



**Course Syllabus**  
**CE5409 – Railroad Track Engineering and Design**  
**College of Engineering**  
**Spring 2009**

***Instructor Information***

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Instructor: Pasi Lautala, PhD, P.E. , Research Assistant Professor  
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***Course Identification***

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Course Number: CE13936-0A  
Course Name: Railroad Track Engineering and Design  
Course Location: 214 Dillman (213 Dillman for MicroStation / Geopak exercises)  
Class Times: TR 12:35am – 13:50pm  
Prerequisites: -----

***Course Description/Overview***

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The course introduces students to the design and development of construction documents for railroad projects, especially the construction of a new or modification of an existing track. The course takes a hands-on approach where assigned readings, interactive lectures, homework assignments and other instructional materials will be applied by participants to complete design exercises and eventually a real-life rail project. Course will provide participants with sufficient understanding of track components and design criteria. Specific topics include horizontal and vertical geometry and cross-section components. While the concentration will be on learning track design principles, roadway design will also be reviewed as it pertains to the course.

Significant portion of the course are hands-on activities, exercises / homework assignment, or preparing designs and documents in MicroStation and Geopak or preparing presentations of the product. The students will work both individually and in 2-3 person teams throughout the course and perform assignments needed to complete the project from the beginning of the design to the delivery of construction documents. The project steps will include taking an existing track layout and topography in a design software, creating a design for modified layout and developing construction documents which will include plan sheets, cross-sections and general cost/quantity estimates. The course will require students to use teamwork and creative thinking to solve an open ended design challenge. Students are expected to handle majority of the cad work within their teams and

regular review sessions with instructor are used to verify the progress and to allow for student questions, The objective is to encourage students to take responsibility of their projects, while feeling comfortable to ask questions when they run into potential roadblocks. Interactions between different teams are encouraged and presentations and reports after project completion are geared toward improvements in oral and written output. By the end of the program, students will have a basic understanding in the fundamentals of the track components, track design principles and criteria and estimating the basic project costs. They have also gained hands-on experience in how to use MicroStation and Geopak software in the design part of the project.

### ***Course Learning Objectives***

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Course has two key goals:

- 1) Learning the railroad track design principles. This goal includes developing an understanding of interrelationships between design, document production and construction, internalization of design principles and criteria and identification of key process steps in rail related projects. Specific attention will be paid to the similarities and differences in track versus roadway design.
- 2) Applying the principles in a computer-aided design process. Students will learn to take the guidance, instructions and references and apply them toward developing a real solution and documents necessary to present their solution while working in a team where they have to depend on each other's individual expertise to get the product done.

### ***Course Resources***

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#### **Course Website(s)**

- Blackboard <<http://www.courses.mtu.edu>>

#### **Required Course Text**

- No required text.
- Selected texts from various sources, handouts and other additional material will be provided by the instructor during the course and through Blackboard course site. Students are encouraged to look for additional information from internet and other sources provided by the instructor. Some of the publications used during the course include *Practical Guide for Railroad Engineering* and *Manual for Railway Engineering* by AREMA, *Manual of Uniform Traffic Control devices* and selected material developed by AREMA Committee 24 – Education and Training. Tutorials and help files for MicroStation and Geopak will also be useful sources to assist in the course exercises and final project which utilize both software.

## Grading Scheme

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### Grading System

<b>Letter Grade</b>	<b>Percentage</b>	<b>Grade points/credit</b>	<b>Rating</b>
<b>A</b>	93% & above	4.00	Excellent
<b>AB</b>	89% – 93%	3.50	Very good
<b>B</b>	85% – 89%	3.00	Good
<b>BC</b>	80% – 84%	2.50	Above average
<b>C</b>	75% – 80%	2.00	Average
<b>CD</b>	70% – 75%	1.50	Below average
<b>D</b>	64% - 70%	1.00	Inferior
<b>F</b>	63% and below	0.00	Failure
<b>I</b>	Incomplete; given only when a student is unable to complete a segment of the course because of circumstances beyond the student's control. A grade of incomplete may be given only when approved in writing by the department chair or school dean.		
<b>X</b>	Conditional, with no grade points per credit; given only when the student is at fault in failing to complete a minor segment of a course, but in the judgment of the instructor does not need to repeat the course. It must be made up within the next semester in residence or the grade becomes a failure (F). A (X) grade is computed into the grade point average as a (F) grade.		

### Grading Policy

Grades will be based on the following:

"U.S. Railroad Project" presentation and report	25%
Track design project presentation and report	45%
Attendance and Participation (includes potential morning quizzes and homework assignments)	30%
<b>Total Percentage</b>	<b>100%</b>

The grading of the class will incorporate following methods.

- There will be no tests during the course, but regular written quizzes and individual homework assignments will be used to test the knowledge on instructional material covered during interactive lectures. These tests and homework assignments will affect the participation portion of the overall grade (30%).

- There will be two team presentations and written reports during the course. First will be in selected U.S. Railroad Project Assignment and second in the final design product. If written report is considered insufficient, a re-submittal will be required until it is considered satisfactory. These presentations and reports will form the majority of the grade (70%). The grades will be based on the quality of the presentations and reports and are determined by course instructor and the evaluations by the fellow students and invited guests. The grade for the presentations and project will be the same for each team member and improvement from previous submittal will be considered an elevating factor for the overall grade. A draft of each report will be graded and commented prior to the final submittal. 50% of the points lost in the draft report evaluation will be rewarded to those teams, who sufficiently address the reviewer comments in the final report.
- Active participation and proper preparation to team activities and to interactive lectures are absolutely essential to the success. Each student will provide feedback on the performance of themselves and their team members in open format twice – in mid-semester and in the end and these will be compared with the instructor’s evaluation. The evaluations and absences together with quizzes and homework assignments will form 30% of the grade.

### **Late Assignments**

Late submittals of assignments will cause automatic 50% reduction of available points, unless exceptional circumstances have prevailed, as determined by the instructor. Assignments will be submitted in electronic or paper format, based on instructor instructions.

### **Course Policies**

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Any absence from the class must be discussed in advance and absence without permission will affect negatively to the participation portion of the grade. The teams are expected to solve potential conflicts internally and are advised to approach the instructor for conflict resolution only when internal efforts haven’t been effective.

### **Collaboration/Plagiarism Rules**

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Collaboration on individual and group assignments is recommended.

Cell phones, Blackberries, iPods, PDAs, or any other electronic devices are not to be used in the classroom. Please make sure to bring a calculator with you to class. Calculators on other devices are strictly prohibited. Information exchanges on these devices during class are also prohibited and violate the Academic Integrity Code of Michigan Tech.

### **University Policies**

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Academic regulations and procedures are governed by University policy. Academic dishonesty cases will be handled in accordance the University's policies.

If you have a disability that could affect your performance in this class or that requires an accommodation under the Americans with Disabilities Act, please see me as soon as possible so that we can make appropriate arrangements. The Affirmative Action Office has asked that you be made aware of the following:

*Michigan Tech complies with all federal and state laws and regulations regarding discrimination, including the Americans with Disabilities Act of 1990. If you have a disability and need a reasonable accommodation for equal access to education or services at Michigan Tech, please call the Dean of Students Office, at 487-2212. For other concerns about discrimination, you may contact your advisor, department head or the Affirmative Action Office, at 487-3310*

**Academic**

**Integrity:**[http://www.studentaffairs.mtu.edu/dean/judicial/policies/academic\\_integrity.html](http://www.studentaffairs.mtu.edu/dean/judicial/policies/academic_integrity.html)

**Affirmative Action:**

<http://www.admin.mtu.edu/aa/>

**Disability**

**Services:**[http://www.admin.mtu.edu/urel/studenthandbook/student\\_services.html#disability](http://www.admin.mtu.edu/urel/studenthandbook/student_services.html#disability)

**Equal Opportunity Statement:**

<http://www.admin.mtu.edu/admin/boc/policy/ch3/ch3p7.htm>

**Course Schedule**

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**Tentative content: Approx. 42hrs of lectures (lecture topics may be reorganized or changed as deemed necessary)**

Week	Date	Activity
Week1	1/13	<b>Welcome to track design course</b> Review of the syllabus and Blackboard learning system and introduction to the reference material available for course participants. Introduction to the critical track components.
	1/15	<b>Introduction to MicroStation 1</b> Getting started with MicroStation.
Week 2	1/20	<b>Railroad track projects - design process</b> Introduction to the steps and flow of railroad design and construction process from the initial idea to the development of construction documents. Concentrates on steps included in

		the planning and design phase. <b>U.S. Railroad Project Assignment.</b>
	1/21	<i>*Last day to drop full semester courses with a refund</i> <i>*Last day to add full semester courses or change a section</i>
	1/22	<b>Railroad surveying and introduction to Geopak</b>  Critical considerations when performing railroad and topo surveys. Importing survey to Geopak and MicroStation. Development of existing layout as a base for design.
<b>Week 3</b>	1/27	<b>Track design principles - horizontal alignments 1</b>  Horizontal curves, limits of curvature and reasons behind them. No curve areas. Superelevations and chord definition in curve design. Benefits and drawbacks of curves.
	1/29	<b>Track design principles - horizontal alignments 2</b>  Curve transition and reverse curves. Railroad vs. highway curves comparison. Geometric design of railroad turnouts and other special trackwork.
	1/30	<i>*Last day to drop full semester courses without a grade appearing on the academic record - No Refund</i>
<b>Week 4</b>	2/3	<b>Track design principles - horizontal alignments 3</b>  Alignment development and stationing. Horizontal clearance considerations. Introduction to horizontal design in MicroStation and Geopak.
	2/5	<b>Winter Carnival - Stay on the right track!</b>
	2/6	<i>Last day to drop full semester courses with a grade of 'W'</i>
<b>Week 5</b>	2/10	<b>Track design principles - vertical alignments 1</b>  Limits of grades, vertical curves and reasons behind them. No vertical curve areas and special considerations for vertical curves. Railroad vs. highway vertical curve comparison.
	2/12	<b>Track design principles - vertical alignments 2</b>  Vertical track clearances. Track profile development principles and design process in MicroStation and Geopak.
<b>Week 6</b>	2/17	<b>"U.S. Railroad Projects" presentations</b>  Each group will make 10-12 minute presentation and deliver a draft written report on selected "U.S. Railroad Project" topic.

		<b>“U.S. Railroad Projects” draft reports due.</b>
	2/19	<b>Track and roadway design principles – Cross section components 1</b>  Introduction to cross section components, materials and critical issues in developing cross sections for construction documents. Typical sections versus special locations. <b>Introduction to Course Design Project.</b>
<b>Week 7</b>	2/24	<b>Track and roadway design principles – Cross section components 2</b>  Development of proposed cross-sections. Developing and automating existing and proposed cross sections in MicroStation and Geopak.
	2/26	<b>Subgrade and drainage design 1</b>  Challenges in subgrade design. The water will always flow downhill. Subgrade materials and construction methods. How to guide water to the preferred locations. How to design ditch profiles and determine, if closed drainage system is necessary. Basic sewer calculations and sizing of the pipes under the tracks.
<b>Week 8</b>	3/3	<b>Highway rail at-grade crossings</b>  Types and materials used in the crossings. Critical design elements and considerations. Development of basic roadway alignment. Pavements markings. Special cross sections at grade crossings. Crossing designs and materials. Other MUTCD issues.
	3/5	<b>Project working and guidance session 1</b>  Working session for a design project in MicroStation and Geopak.
<b>Week 8.5</b>		<b>Spring Break, Don’t get derailed!!</b>
<b>Week 9</b>	3/17	<b>Basics of plan production 1</b>  Basic rules and information represented in the plans and cross sections. Introduction to necessary drawings and documents.

	3/19	<p><b>Basics of plan production 2</b></p> <p>Introduction to developing general, plan, profile and cross section sheets for rail project in MicroStation and Geopak.</p>
Week 10	3/24	<p><b>Quantity estimates for rail projects</b></p> <p>Quantity takeoffs from design documents and cross sections. Typical work items descriptions and units.</p>
	3/26	<p><b>Cost estimates for rail projects</b></p> <p>Unit costs and their application in the process. Different types of contracts at the unit cost estimate. Other types of cost estimates and alternative comparisons through cost estimates.</p>
Week 11	3/31	<p><b>Utilities, ROW and environmental considerations in track projects</b></p> <p>Typical utilities on railroad ROWs and their modifications as part of projects. Standard requirements for utility crossings. Environmental challenges and considerations.</p>
	4/2	<p><b>Project guidance / comment session</b></p> <p>Comments on the draft project designs. Individual guidance for teams in their design projects. Q&amp;A session for Final Project Reports.</p>
Week 12	4/7	<p><b>Construction documents and stakeout</b></p> <p>Discussion of basic construction documents and specifications and project elements unaddressed in the course project. How to prepare information for construction stakeout in the field. Development of stakeout information and guidance for surveyors.</p>
	4/9	<p><b>Construction, contract development and construction management</b></p> <p>Steps in contract development. Introduction to construction management principles and key aspects of management activities and stakeholders.</p>
Week 13	4/14	<p><b>Final project presentations</b></p> <p>15-20 minute presentations of completed plans and cost estimates for the evaluation committee.</p>

	<b>4/16</b>	<b>Final draft reports due</b> Draft drawings and reports submitted for review. Review of important additional topics identified during the course.
<b>Week 14</b>	<b>4/21</b>	<b>Feedback session on design reports</b> Instructor feedback on design reports to be incorporated in the final reports.
	<b>4/23</b>	<b>Final reports due - review and course feedback session</b>