Part I Course Organization
Course description:
The course aims to acquaint the student with the concept of “soil” as an engineering material and the properties and methods used to characterize soil for Geotechnical analysis and design. The course will cover terminology and parameters used to characterize and classify soils; stresses and stress conditions in soils; factors affecting soil strength and stress-strain behavior; seepage and water flow through soils and their effects on soil stresses and strength; deformation and settlement characteristics of soils; lateral earth pressure, bearing capacity and slope stability concepts.

Course Objectives:
• Learn the common terminology used in the field of Geotechnical Engineering
• Develop a feel for relevant factors to consider in analyzing soil behavior
• Understand the interaction between water and soil and the effects of static vs. flowing water on soil strength
• Understand the fundamental differences between behaviors of sands and clays and between total & effective stresses
• Become familiar with common laboratory tests to classify soils and characterize soil properties
• Develop an appreciation for the inherent variability of soils and the scatter produced in geotechnical data and the challenges this poses to Geotechnical analysis and design

Instructor: Dr. Amy L. Rechenmacher arechenm@usc.edu KAP 230C (213) 740-3615
Instructor Office Hours: TBA

Lectures: T,Th 11:00 a.m. – 12:15 p.m., location TBA

Laboratories: T 12:30-2:20, W 9-11, W 1:30-3:30, Th 3:30-5:30, F 10-12; all in KAP B40

Teaching Assistants: TBA

TA Office Hours: TBA

Course Website: Blackboard: https://blackboard.usc.edu/

Grading: Homework 17.5% Exam 1 20% Final Exam 25%
Laboratory 17.5% Exam 2 20%

Homework Guidelines:
1. Homework is due at the end of class on the due date, typically Thursdays. Late homework will not be accepted unless prior arrangements are made with the professor. Homework assignments will be posted on Blackboard as they are assigned. Homework solutions will be posted following their due dates.

2. All homework calculation-type problems and graphs must be written on Graph or Engineering Paper
3. Homework should be neat and clearly legible. Lines meant to be straight should be drawn with a ruler.
4. Axes on graphs should be labeled and include proper units.
5. If you make your graphs using a spreadsheet program (i.e. Excel), use care in fitting trendlines to data. This topic will be discussed in detail during the lectures.

Statement for Students with Disabilities
Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776.

Statement on Academic Integrity
USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one’s own academic work from misuse by others as well as to avoid using another’s work as one’s own. The USC Viterbi School of Engineering adheres to the University's policies and procedures governing academic integrity. Viterbi students are expected to be leaders at USC and should be aware of and observe academic integrity standards in all their courses and activities. These standards will be enforced in this class on all assignments. (Resources and more details are available at http://viterbi.usc.edu/academics/integrity/).
**SYLLABUS**

**Instructor:** Dr. Amy L. Rechenmacher, KAP 230C, 213-740-3615, arechenm@usc.edu

**Textbooks:** Craig’s Soil Mechanics, 8th ed., by J.A. Knappett and R.F. Craig, Spon Press
Experimental Soil Mechanics, by J.P. Bardet, Prentice Hall *(available on Blackboard)*

<table>
<thead>
<tr>
<th>Week No.</th>
<th>Period No.</th>
<th>Date</th>
<th>Chapter/Section*</th>
<th>Topic</th>
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<tr>
<td>1</td>
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<td>1/15</td>
<td>1.1–1.2</td>
<td>Introduction, nature of soil, weathering, clay mineralogy</td>
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<td>2</td>
<td>1</td>
<td>1/17</td>
<td>1.3–1.4</td>
<td>Particle size, classification tests, plasticity</td>
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<td>2</td>
<td>3</td>
<td>1/22</td>
<td>1.5, B 116-127</td>
<td>Soil description and classification (USCS)</td>
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<td>2</td>
<td>4</td>
<td>1/24</td>
<td>1.6</td>
<td>Phase relations</td>
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<td>3</td>
<td>5</td>
<td>1/29</td>
<td>1.6–1.7</td>
<td>Phase problems, compaction</td>
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<tr>
<td>3</td>
<td>6</td>
<td>1/31</td>
<td>1.7, 2.1</td>
<td>Compaction, cont’d; Soil water</td>
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<td>7</td>
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<td>2.1, 6.2</td>
<td>Bernoulli equation, 1-D flow, piezometers</td>
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<td>8</td>
<td>2/7</td>
<td>2.2</td>
<td>1-D flow problems; Darcy’s Law, permeability</td>
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<td>5</td>
<td>9</td>
<td>2/12</td>
<td>2.3</td>
<td>2-D seepage, seepage theory</td>
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<td>5</td>
<td>10</td>
<td>2/14</td>
<td>2.3–2.4</td>
<td>Flow nets, 2D seepage problems</td>
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<td>6</td>
<td>11</td>
<td>2/19</td>
<td>2.4, 3.1–3.2</td>
<td>2-D seepage problems, cont’d; Effective stress concepts</td>
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<tr>
<td>6</td>
<td>12</td>
<td>2/21</td>
<td>3.2, 3.4</td>
<td>Effective stress concepts</td>
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<td>7</td>
<td>13</td>
<td>2/26</td>
<td>3.6–3.7</td>
<td>Effect of seepage on effective stress</td>
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<tr>
<td>7</td>
<td>14</td>
<td>2/28</td>
<td></td>
<td></td>
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<td>8</td>
<td>15</td>
<td>3/5</td>
<td>5.3, B 239-243</td>
<td>Shear strength of soil, Mohr circle</td>
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<td>8</td>
<td>16</td>
<td>3/7</td>
<td>5.3, B 239-243</td>
<td>Mohr-Coulomb model, shear strength parameters</td>
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<td>9</td>
<td>17</td>
<td>3/12</td>
<td>5.4, B 265-276</td>
<td>Shear strength tests</td>
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<td>18</td>
<td>3/14</td>
<td>5.4, B 265-276</td>
<td>Shear strength tests, cont’d</td>
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<td>10</td>
<td></td>
<td>3/18 – 3/22</td>
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<td>SPRING BREAK – No class</td>
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<tr>
<td>11</td>
<td>19</td>
<td>3/26</td>
<td>5.5, B 370-383</td>
<td>Shear strength of sands</td>
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<tr>
<td>11</td>
<td>20</td>
<td>3/28</td>
<td>5.6, B 383-400</td>
<td>Shear strength of clays</td>
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<tr>
<td>12</td>
<td>21</td>
<td>4/2</td>
<td>4.1–4.2</td>
<td>Consolidation settlement, oedometer test</td>
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<tr>
<td>12</td>
<td>22</td>
<td>4/4</td>
<td>4.3</td>
<td>Consolidation: 1-D settlement calculations</td>
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<td>13</td>
<td>23</td>
<td>4/9</td>
<td>4.4–4.5</td>
<td>Time rate of consolidation: Terzaghi’s 1D Theory</td>
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<tr>
<td>13</td>
<td>24</td>
<td>4/11</td>
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<td></td>
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<tr>
<td>14</td>
<td>25</td>
<td>4/16</td>
<td>4.6</td>
<td>Coefficient of consolidation</td>
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<tr>
<td>14</td>
<td>26</td>
<td>4/18</td>
<td>4.4–4.5</td>
<td>Time rate of consolidation, examples</td>
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<td>15</td>
<td>27</td>
<td>4/23</td>
<td>8.5–8.6</td>
<td>Stresses/displacements due to surface loads</td>
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<tr>
<td>15</td>
<td>28</td>
<td>4/25</td>
<td>11.1–11.3</td>
<td>Lateral earth pressure</td>
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<tr>
<td>16</td>
<td>29</td>
<td>4/30</td>
<td>11.1–11.3</td>
<td>Lateral earth pressure</td>
</tr>
<tr>
<td>16</td>
<td>30</td>
<td>5/2</td>
<td>12.1–12.3</td>
<td>Slope stability</td>
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</tbody>
</table>

*Refers to section numbers in Craig; numbers following a “B” refers to pages in Bardet.*

**EXAMINATION 1: Ch 1-2**

**EXAMINATION 2: Ch 3 & 5**

**Tues May 14**
11 am – 1 pm

**FINAL EXAM (cumulative)**
CE467L Laboratory Info

CE 467L Geotechnical Engineering
Spring 2013

**LABORATORY INFORMATION**

Instructor: Dr. Amy Rechenmacher, KAP 230C, 213-740-3615, arechenm@usc.edu
Laboratory T.A.’s: TBA

Text: Bardet, J.P. Experimental Soil Mechanics, Prentice Hall (available on Blackboard!!)

Laboratory Room: KAP B40

Laboratory Schedule:

<table>
<thead>
<tr>
<th>Lab No.</th>
<th>Dates</th>
<th>Laboratory/Discussion</th>
<th>Reading (pages in Bardet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Tues Jan 15 – Fri Jan 18</td>
<td>NO LAB</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Tues Jan 22 – Fri Jan 25</td>
<td>Sieve Analysis</td>
<td>9 - 30</td>
</tr>
<tr>
<td>2</td>
<td>Tues Jan 29 – Fri Feb 1</td>
<td>Liquid Limit</td>
<td>75 - 91</td>
</tr>
<tr>
<td>3</td>
<td>Tues Feb 5 – Fri Feb 8</td>
<td>Compaction</td>
<td>147 - 165</td>
</tr>
<tr>
<td>4</td>
<td>Tues Feb 12 – Fri Feb 15</td>
<td>Permeability</td>
<td>177 - 206</td>
</tr>
<tr>
<td></td>
<td>Tues Feb 19 – Fri Feb 22</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Tues Feb 26 – Fri Mar 1</td>
<td>Discusion Section*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tues Mar 5 – Fri Mar 8</td>
<td>NO LAB</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Tues Mar 12 – Fri Mar 15</td>
<td>Unconfined Compression</td>
<td>265 – 276, 404 – 420</td>
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<tr>
<td></td>
<td>Tues Mar 19 – Fri Mar 22</td>
<td>SPRING BREAK: NO LAB</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Tues Mar 26 – Fri Mar 29</td>
<td>Direct shear</td>
<td>421 – 442</td>
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<tr>
<td></td>
<td>Tues Apr 2 – Fri Apr 5</td>
<td>Discusion Section*</td>
<td></td>
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<tr>
<td></td>
<td>Tues Apr 9 – Fri Apr 12</td>
<td>NO LAB</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Tues Apr 16 – Fri Apr 19</td>
<td>Consolidation</td>
<td>297 - 359</td>
</tr>
<tr>
<td></td>
<td>Tues Apr 23 – Fri Apr 26</td>
<td>Consolidation, cont’d</td>
<td>297 - 359</td>
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<tr>
<td></td>
<td>Tues Apr 30 – Fri May 3</td>
<td>Discusion Section*</td>
<td></td>
</tr>
</tbody>
</table>

* location TBA

Lab rules:

1. In each lab section, students will be divided into “groups” of 3-4 students. Attendance is required for all group members for all laboratories. Only pre-arranged absences will be accepted. One lab report per lab group is required, due the following lab period. Students who do not attend lab due to a pre-excused absence must still contribute to report writing.

2. Read the appropriate laboratory procedure before the laboratory period. Laboratory procedures are available through Blackboard. Print out the procedure and bring it to lab with you.

3. THE LABORATORY MUST BE CLEANED FOLLOWING EACH LAB PERIOD. This includes washing/rinsing equipment, wiping off the lab tables, storing soil samples.

4. NO FOOD OR DRINK IS ALLOWED IN THE SOILS LABORATORY AT ANY TIME.
Laboratory Reports:

1. One report per group is required. The group as a whole is responsible for: i) ensuring that work is fairly distributed among group members; and ii) checking each others’ work.
2. *Reports must be signed by all group members upon submission.* Anyone not signing the report will not be given credit.
3. Reports must be neat, well organized, and professionally presented.
4. Report organization:
   - **Cover page:** Title of experiment, course name and number, date lab performed, date report submitted, names and signatures of group members performing the lab.
   - **Introduction:** Offer a brief description of the purpose of the test, the basic principles used to develop test measurements, and how the results may be used in geotechnical practice.
   - **Procedure and Material Description:** If you followed the procedure outlined in the text, then you only need to reference it, highlighting any modifications/adjustments. If you used a different procedure, then state the steps you followed. *Describe the soil tested!*
   - **Results:** Here is where you summarize the data you collected and analyzed (note, raw data is presented in the appendix, see below), and the methods used for analysis. Sample calculations must be included, as well as any required graphs and/or tables of data used in your evaluation. Here, summarize clearly the material or behavioral parameters you obtained.
   - **Discussion of Results:** Repeat your findings here, and discuss if they make sense: i.e., how they relate to information discussed in class and/or in the textbook. Here, also offer a discussion of possible sources of error, accuracy of the test method, effects of the experience of the testers, and anything else noteworthy during the test.
   - **References:** *(only if applicable).*
   - **Appendix:** Raw data taken during the test.
5. All graphs and tables should be labeled by way of an assigned a figure/table number, numbered in the order in which they appear in the report; the report text then should reference the relevant table/figure number. Example: “The compaction curve for the five trials is shown in Figure 2.” Place figure titles directly below the figures, and table titles directly above the table.
6. Graphing etiquette:
   - a. All graphs should be drawn or plotted on lined graph paper or generated by Excel or the graphing program of your choice.
   - b. Include grid lines to help enable proper interpretation of graphical parameters.
   - c. Label all graph axes and include proper units.
   - d. Size all graphs large enough to enable proper data interpretation. **Graphs should generally be about 1/2 to 1 full page in size.**
   - e. Arrange the axes data ranges so that the data you are plotting will be centered on the graph. For instance, if y-axis data range from 10 to 14, do NOT plot the the y-axis range from 0 to 15, as all the data points will be “scrunched” together in the top part of the graph!
7. Reports are due the following lab period after the lab was performed (one week later), at the beginning of class. A 50% penalty will be applied to late reports, unless prior arrangements are made.
Part II  Detailed Course Objectives
ABET Course Syllabus

Course Description: Fundamentals of geotechnical engineering; soil classification, seepage, stress-strain behavior, shear strength, consolidation, design of retaining structures and foundations, and slope stability. Soil testing. (Duplicates credit in CE 464 and CE 468.)

Required for all BSCE: BSCE, BSCE Structural, BSCE Building Science, and BSCE Environmental

Prerequisite: CE 225 Mechanics of Deformable Bodies

Co-Requisite: none


Reference: none

<table>
<thead>
<tr>
<th>Topics Covered</th>
<th>Learning Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geological and physical origins of soils; description of soils in terms of grain distribution, plasticity, and weight-volume relationships</td>
<td>Students will have learned to:</td>
</tr>
<tr>
<td></td>
<td>1. Understand the relations between soils, elements, minerals, and rocks</td>
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<td></td>
<td>2. Characterize soils by grain size analysis and plasticity and classify soils for engineering</td>
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<tr>
<td></td>
<td>3. Characterize the states of soils using weight-volume relationships</td>
</tr>
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<td></td>
<td>4. Understand soil compaction</td>
</tr>
<tr>
<td>Flow of water through soils using different approaches</td>
<td>5. Analyze a seepage problem using flow nets obtained by hand sketching and electrical analogy</td>
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<td></td>
<td>6. Define pros and cons of different methods of analysis</td>
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<td></td>
<td>7. Calculate seepage forces on hydraulic structures</td>
</tr>
<tr>
<td></td>
<td>8. Calculate water pressure within earth dams</td>
</tr>
<tr>
<td>Calculation of stress states in soil deposits and below foundations</td>
<td>9. Use Mohr’s circle and pole</td>
</tr>
<tr>
<td></td>
<td>10. Calculate stress increase due to foundations</td>
</tr>
<tr>
<td></td>
<td>11. Calculate amplitude and rate of settlement</td>
</tr>
<tr>
<td></td>
<td>12. Determine soil properties from laboratory test for calculation of settlement</td>
</tr>
<tr>
<td>Stability of retaining structures</td>
<td>13. Measure shear strength properties from laboratory tests</td>
</tr>
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<td></td>
<td>14. Calculate lateral stresses on retaining walls</td>
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<td></td>
<td>15. Design gravity walls and sheet pile walls</td>
</tr>
<tr>
<td>Use of MSExcel and MSWord for data processing and engineering reports</td>
<td>16. Write Visual Basic subroutines to customize spreadsheets</td>
</tr>
<tr>
<td></td>
<td>17. Perform engineering calculations with spreadsheets</td>
</tr>
<tr>
<td></td>
<td>18. Write organized reports including experimental results</td>
</tr>
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<td></td>
<td>19. Use experimental results in engineering calculations</td>
</tr>
<tr>
<td></td>
<td>20. Present results as PowerPoint presentations</td>
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### Topics Covered

<table>
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<tr>
<th>Lab experimentation with materials and processes; analysis and reporting on the data</th>
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<table>
<thead>
<tr>
<th>Learning Outcomes</th>
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</thead>
<tbody>
<tr>
<td>21. Process data and write reports</td>
</tr>
<tr>
<td>22. Do grain-size analysis</td>
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Students will have learned about:

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>23. Soil compaction</td>
</tr>
<tr>
<td>24. Flow of water through soils</td>
</tr>
<tr>
<td>25. Shear strength</td>
</tr>
<tr>
<td>26. Compressibility of soils</td>
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### Lecture and Lab Schedule

<table>
<thead>
<tr>
<th>Lecture</th>
<th>Lab</th>
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<tr>
<td>Sessions per Week</td>
<td>Duration per Session</td>
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<tr>
<td>1</td>
<td>1.5 hours</td>
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### Contribution of Course to Meeting the Professional Component

#### Engineering Topics

This course is an introduction to soil mechanics, foundation engineering and design, soil testing, soil classification, seepage, stress-strain behavior, shear strength, consolidation, retaining structures, laboratory data processing, foundations, slope stability, laboratory data processing, use of experimental data in geotechnical engineering calculations, and report writing.

### Relation of Course Objectives to Program Outcomes

The Civil Engineering program is designed to teach beyond the technical content of the curriculum and prepare the students to utilize what they learn in a professional setting.

This course contributes to the program outcomes as outlined in the adjacent table.

<table>
<thead>
<tr>
<th>Course Contribution to Program Outcomes (a-k)</th>
<th>✓ Key</th>
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</thead>
<tbody>
<tr>
<td>a. An ability to apply knowledge of mathematics, science, and engineering.</td>
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<tr>
<td>b. An ability to design and conduct experiments, as well as to analyze and interpret data.</td>
<td>✓</td>
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<tr>
<td>d. An ability to function on multi-disciplinary teams.</td>
<td>✓</td>
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<tr>
<td>e. An ability to identify, formulate and solve engineering problems.</td>
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</tr>
<tr>
<td>g. An ability to communicate effectively.</td>
<td>✓</td>
</tr>
<tr>
<td>i. Recognition of the need for, and an ability to engage in life-long learning.</td>
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</tr>
<tr>
<td>j. Knowledge of contemporary issues.</td>
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</tr>
<tr>
<td>k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.</td>
<td></td>
</tr>
</tbody>
</table>

Prepared by: Dr. A. Rechenmacher
Professor of Civil and Environmental Engineering

Date: Spring 2013