COURSE OUTLINE

CIV216 Highway Engineering

Course Number

Highway Engineering

Course Title

3 Credits

Lecture/Laboratory Hours

COURSE DESCRIPTION

Explores the planning, design, construction, and characteristics of highways and city streets, including layout, traffic requirements, safety and control, drainage, sub-grade structure, base courses, and surface pavements. Problems to be solved include geometric design, traffic volume, channelization, and hydrology. Lab projects involve roadway designing. Spring offering.

Text (s): Highway Engineering
By Oglebsy
Publisher: Wiley & Sons, Latest Edition

Prerequisites: ENT116

Co-requisites: CIV102, DRA190 or divisional permission.

Course Coordinator: Jim Maccariella

Latest Review: Spring 2019
I. GENERAL OBJECTIVES

The student will be able to:

1. Demonstrate highway terminology.
2. Demonstrate the design requirements for roads and highways.
3. Demonstrate the construction and inspection requirements of roads.
4. Demonstrate safety, traffic analyses and vehicle abilities in the design of roads.
5. Demonstrate drainage design for roads.
6. Demonstrate the relationship between surveying, and highway design and layout.

Course-specific General Education Knowledge Goals and Core Skills.

General Education Knowledge Goals
Goal 1. Communication. Students will communicate effectively in both speech and writing.
Goal 2. Mathematics. Students will use appropriate mathematical and statistical concepts and operations to interpret data and to solve problems.
Goal 3. Science. Students will use the scientific method of inquiry, through the acquisition of scientific knowledge.

MCCC Core Skills
Goal A. Written and Oral Communication in English. Students will communicate effectively in speech and writing, and demonstrate proficiency in reading.
Goal B. Critical Thinking and Problem-solving. Students will use critical thinking and problem solving skills in analyzing information.
Goal F. Collaboration and Cooperation. Students will develop the interpersonal skills required for effective performance in group situations.

II. SPECIFIC OBJECTIVES

UNIT I (3 Weeks): INTRODUCTION; TERMINOLOGY; HIGHWAY PLANNING AND ECONOMY; PARKING

(Course Competencies 1, 2, 3, & 6; Gen Ed Goals 1, 2 & 3; Core Skills A, B & F).

1. List and describe the major areas of study and analysis for highway development.
2. List and describe the different types of governmental highway systems, and give real examples of each.
3. Discuss the Interstate Highway system.
4. List and describe the highway types.
5. List and describe several highway organizations and associations.
6. List and describe the various classes of data that must be complied in highway planning.
7. List and describe the costs to be included in highway economy studies.
8. Compute motor vehicle operating costs to the highway user.
9. Describe the requirements for a small shopping center parking lot as to space dimensions and angles, driveway widths and turning radii.
UNIT II (3 Weeks): DRIVER, VEHICLE AND ROAD CHARACTERISTICS; HIGHWAY DESIGN

(Course Competencies 1, 2, 3, 4, & 6; Gen Ed Goals 1, 2 & 3; Core Skills A, B & F).

1. Define “perception time” and “reaction time,” and give recommended design values.
2. List and differentiate between the four methods of estimating future traffic volumes.
3. Define and calculate service volumes of highways considering the effects of sight distance, obstructions, grades, land widths and commercial vehicles.
4. Using the “benefit cost ratio” method, determine if it is economically feasible to construct a particular highway alignment.
5. List the factors that reduce highway capacity.
6. Compute safe stopping and passing distances for level roadways and for vertical curves in crest or sag.
7. Compute super-elevation requirements for horizontal curves considering design speed, friction and radius in the calculations. Describe the meaning of “runout” as it applies to super-elevation of horizontal curves.
8. Compute stations and elevations along horizontal and vertical curves.
9. Sketch typical cross sections and profiles of highways.
10. List the values of typical lane widths, grades and design speeds.
11. Determine the minimum vertical curve length to provide safe stopping sight distance and safe passing sight distance.
12. Determine the appropriate speed degree of curvature and/or radius for horizontal curves.

UNIT III (1 Week): TRAFFIC ENGINEERING

(Course Competencies 1, 2, 3, 4, & 6; Gen Ed Goals 1, 2 & 3; Core Skills A, B & F).

1. Describe various channelizing devices.
2. List and describe the general types of intersections at grade and grade separated, and list the advantages and disadvantages of each.
3. Draw a space-time diagram between two intersections given the traffic signal cycles.
4. Calculate the ideal distance between the intersections given the space-time diagram and the roadway design speed.
5. Calculate the ideal speed between two intersections given the distance and traffic signal cycles.
6. State the advantages and disadvantages of traffic signals.
7. Define traffic actuated and fixed time signals.
9. List and describe the various types of traffic control devices.

UNIT IV (3 Weeks): HIGHWAY DRAINAGE

(Course Competencies 1, 2, 3, 5 & 6; Gen Ed Goals 1, 2 & 3; Core Skills A, B & F).

1. Compute the water runoff from a drainage area, given the storm frequency, character and slope of ground surface using available charts and graphs and the “rational formula”: i.e. \( Q = Aci \).
2. Explain the meaning of each parameter in the “rational formula.”
3. Design a circular pipe, trapezoidal culvert and rectangular culvert to efficiently carry a particular water flow, under free flow conditions, using available charts and graphs and the Manning Formula.
4. Analyze a given storm drain system for various flow parameters, such as velocity and flow using the Manning Formula.
5. Set-up in tabular form the necessary chart for completely analyzing or designing a simple storm drain system.
6. List and describe various drainage structures such as manholes, inlets, end-walls and headwalls.
7. Classify sub-critical and supercritical flow.

UNIT V (2 Weeks): HIGHWAY SUB-GRADERS, BASE COURSES, AND SURFACE COURSES

(Course Competencies 1, 2, 3, & 6; Gen Ed Goals 1, 2 & 3; Core Skills A, B & F).

1. Sketch a cross section of a roadway including a description of “surface courses,” “base course,” “sub-base” and “sub-grade.”
2. List and describe the soil characteristics which influence the quality of sub-grades under highway pavements.
3. Describe the different types of base courses.
4. Describe the correct procedures for constructing base courses.
5. Contrast and compare rigid and flexible pavements.
6. List and/or define the methods for the design of flexible pavements.
7. Design a flexible base pavement using the AASHO Method.
8. Compare and contrast “elastic,” “consolidation” and “plastic” deformations as they apply to loadings of flexible pavements.

UNIT VI (2 ½ Weeks): BITUMINOUS MATERIALS AND PRODUCTION PROCESSES

(Course Competencies 1, 2, 3, & 6; Gen Ed Goals 1, 2 & 3; Core Skills A, B & F).

1. Explain the procedure for manufacture of “asphalt cements” and “rapid curing,” “slow curing,” “medium curing” and emulsified asphalt binders.
2. Compare and contrast the uses of the various materials listed in number (1).
3. List and define the various methods for testing the stability of bituminous concrete mixtures.
4. Explain the correct construction procedure for the spreading and compacting of bituminous concrete base and surface courses.
5. Explain the various steps in the preparation of bituminous concrete mixtures in a “batch type” plant.
6. Define the various types of surface treatments used to restore existing bituminous concrete and stone roads.
7. List the items that an inspector should look for at the site of bituminous concrete construction.

III. REVIEW

Time: 1/2 Week

IV. EVALUATION

2 Tests and a Final Examination will be given.

Objective questions (closed book) and analytical problems (open book) are given.
Each test is approximately 2 hours in duration.
V. **GRADE WEIGHT**

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<thead>
<tr>
<th>Item</th>
<th>Weight</th>
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<tbody>
<tr>
<td>2 Tests</td>
<td>35 - 40%</td>
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<tr>
<td>Final Examination</td>
<td>20 - 25%</td>
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<tr>
<td>Laboratory Projects, including written report and oral presentation</td>
<td>25 - 30%</td>
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<tr>
<td>Homework, attitude toward learning, class participation and interest, and attendance</td>
<td>10%</td>
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100%

VI. **WRITTEN REPORT/ORAL PRESENTATION**

A written report on a topic approved by the instructor will be required. Students will be expected to research library periodicals and textbooks. At least three sources must be included in the bibliography section of the report. An oral presentation of the report will be required.
LECTURE SCHEDULE

Week

1  Introduction:
The field of highway engineering
Terminology: Highway systems, types and organizations
Parking lot requirements

2  Highway Planning:
   Road inventory
   Rural traffic surveys
   Urban travel studies
   Highway financing
   Vehicle ownership and use
   Special studies
   Traffic Forecasting

2, 3  Highway Economy:
   Terminology
   Cost of the highway user

4, 5, 6  Driver, Vehicle and Road Characteristics:
   Highway Capacity
   Highway Design
   Geometry of Roads
   Highway standards
   Design speeds
   Cross sections
   Profiles
   Sight distance
   Vertical curves
   Horizontal curves
   Channelization and Traffic Control Devices

7  Traffic Engineering

8, 9, 10  Highway Drainage:
   Hydrology
   Methods of runoff analysis
   Rational method of runoff analysis
   Design of drainage structures
LECTURE SCHEDULE

Week

11, 12  Highway Sub-grades:
        Design of flexible base pavements

12  Base Course

13  Surface Courses

14  Bituminous Pavements:
        Binder
        Aggregate

15  Review

Laboratory

Laboratories will be used for design projects. Slides and films will be used for stimulating discussion of highway construction techniques. Guest lecturers might be invited to discuss specific topics.

TWO MAJOR DESIGN PROJECTS WILL BE UNDERTAKEN

1. **Parking Lot**

   Layout of property lines, fencing, curb, aprons, ingress, and egress, parking stalls, details of curb, pavement, etc. Students may be expected to produce this drawing using SOFTDESK/AUTOCAD civil engineering and drafting computer techniques.

2. **Highway Design**

   The reconstruction and redesign of a major traffic artery requiring calculations for width of roadway, intersections, drainage, pavement, alignment and quantity estimates. A set of drawings will be prepared. Students may be expected to produce drawings using SOFTDESK/AUTOCAD civil engineering and computer drafting techniques.

REFERENCES

2. **Traffic Engineers Handbook**, H. Evans
5. **Data Book for Civil Engineers**, E. E. Seelye, J. Wiley & Sons
11. Highway Research News
12. Highway Research Circular
13. Highway Research Board Special reports
15. Various State and Federal announcements and publications

Addresses of Highway Associations

1. Highway Research Board
   2101 Constitution Avenue
   Washington, DC 20418

2. American Association of State Highway & Transportation Officials
   444 North Capitol Street, N. W.
   Suite 225
   Washington, DC 20001
   (202) 624-5800

3. The Asphalt Institute Building
   College Park, Maryland 20740

Academic Integrity Statement:
Students are expected to comply with the college-wide requirements for academic integrity. Mercer County Community College is committed to Academic Integrity—the honest, fair, and continuing pursuit of knowledge, free from fraud or deception. This implies that students are expected to be responsible for their own work. Presenting another individual’s work as one’s own and receiving excessive help from another individual will qualify as a violation of Academic Integrity. The entire policy on Academic Integrity is located in the Student handbook and is found on the college website (http://www.mccc.edu/admissions_policies_integrity.shtml).

Mercer County Community College is committed to ensuring the full participation of all students in all activities, programs, and services. Please refer to the Student Handbook to review accommodations available for Students with Special Needs.