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Fall 2018

# CE 200-001: Surveying

Laramie Potts

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JOHN A. REIF, JR. DEPARTMENT OF  
**CIVIL AND ENVIRONMENTAL  
ENGINEERING**



**CE 200 – Surveying  
Section: 001**

**Fall 2018**

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**Instructor: Dr. Laramie Potts**

**Contact:** email [lpotts@njit.edu](mailto:lpotts@njit.edu)

**Office Hours in 2510 GITC: Monday 4:00 – 5:30 pm**

**Classroom: CULM LEC 2 (Wednesday: 8:30 am – 9:50 am)**

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**Course Description:**

This course will introduce the fundamentals of surveying measurements to provide a broad overview of the surveying instrumentation (Total Station, Digital Level), procedures, measurement corrections and reductions, survey datums, and computations that are required to produce a topographical map or a site plan for engineering and design projects. This course covers three main themes: 1) terrestrial-based survey measurements, 2) space-based positioning (Global Positioning System (GPS)) and surveying (Remote Sensing) techniques, and automated mapping with Geographic Information Systems (GIS)

Fundamentals of terrestrial surveying measurements include leveling, distances, and angle measurements to compute Orthometric heights relative to a vertical survey datum and 2-D Cartesian coordinates in a horizontal survey datum for engineering projects. Topics on photogrammetry include photography scale, and coordinate computation of features in imagery. Basic elements of map design and production methods are introduced.

Basic concepts on space-based positioning include GPS components and measurements and Remote Sensing technologies for surveying. Concepts on measurement corrections and data reductions for 3-D coordinate computations with respect to a global geodetic reference frame to solve surveying problems encountered in construction, earthworks, and environmental engineering. Simple concepts on Geographic Information System (GIS) database design and data integration are introduced for a perspective on a useful tool for rapid geospatial mapping and data queries.

**Course Format:** This course is taught as Hybrid (self-paced) learning. Half of the lectures (Dates on course syllabus indicated in red) will be in-class (face-o-face) interaction and the other half of the

time is set aside for exploratory learning aided by videos and websites (dates in blue). It is imperative that students attend the face-to-face classes where numerous examples and class exercises will solidify concepts learned.

**Prerequisites:** Prerequisite: MATH 111 or ENGR 101

**Textbook(s)/Materials Required:**

**Elementary Surveying:** *An Introduction to Geomatics*, 15<sup>th</sup> Edition, Charles D. Ghilani, Pearson. ISBN-13: 978-0134604657

**Supplemental Text:** (not required to be purchased)

- a) **Route Location and Design**, 5<sup>th</sup> Ed. McGraw Hill Book Co.
- b) **Surveying with Construction Applications**, 3<sup>rd</sup> Edition, Prentice Hall 1997.
- c) ASSHTO “**A Policy on Geometric Design of Highways and Streets**” 2004 Edition.

**Objectives:**

1. Develop an understanding of the basic principles of surveying including the Traditional measurements and representations as well as such modern techniques as Global positioning.
2. Integrate CAD techniques and tools into the application of basic surveying principles.
3. Gain an appreciation for the importance of the survey database in all phases of a project.

**Topics:**

- Introduction to surveying and field notes
- Theory of measurements and errors
- Distance measurements with tapes and EDM
- Leveling, Leveling procedures and computations
- Angular Measurements: Bearings and Azimuths
- Traverse computations
- Coordinate computations
- Earthworks: Areas and Volumes
- Topographic surveys and mapping
- Horizontal and Vertical Curves
- Construction surveys
- State Plane Coordinate Systems
- Photogrammetry & Remote Sensing
- Global Positioning Systems
- Introduction to Geographic Information Systems
- Hydrographic surveys

**Schedule:** Lecture/Recitation- 3 hour class face-to-face sessions as scheduled and Web-enhanced for self-paced learning.

**Professional Component:** Engineering Topics

**Prepared By:** Dr. Laramie V. Potts

**Date:** 7/31/2018

## Course Outline

Fall 2018

| Week & In-Class Date | Lecture Topic  | Reading                        | Assignment Due in Moodle (Sunday 11 pm) |
|----------------------|--|--------------------------------|---|
| 1<br>9/05            | <u>Introduction</u> (Video – V1) <ul style="list-style-type: none"> <li>• Introduction to Surveying</li> <li>• Modern Spatial Data Collection &amp; Field Notes</li> <li>• Math Review</li> </ul>  | Chp 1 -2                       |   |
| 2<br>9/12            | <u>Measurement Errors</u> (Video – V2) <ul style="list-style-type: none"> <li>• Surveying Measurements (Terrestrial, Airborne, Space-based)</li> <li>• Theory of Errors</li> </ul>   | Chp 3                          | Review V1<br>Review V2                  |
| 3<br>9/19            | <i>Quiz 1</i><br><u>Leveling</u> (Video - V3) <ul style="list-style-type: none"> <li>• Introduction to Leveling</li> <li>• Leveling Procedures</li> <li>• Leveling Computations &amp; Adjustments</li> <li>• Profiles</li> </ul>   | Chp 4-5                        | HW #1<br>Review V3                      |
| 4<br>9/26            | <u>Survey Measurements</u> (Video – V4) <ul style="list-style-type: none"> <li>• Principles of Electronic Distance Measurement</li> <li>• Measurement Corrections &amp; Calibration</li> <li>• Optical Measurement - Corrections &amp; Calibration<br/>Angles, Azimuth &amp; Bearings</li> </ul> | Chp 6<br>Part III<br><br>Chp 7 | HW #2<br>Review V4                      |
| 5<br>10/03           | <i>Quiz 2</i><br><u>Coordinate Geometry</u> (Video – V5) <ul style="list-style-type: none"> <li>• Departures and Latitude</li> <li>• Computations in Rectangular Coordinates</li> </ul>  | Chp 11                         | HW #3<br>Review V5                      |
| 6<br>10/10           | <u>Geodetic Control</u> <ul style="list-style-type: none"> <li>• Traversing (Video – V6)</li> <li>• Traverse Adjustment</li> </ul>   | Chp 9 &<br>Chp. 10             | HW #4<br>Review V6                      |
| 7<br>10/17           | <u>Geodetic Control (contd)</u> <ul style="list-style-type: none"> <li>• Intersection</li> <li>• Resection</li> </ul> Midterm I: (covering material from Lectures 1-4)   |                                | Midterm I<br>Review V7                  |
| 8<br>10/24           | <u>Horizontal Curves</u> (Video – V7) <ul style="list-style-type: none"> <li>• Coordinate Geometry and Formulae</li> <li>• Curve Layout</li> </ul>   | Chp 24                         | HW # 5<br>Review V8                     |
| 9<br>10/31           | <i>Quiz 3</i><br><u>Vertical Curves</u> <ul style="list-style-type: none"> <li>• Geometry and Formulae (Video –V8)</li> <li>• Curve Layout</li> </ul>  | Chp. 25                        | HW # 6<br>Review V9                     |
| 10<br>11/07          | <u>Global Positioning System (GPS)</u><br><u>Introduction to GPS</u> (Video –V9)<br>Theory of GPS (Orbit, Signals, Observations)<br>Surveying with GPS   | Chp 13<br>Chp 14               | HW # 7                                  |
| 11<br>11/14          | <u>Elements of Aerial Mapping</u> <ul style="list-style-type: none"> <li>• EMR – and Properties</li> <li>• Aerial Optical Imaging Systems and Data Acquisition</li> <li>• Elements of Integrated Geospatial Mapping Systems</li> </ul>   | Chp 27                         | HW #8                                   |

|             |  |   |   |
|-------------|--|---|---|
| 12<br>11/28 | Exam II<br>(covering material from Lecture 5-8)  |   | Midterm II  |
| 13<br>12/05 | <b>Quiz 4</b><br><b>Geographic Information System (GIS) (Video – V10)</b> <ul style="list-style-type: none"> <li>• GIS theory</li> <li>• Data models</li> <li>• GIS operations</li> <li>• Applications to the Built Environment</li> </ul>   | Chp 28                                    | HW # 9<br>Review V10  |
| 14<br>12/12 | <b>Mapping &amp; Earthworks (Video – V11)</b> <ul style="list-style-type: none"> <li>• Engineering Surveying – Area &amp; Volume Computations</li> <li>• Topographical Surveys</li> <li>• Contours and Gradients</li> </ul> <b>Construction Surveys (Moodle)</b> <ul style="list-style-type: none"> <li>• Equipment</li> <li>• Construction Surveying Procedures</li> </ul> <b>Course Review</b> | Chp 16<br>Chp.23<br>Chp.26<br><br>Handout | HW #10<br>Review V11<br><br>Complete<br>4 Online<br>Quizzes |
| 12/15       | Final Exams - See Registrar's Webpage for Place and Time Details<br>(Final Exam will cover material from Lectures 9-15)  |   | Final Exam  |

**Course Objectives:** By the end of the course you should be able to do the following:

- **Orthometric Heights:** Be able to perform a basic leveling field survey to accurately establish heights for control points in the NAVD88 Datum. Be able to use survey data to compute adjusted elevations for the control points and determine relative precision estimates.
- **Elementary Surveying Computations:** Understand and know how to apply data corrections and reductions from TSI distance and angle measurements. Be able to apply basic trigonometric formulae to compute planar coordinates of survey control points by traverse, intersection, and resection methods. Understand and know how to apply Federal Geodetic Control Commission accuracy standard and survey procedures. Know how to apply formulas for setting out horizontal and vertical curves (i.e., railroads, highways, etc.).
- **Space-based Geospatial Mapping Technology:** Understand the orbital attributes (and characteristics) and signal structure of GPS technology for point positioning. Understand and know how to compute geodetic coordinates from GPS pseudorange measurements. Understand the geometric and radiometric characteristics of remotely sensed imagery for surveying-based solutions to environmental engineering problems. Be able to generate a digital topographical map using terrestrial and space-based surveying technologies.

**Additional Information:**

1. **Materials Required** -- Calculator, Engineering Computation Pad.

2. **Grading**

- Reports of Videos.... 5% (due dates as shown on syllabus)
- Homework ..... 10% (due dates as shown on syllabus)
- Quizzes.....15% (four (4) 10-minutes long online multiple choice questions)
- Exam I ..... 20% (in-class closed book. Date shown on syllabus)
- Exam II..... 20% (in-class closed book. Date shown on syllabus)
- Final..... 30% (in-class closed book. Date shown on Registrar Webpage)

3. **Homework** is due on or before the posted date. Late homework will not be accepted. Handout problems may be assigned or substituted. Homework is to be neat and orderly. All calculations of homework problems are to be in an orderly fashion and completed on [engineering computation pad](#). You are to show all calculations. **Note: Sloppy and untidy submissions will not be accepted.** All written assignments shall be typed (or neat hand writing). Assignments will be uploaded to Moodle before the posted deadline. Upload assignments as one pdf or word document. *80% of the assigned homeworks must be completed and submitted via Moodle otherwise an incomplete "I" grade will be assigned as the final grade for the course.*

Your name and the date are to be on homework pages.

4. ***Reviews of Learning Object (Videos)*** is due the following class. View the learning object in your web browser (e.g., Internet Explorer) automatically. Your review will have four parts:
  - a) What is the video about?
  - b) List three main ideas covered in the Video
  - c) How does the topic apply to your major (Architecture, Civil Eng., Constr. Eng., etc)
5. You must ***be signed up*** for both the lab classes and lecture classes.
6. Unexcused ***absences*** from more than three classes will result in a grade of F. Being late will count as an absence. Coming to class more than five minutes after the assigned time will be considered late.
7. The NJIT ***Honor Code*** will be upheld, any violations will be brought to the immediate attention of the Dean of Students.
8. The students will be informed of any ***changes to syllabus*** at least one week in advance.
9. To schedule consultation ***outside office hours***, send a request via email

**Outcomes Course Matrix – CE 200 Surveying**

| Strategies, Actions and Assignments  | ABET Student Outcomes (1-7) | Program Educational Objectives | Assessment Measures               |
|--|-----------------------------|--------------------------------|-----------------------------------|
| <b>Student Learning Outcome 1: Develop an understanding of the basic principles of surveying including the traditional measurements and representations as well as such modern techniques as global positioning.</b> |                             |                                |                                   |
| Introduce the theory of measurements and related errors.   | 1                           | 1, 2                           | Homework, quizzes and exams       |
| Examine aspects of Geographic Information System (GIS) and Global Positioning System (GPS).  | 7                           | 1, 2                           | Homework, quizzes and exams       |
| Discuss surveying theory as applied to engineering projects.   | 1, 2                        | 1, 2                           | Homework, quizzes and exams       |
| <b>Student Learning Outcome 2: Integrate CAD techniques and tools into the application of basic surveying principles.</b>  |                             |                                |                                   |
| Introduce the theory of mapping and CAD.   | 1, 7                        | 1, 2                           | Homework, labs, quizzes and exams |
| Demonstrate surveying equipment and its proper use.  | 7                           | 1                              | Homework, labs, quizzes and exams |
| Use Geographic Information System (GIS) as a mapping tool.   | 1, 2, 7                     | 2                              | Homework, quizzes and exams       |
| <b>Student Learning Outcome 3: Apply the survey database to phases of project control.</b>   |                             |                                |                                   |

|   |   |      |                                     |
|---|---|------|-------------------------------------|
| Introduce the control network as a basis for mapping.                 | 1 | 1    | Homework, labs, quizzes and exams.  |
| Practice computations associated with route and construction surveys. | 1 | 1    | Homework, labs, quizzes and exams.  |
| Combine mapping with CAD.   | 7 | 1, 2 | Mapping project, quizzes and exams. |

### **CEE Mission, Program Educational Objectives and Student Outcomes**

The mission of the Department of Civil and Environmental Engineering is:

- to educate a diverse student body to be employed in the engineering profession
- to encourage research and scholarship among our faculty and students
- to promote service to the engineering profession and society

Our program educational objectives are reflected in the achievements of our recent alumni:

1 – Engineering Practice: Alumni will successfully engage in the practice of civil engineering within industry, government, and private practice, working toward sustainable solutions in a wide array of technical specialties including construction, environmental, geotechnical, structural, transportation, and water resources.

2 – Professional Growth: Alumni will advance their skills through professional growth and development activities such as graduate study in engineering, research and development, professional registration and continuing education; some graduates will transition into other professional fields such as business and law through further education.

3 – Service: Alumni will perform service to society and the engineering profession through membership and participation in professional societies, government, educational institutions, civic organizations, charitable giving and other humanitarian endeavors.

Our Student Outcomes are what students are expected to know and be able to do by the time of their graduation:

1. an ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety and welfare, as well as global, cultural, social, environmental and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data and use engineering judgment to draw conclusions an ability to acquire and apply new knowledge as needed, using appropriate learning strategies
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

**Revised: 2/13/18**