curvature Resistance	3.2.1.3- 3.2.2.2		
11		Vehicle Propulsion Units Traction: Internal Combustion Traction: Electric Power	3.3.1-3.3.3.2		
12		Speed Regulation and Braking Acceleration, Braking & Stopping	3.3.3-3.3.4 3.5		
13		Transit Travel Between Stops Regimes of Motion	3.6-3.6.2.5		

14	Travel Time Equations & Plots	3.6.3-3.6.3.4
15	Time-Station Spacing Diagram Line Travel Time Speed, Time and Station Spacing	3.6.3.5- 3.6.4.3
16	Characteristics of Buses Bus Propulsion Methods Aspects of Bus Sizes	4.1-4.2.2.1
--	**Exam 1** (Modules 1 and 2)	--
17	Bus Dimensions & Turning Radii: Mini, Standard, Articulated	4.2.2.2- 4.2.2.4
18	Bus Performance Buses: Boarding and Interior	4.2.3-4.2.3.2 4.2.4-4.2-4.3
19	Bus Operations on Streets Preferential Treatments	4.3-4.3.3.3
20	Preferential Treatment of Buses (continued)	4.3.3.4- 4.3.6.3 Handout
21	Bus Stops on Streets	4.4-4.4.1.3
22	Bus Stops on Freeways Bus Stations and Terminals	4.4.2-4.4.3
23	Bus Performance Characteristics Service Quality Measures Investment and Operating Costs	4.5-4.5.4
24	Rail Transit Characteristics Rail Transit Modes	5.1-5.1.2.5
25	Rail Vehicles and Components	5.2.1-5.2.2
26	Rail Transit Vehicle Dimensions and Turning Radii Rail Transit Vehicle Interiors	5.2.3-5.2.4.2
27	LRT Vehicles Rail Transit Units and Fleets	5.2.4.2- 5.2.5.4
28	Rail Transit Travel Way Curvature and Gradient Clearance	5.3-5.3.1.2
29	Rail Track Structure Aspects of Shared Right-of-Way	5.3.2-5.3.3.1
--	**Exam 2** (Modules 3 and 4)	--

Notes:

[1] Module 1: Lessons 1-8; Module 2: Lessons 9-15; Module 3: Lessons 16-23; Module 4: 24-29.
[2] The homework assignments are under development.