A Guide to Senior Design

CE 401 Capstone Project – Site Design
CE 403 Capstone Project – Building Design

Bachelor of Science in Civil Engineering
Bachelor of Science in Architectural Engineering
Bachelor of Science in Construction Engineering
Bachelor of Science in Environmental Engineering

Updated April 1, 2016
# Table of Contents

Introduction 1

Engineering Design 1
  - Engineering Design in Civil Engineering
  - Engineering Design in Construction Engineering
  - Engineering Design in Architectural Engineering
  - Engineering Design in Environmental Engineering

Design Projects 2
  - Site Design Project
  - Building Design Project

Faculty Instructors and Practitioner Partners 8
  - Faculty Instructors
  - Practitioner Partners

Design Teams and Team Leaders 9
  - Design Teams
  - Team Leaders
  - Expectations of Team Members
  - Statement of Qualifications

Course and Project Requirements 10
  - Core Curriculum Designations (W and C)
  - Individual Writing Assignments
  - Computer Applications
  - Preliminary and Final Project Reports

Senior Design Expo 11

Course Grading 12
  - Graduation Portfolios

Appendix A – Student Questionnaire

Appendix B – Self and Peer Evaluation Form

Appendix C – Team and Individual Presentation Evaluation Forms
Introduction

CE 401 Capstone Project – Site Design and CE 403 Capstone Project – Building Design provide a coordinated, multidisciplinary, team-based design experience for students in their last semester before graduation. These courses culminate the undergraduate education, requiring students to draw from all their coursework and apply and demonstrate the knowledge and skills they have developed prior to entering the profession. The goal is to emulat, inasmuch as possible, a design office environment. Accordingly, CE 401 and CE 403 are very different than any other course offered by the department. In addition to the educational experience for students, CE 401 and CE 403 also serve an important role in accreditation and assessment.

This guide is intended to define expectations, basic requirements, and the operational framework of the course. Each semester's project will dictate the specific details for the courses. However, since these courses, as mentioned, are fundamentally different than any other courses, serve four different degree programs, and are conducted in partnership with the department's External Advisory Board, it is critical that there is a common understanding of project requirements and expectations among those involved.

Engineering Design

Since CE 401 and CE 403 are, by intent, multidisciplinary in nature and are intended to provide a robust and realistic design experience, it is helpful to have a definition of engineering design, including definitions of design for each discipline.

Engineering design is a creative, systematic, and iterative application of scientific, mathematical, and basic engineering principles to conceive, develop and define components, systems, and processes in response to a defined need. Engineering creativity is fueled by ideas and knowledge of technology. Engineering design includes a consideration of multiple criteria -- economic, health and safety, social and environmental, and appropriate measures of functionality and performance -- as well as applicable codes, standards, and regulations. The engineering design process is made up of stages, which typically include

- Identification of need,
- Development of scope,
- Identification of constraints, including applicable codes and standards,
- Iteration between synthesis and analysis of design alternatives,
- Selection of the best design based on applicable criteria, and
- Documentation.

A more in-depth definition of engineering design and the engineering design process is, to a certain extent, engineering-discipline specific. That is, the process to design a water filtration system may share elements with the process to design a new subdivision, but the two design processes diverge in many specifics. Short definitions of engineering design for civil engineering, construction engineering, architectural engineering, and environmental engineering are found below.

Engineering Design in Civil Engineering – Civil engineering is the broad umbrella connecting engineering disciplines that focus on improving the quality of our built and natural environments. Civil engineers provide designs for a diverse set of components and systems that support society and define our communities. Examples of civil engineering design include, but by no means are limited to the following examples: a soil nail system to fortify an unstable slope; a highway pavement system composed of layers of soil, aggregate, and concrete or asphalt; the configuration and sizing of connections and members of a steel bridge; and a water purification and distribution system for a community.

Engineering Design in Construction Engineering – In construction engineering, the focus is on the design of the construction process, or the means of accomplishing the construction of a facility. The process involves the design of many construction-related plans, controls, systems, and components such as costs, schedule, site layout, labor resources, safety systems, temporary structures and support...
facilities, and equipment operations. Construction engineers often use fundamental knowledge from other disciplines in their designs.

**Engineering Design in Architectural Engineering** – Architectural engineering is the application of engineering principles to the design of buildings and building support systems. Architectural engineers coordinate the many facets of building design, including the design of: structural components and systems, construction processes, maintenance and operational processes, mechanical systems, electrical systems, architectural acoustics, and energy conservation. Architectural engineers work closely with architects in bringing to reality the architectural vision for space, function, and aesthetics.

**Engineering Design in Environmental Engineering** – The focus of design in environmental engineering includes both the built and natural environments. The application of hydrologic and water quality models to maximize environmental or public benefit are examples of environmental engineering design applied to the natural environment. Similarly, developing a unit process in a wastewater treatment plant or specifying the number of air exchanges needed for indoor air quality are examples of environmental engineering design in the built environment.

**Design Projects**

A joint committee of department faculty and members of the department’s External Advisory Board Senior Design Committee select a project or projects for each semester’s capstone design project. A common site may be used for both CE 401 and CE 403 projects. Both CE 401 and CE 403 projects utilize a team-design concept that mimics a small, multidisciplinary engineering firm to produce and present design work because the scope of the project exceeds what any individual student could accomplish alone.

**CE 401 Site Design Project** – BSEnvE students must take CE 401. BSCivE and BSConE students may choose either CE 401 or 403 (making sure they satisfy the prerequisites). Accordingly, the CE 401 site design project must include elements appropriate to civil, construction, and environmental engineering students.

To provide the student with the design office experience, site design projects include some or all of the following elements:

- **Zoning/Entitlements**
  - Difficult site zoning requirements or subdivision requirements, including challenging buffers, setbacks, rezoning, easements, etc,
  - A Planned Unit Development (PUD) or similar zoning with numerous requirements, or
  - Typical zoning/subdivision requirements

- **Grading/Earthwork**
  - An urban highly constrained site. The grading of such a site is largely dictated by the constraints such as adjacent roadway grades, elevations of existing utilities, etc. Earthwork balance is not an overriding concern. Having the site function properly, drain appropriately, and meet ADA comprise the main design issues.
  - Greenfield with topography. Balancing the earthwork while working with constraints is the goal.
  - Students will use Civil 3D to develop digital terrain models of existing and proposed grades.

- **Stormwater**
  - Collection and transport only. Students must know the general rules of the local authority. Skills include the Rational Method and Manning’s equation.
  - Stormwater management with peak rate control. This involves designing a detention pond. Skills include Hydrograph methods, and knowledge of SCS hydrologic methodology.
• Stormwater management with rate and water quality. This involves designing a detention and/or retention pond with water quality features. Skills - Hydrograph methods, knowledge of SCS hydrologic methodology.

• Stormwater management with Low Impact Development (LID) or sustainable site measures/volume control. This may involve designing LID measures, possibly in conjunction with a detention and/or retention pond. Skills - include LID runoff volume computations, Hydrograph methods, knowledge of SCS hydrologic methodology and familiarity with sustainable site features.

Site Environmental - Waters of the United States

• Wetlands and/or streams on site - Impacts with Nationwide Permit or Individual Permits
• Wetlands and/or streams on site - layout site development to avoid impacts
• No issues

Sanitary Sewer

• Tie to existing sanitary with lateral. Students must know the rules of the governing authority. Skills - flow calculations, Manning' equation for flow in a pipe.
• Extend public gravity main to existing sewer. Must know the rules of the governing authority. Must check for adequacy of size and for adequate scouring velocity. Skills - flow calculations, Manning' equation for flow in a pipe.
• Pump station with force main tie to existing sewer. Must know the rules of the governing authority. Will size the pumps, wet well, and force main. Skills - flow calculations, estimating peak factors, pump sizing and reading pump curves, calculations of flow in a closed conduit using Hazen and Williams.
• On-site system such as a drip system. Must know how to compute flows and have knowledge of drip systems. The design would generally be only siting and sizing the disposal field.

Water Supply

• Public main at site with pressure and flow information available. In this simple case the fire and domestic flows would be computed and the system evaluated to assure that the required flow was available. Skills - pipe network modeling, flow computations by use and by code, knowledge of how to use a fire flow test.
• Public main at site - fire flow test information provided. This is a more realistic case. The flow test would have to be evaluated and a model (either spreadsheet or with a KY-Pipes-type model) developed. Skills - pipe network modeling, flow computations by use and by code, knowledge of how to use a fire flow test.
• Public main nearby with flow test- water system must be evaluated for delivery and pressure. This is a very typical scenario. Generally, modeling with KY pipes (EPANET) would be required. Skills - Flow computation from code, etc., modeling of system with KY-pipes or other, understanding of how to use a flow test.
• Water tank required or booster station. Generally, modeling with KY pipes (EPANET) would be required. Skills - Flow computation from code, etc., modeling of system with KY-pipes or other, understanding of how to use a flow test.

Geotech

• Typical Geotechnical - mainly soil with some rock. In this scenario, the Geotechnical report does not materially affect the site design.
• Difficult Geotechnical – rock, unsuitable soils (alluvium, colluvium, highly plastic, etc.). In this scenario, the Geotechnical information will greatly affect the site design and cost estimate.
CE 401 will focus on the design of the site, including but not limited to, boundary and topographic survey, site layout (zoning, buffers, setbacks, easements, parking, building placement, ADA accessibility, access roadways, etc.), grading, storm drainage, storm water detention/retention, erosion control, utilities (domestic and fire water systems & sanitary sewer – gravity or pressure systems), and sustainable site features. The design documents should clearly identify the developed civil design. All major features and components of the design solution should be included as well as cost estimates, schedule and construction site plan. In general, the project will have the following minimum deliverables:

- **Site Plan:**
  This plan should depict the building tied down dimensionally to the boundary survey, roadways, property lines, required setbacks, easements, right-of-way, retaining wall, sidewalks, ADA accessible ramps, stairs, driveways, parking areas, loading areas/service courts. The plan should also include a typical pavement section showing thickness and type of material.

- **Site Grading and Drainage Plan:**
  This plan should clearly demonstrate the design intent by showing contours at one foot intervals, retaining walls, critical spot elevations, ADA routes & compliance, stormwater collection system with pipe sizes and inverts, and stormwater detention/retention areas. The plan should demonstrate how the design team intends to address any impaired waterways or other environmental concerns such as US Army Corps of Engineers regulated streams and wetlands. Supporting calculations should include storm sewer calculations as required by the local municipality for the conveyance and detention systems.

- **Erosion Control Plan:**
  The plan should demonstrate design intention and Best Management Practices required to protect the downstream environment and general compliance with NPDES regulations.

- **Site Utilities Plan:**
  The purpose of the plan is to show design intent and schematic design of the water distribution system, fire protection system and sanitary sewer collection system. Special attention should be paid to areas where the sanitary sewer system crosses the storm drainage system due to elevation conflicts. The plan should include main sizes, fire hydrant locations, valve placement, water meter locations and sanitary sewer main inverts. If a pump station is required, the plan should show the location of the station and force main routing along with preliminary pump sizing calculations.

- **Site Construction Layout Plan:**
  During construction the equipment, materials and personnel share the site. Storage, office space, site access, security, and movement pathways must be considered to successfully transform the site from the raw to the finished state.

- **Cost Estimate:**
  Typical projects will usually be budget constrained. Students must show clearly how the budget will be spent.

- **Schedule:**
  Students must develop a schedule showing all major activities and their progression with appropriate start/finish linkages.
Building Design Project – BSArchE students must take CE 403. BSCivE and BSConE students may choose either CE 401 or 403 (making sure they satisfy the prerequisites). Accordingly, the CE 403 building design project must include elements appropriate to civil, construction, and architectural engineering students.

To provide the student with the design office experience, building design projects include some or all of the following elements:

**Codes, standards and regulations**
- Students must determine what codes govern the building site and incorporate those codes into the design.

**Site Development:**
- Site development includes positioning the building to take maximum advantage of the site geography for passive solar, lighting, exposure and access; a basic plan for grading and drainage, site utilities, parking, and traffic flow into and out of the facility.

**Architectural Programming and Floor Plans:**
- Students will allocate space according to an architectural program, ultimately leading to floor plans for each level of the building (including the roof) and identifying room layouts, etc. that meet the life safety requirements of the building code.

**Structural:**
- Students provide general notes, typical details, and floor plans identifying the primary structural elements including sizes and locations. Provide sections/details as required to convey the design to the contractor.

**Utilities:**
- Students develop a utility plan identifying new and existing utilities (locations and invert elevations) that is coordinated with local utility providers and project requirements.

**Construction Planning:**
- Students evaluate site layout and laydown space for equipment and materials during construction and coordinate with construction sequencing.

**Cost Estimate:**
- Students evaluate project scope and design to provide the most economical design to meet the project requirements regarding cost of building (initial cost plus operation/maintenance cost over the life cycle of the project) and produce a cost estimate at various stages of the project design to ensure that the design is being performed within the financial constraints of the project.
CE 403 will focus on the design of a building, including, at a minimum, the following three phases with specific deliverables:

**Schematic Design Phase:**
- The Schematic Design Phase will use the space program to develop floor plan(s) which show circulation and room adjacencies.
- The objective is the overall organization of the plan not specific room details.
- Preliminary code reviews should be performed during Schematic Design Phase — Zoning, Building and other special jurisdictions.
- Begin to prepare cost estimate based on a square footage and unit price basis.
- Begin to prepare a project schedule indicating major milestones.
- Clarify any items unknown relating to surveys, topographic, sub-surface exploration and other site items.
- Building Design Concept or "Parti" — at minimum should consist of description guiding principles, goals of design concept and basis of design formulate by your group.

**Schematic Design Deliverables:**
1. Concept Statement or guiding principles for design based upon understanding of client needs assessment.
2. Site Plan — overall site circulation, parking, sidewalks, and landscape areas. Suggest the use of color for clarity.
3. Floor Plans — walls, windows, doors and architectural significant elements (ASE) such as plumbing fixtures at the toilet rooms. Suggest the use of color for functional use and circulation flow clarity.
4. Space Allotments — actual room square footage allotments.
5. Preliminary code analysis — zoning and building code analysis
6. Primary Building Elevation(s)
7. Building Section(s) — can be diagrammatic
8. Material(s) — discussion of major building materials (exterior and interior)
9. Engineering Systems — Narrative Descriptions
10. Project Costing Analysis— Probable Construction based upon square footage and unit pricing
11. Project Schedule — Preliminary Milestone Schedule
12. Optional 3D mass model — massing and major architectural features

**Design Development Phase:**
- The Design Development Phase builds on the SD drawings to further develop the Architectural Floor Plans including coordination of the structural elements (columns, beam depths vs. ceiling heights/floor to floor elevations/MEP zone above ceiling and below structure).
- Code reviews should be finalized for areas of separation, life safety items, and structural design criteria.
- Preliminary structural analysis should be performed to provide typical beam, column, and foundation sizes for use in Cost Estimates.
- Identify unknown items related to code review, site analysis, complicated framing conditions, etc. that need to be resolved in order to finalize the Construction.
- Cost Estimates should be performed based on RS Means and quantities obtained from Revit and/or hand calculations.

**Design Development Deliverables:**
1. Site Plan – overall site circulation, parking, sidewalks, and landscaping.
2. Floor Plans – walls (including wall types and fire ratings where applicable), structural columns and column grids shown, windows, doors, Reflected Ceiling Plans identifying ceiling heights and ceiling types.
3. Space Allotments – revise SD based on changes and progress with the building design.
4. Code Analysis
5. Exterior Building Elevations
6. Building Sections in primary directions (north-south and east-west)

Structural DD Deliverables
1. General Notes – identify general design criteria, foundation requirements, building material notes (concrete, steel, etc.)
2. Typical Details – Typical slab on grade details, tension lap splice table, column, and footing schedule can be shown here.
3. Floor Plans – column grids and column locations (include dimensions to show coordination between structural and architectural drawings). Identify horizontal framing for elevated floor and roof. Show some typical sizes for repetitive framing members (this helps the contractor with the Cost Estimate for the structural components). Show typical sizes for columns and footings (Typical corner, exterior, interior, and any special conditions that may affect the cost). Include plan notes and north arrow on all plans.
4. Typical foundation, floor, and roof sections. NOT required but good to include if possible.

Construction DD Deliverables
1. Project Cost Analysis – Provide detailed cost analysis based on actual quantities for the building.
2. Project Schedule – Develop the SD schedule and provide more detail regarding the relevant tasks, durations, and milestones.
3. Site Laydown/Site Use drawing identifying the proposed plan for use of the site during the construction.

75% Construction Document Set:
3D renderings of the building characterizing the group’s architectural design concept.
- A line drawing on the cover of their drawing package,
- A color print for display at the Senior Design Expo.

Drawings:
- General
  1. Cover Sheet (list of drawings, vicinity map)
  2. General Notes / Information
  3. Life Safety Plan and Code Matrix (egress paths, exit loads and capacities, rated walls)
- Architectural
  1. Site Plan – (Bldg Elevation, Contour Lines (dashed) with elevations, Sidewalks and Landscaping, Roads and Parking)
  2. Demolition Plan (if appropriate)
  3. Overall Floor Plan
  4. Furniture Plan (show furniture, fixture and equipment if needed)
  5. Roof Plan
  6. Enlarged Plans
  7. Exterior Elevations
  8. Building Sections
  9. Wall Sections
  10. Wall Partition Types
  11. Roof Details (optional)
  12. Interior Elevations
  13. Reflected Ceiling Plan
• Structural
  1. General Notes
  2. Typical Details (multiple sheets if required)
  3. Foundation/First Floor Plan
  4. Second Floor Plan
  5. Roof Plan
  6. Column and Footing Schedule (can be in the typical details for steel frame)
  7. Beam and Slab Schedules (concrete frames)
  8. Sections (multiple sheets)
• Construction
  1. Site Layout during Construction

Design Notebook:
  1. Code Review
  2. Outline Listing of Major Materials selected (major materials specified and manufacturers if applicable)
  3. Loads (Dead Load for Floor and Roof, Live Loads, Wind Loads, Seismic Loads)
  4. Foundation design
  5. Beam Design
  6. Column Design
  7. Lateral Design (Wind/ Seismic)
  8. LEED checklist/applicable points with a description of the sustainability approach for design
  9. Cut/Fill calculation
  10. Schedule of Values/Cost Estimates
  11. Construction Schedule
  12. Any other information pertinent to your design (manufacturer’s data from website, etc.)

Faculty Instructors and Practitioner Partners

An important aspect of CE 401 and CE 403 is the active involvement of design professionals, or practitioner partners. The faculty instructor and practitioner partners work together to achieve the goals of the course and provide a positive and meaningful design experience for students.

Faculty Instructors – The faculty instructors are responsible for organizing and coordinating the courses. Typically one faculty instructor will be responsible for CE 401, and another will be responsible for CE 403. They will, however, work together to assure coordination between the two courses is maintained. The faculty instructors will also be responsible for the grading of assignments, projects, and the course. They will seek input from the practitioner partners and others, but the actually assigning of grades is the faculty instructors’ responsibility.

Practitioner Partners – To provide realistic projects and to emulate a design office environment, practitioners volunteer their time and expertise to help mentor and guide students as they complete their design projects. Practitioner partners will evaluate and comment on the designs, but are not responsible for assigning grades. Also, practitioner partners will identify other professionals who can provide assistance for specific tasks or topics during the course of the semester. This may be providing a lecture on sustainability or low impact development principles for a site or walking the students through an earthwork calculation. This is an opportunity for professionals to give back to the profession by teaching, leading, and mentoring the next generation of engineers.

The time commitment for a practitioner partner is limited to the 2 hour and 50 minute class time on two days per week (Monday and Wednesday or Tuesday and Thursday) throughout the Fall or Spring semesters. Practitioner partners will assist with the development of the project outline and schedule as
well as providing several lectures throughout the semester with a mid-term and final presentation. This will include “over the shoulder” reviews during lab time when practitioners have the opportunity to work one on one with groups of students fielding questions and critiquing their design. Advisory Board members and Faculty will assist the practitioner partner with any questions during the semester and will be available to provide lectures and assist with reviews.

Design Teams and Team Leaders

At the beginning of the semester, all students will submit a one-page survey of interests, skills, and experience to assist in selection of team leaders and team members (See Appendix A). Though successful completion of the FE is not a requirement for completing this course, as part of the survey all students are required to indicate if they have passed the Fundamentals of Engineering (FE) exam or they are committed to taking the FE during the semester.

Team Leaders – Team leaders will be the primary point of contact between the design team and the faculty instructor and practitioner partners. Further, team leaders must coordinate planning, communication, and job responsibilities among the team members. The faculty instructor will select team leaders with input from department faculty, staff, and students enrolled in the course as appropriate. Selection as a team leader is an honor and is based on evidence of both technical and leadership abilities. Although not a requirement, team leaders should have passed the Fundamentals of Engineering (FE) exam or be committed to taking the FE during the semester.

Design Teams – The faculty instructor, who may consult with the selected team leaders and other members of the faculty, will assign student members to the design teams. Every effort will be made to distribute students based on their technical area(s) of interests, skills, and experience so that all teams are equally positioned for success. Having design teams balanced in terms of expertise is important since the scope of the project and expectations for all project deliverables will be the same for all design teams in each course. Barring any extenuating circumstances, design teams will consist of no fewer than 4 and no more than 6 members, including the team leader.

Expectations of Team Members – All team members are expected to make a full effort and to positively contribute to the project. Each team member is required to take responsible charge of appropriate technical and design tasks as required for the project. Additionally, each team member should exhibit positive attributes such as commitment, confidence, consideration of others, fairness, high expectations, honesty, integrity, optimism, persistence, positive attitude, respect, thoughtfulness, thoroughness, and tolerance. In addition to the faculty instructor and practitioner partner assessments of team members, a self- and peer-evaluation will be required from each student (See Appendix B).

Statement of Qualifications – To illustrate the qualifications based selection (QBS) process, a statement of qualifications (SOQ) will be prepared and submitted by each team at the beginning of the semester. The statement of qualifications should include, at a minimum, a concise statement of the team’s qualifications to complete the project and individual one-page resumes for each team member. Students are encouraged to indicate if they have passed the Fundamentals of Engineering exam (FE). Usually, to be designated as an EI, one needs to have an ABET-accredited degree and to have passed the FE. However, by special permission of the Alabama State Board of Licensure, students in CE 401 or CE 403 who have passed the FE may designate themselves as an Engineer Intern (EI) during the course; for example, Jane Smith, EI. The faculty instructor will provide additional details regarding the SOQ.

Course and Project Requirements

A variety of reports and other requirements are used to assess the abilities of students to work collaboratively and to assess each student’s contributions to completing the comprehensive design project.
Core Curriculum Designations (W and C) – Both CE 401 and CE 403 have core curriculum designations as W (writing) and C (computer) courses and partially satisfy core curriculum requirements for each major. As such, each student must individually demonstrate competency and receive passing grades in both the writing and computer portions of the course.

Individual Writing Assignments – Reporting progress of a project as well as communicating the final design is necessary in all engineering projects. As a W-designated course, individual writing assignments, including various reports, will be evaluated according to UA policies (http://registrar.ua.edu/academics/core-curriculum/engineering/). Assignments will be made, evaluated, and returned with feedback in such a frequency as to allow students to use the feedback to improve their writing skills. Students must receive an overall passing grade on the individual writing portion of the course to pass the course.

Weekly Team Project Reports (Rotating Individual Authorship)
- Weekly project reports are required from each team.
- The responsibility (authorship) for the report will rotate among all team members, with the report author clearly identified. Every team member must write at least one weekly report.
- These reports must be written in a professional manner and include, at a minimum, (1) a list of the week’s accomplishments, (2) problems that may have been encountered during the week, and (3) a plan for the upcoming week. The planned and completed activities of each team member must be identified.
- A Gantt chart or equivalent should be included with each weekly group report.
- These reports will be used to confirm appropriate progress is being made on the project and will be graded for both technical and grammatical content.
- The faculty instructor will provide report style and specific content information. The report will include only original writing of the individual student authoring the report, but may contain graphical and design summaries that are the work of the team.
- Reports will be graded by the faculty instructor and returned prior to the next report submission.

Biweekly Individual Reports
- Each student is to submit a biweekly personal/individual progress report.
- These reports must be written in a professional manner and include, at a minimum, (1) a specific discussion of the student’s own contributions to the project, and (2) self and peer evaluations of all team members (see Appendix B).
- The faculty instructor will provide report style and specific content information. The report will include only original writing of the individual student, but may contain graphical and design summaries that are the work of the team.
- Individual reports will be graded for both technical and grammatical content by the faculty instructor and returned prior to the next report submission.

Individual Midterm Report
- Associated with the team’s midterm report submission, an individual midterm report is required from each student. This report may be in lieu of a biweekly individual report.
- These reports must be written in a professional manner and include thorough self and peer evaluations of all team members (see Appendix B).
- This is a non-technical report and is similar to employee evaluations that may be required of an engineering manager in practice.
- A specific and detailed discussion of the student’s own contributions to the project, including documentation of use of appropriate computer applications that demonstrate fulfillment of the design requirements.
- The faculty instructor will provide report style and specific content information. The report will include only original writing of the individual student, but may contain graphical and design summaries that are the work of the team.
- This report will be graded by the instructors and returned to the students.

Computer Applications – Computing is ubiquitous in engineering analysis and design. To complete the necessary analysis and design for the CE 401 and CE 403 projects, a variety of software applications will
need to be used. As a C-designated course, individual students must document and have assessed their use of relevant computer applications for completion of the project. Students should include this in their individual midterm and final reports.

**Preliminary and Final Project Reports** – The two major deliverables associated with CE 401 and CE 403 are the preliminary and final project reports. Oral presentations will accompany both reports.

**Preliminary Project Report**
- Each team will provide one or more comprehensive preliminary reports and present the report to the faculty instructor, practitioner partner(s), and others selected panelists.
- The preliminary project report is a team effort and a team product.
- The specific responsibilities and contributions of each team member must be clearly delineated in the report(s).
- A formal oral presentation is required as part of the preliminary project report(s).
- The faculty instructor will provide report style and specific content information.

**Final Project Report**
- Each team will provide a comprehensive final report, typically in the form of a presentation at the Senior Design Expo.
- The final project report is a team effort and a team product.
- The specific responsibilities and contributions of each team member must be clearly delineated in the report.
- The faculty instructor will provide report style and specific content information.

**Senior Design Expo**

All design teams will present their final designs during the department’s Senior Design Expo. The Senior Design Expo is similar to a technical exposition and requires teams to prepare for both technical and non-technical questions.

Several rooms will be reserved for the presentations. Roughly four teams will be assigned to each room, and each team will give a 25-minute presentation during the two-hour Expo, with five minutes between presentations to allow set-up and break-down. It is anticipated that the majority of the presentation will be made through computer visualizations, but teams may consider providing poster boards and physical models to help present their design. Each team must produce one poster board to be retained for examination during the next ABET review.

Formal presentations will last roughly 15 minutes. After a short introduction, all team members are expected to speak for roughly 3 minutes to describe their part in the design. The last 10 minutes will be devoted to question and answer sessions. Presentation style may vary, but each team should carefully review the items listed in Attachment C to understand the elements on which they will be graded, both as a team and individually.

All teams are required to have name tags for each team member, including designation as an EI if the student has passed the FE exam (e.g., Jane Smith, EI).
Course Grading

The course grade will be determined based on two categories: (1) individual effort (reports completed and submitted as an individual) and (2) group effort (projects and reports complete and submitted as a member of a group). Grades resulting from the group effort will be subject to adjustments based on both peer and instructor evaluations (i.e., not everyone in a team will necessarily receive the same grade for their group effort). How the course grade is determined may differ based on project specifics, faculty instructor preferences, and input from the practitioner partners; however, the following has been used:

<table>
<thead>
<tr>
<th>Individual Effort¹</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekly and Biweekly Reports</td>
<td>5%</td>
</tr>
<tr>
<td>Midterm Report</td>
<td>5%</td>
</tr>
<tr>
<td>Final Report</td>
<td>5%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group Effort</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statement of Qualifications</td>
<td>5%</td>
</tr>
<tr>
<td>Preliminary Written Report/Presentation</td>
<td>20%</td>
</tr>
<tr>
<td>Final Report/Presentation</td>
<td>50%</td>
</tr>
<tr>
<td>Reviewer Evaluations</td>
<td>10%</td>
</tr>
</tbody>
</table>

Graduation Portfolios – To graduate, all students must submit a graduation portfolio that clearly demonstrates his or her understanding and attainment of each and every student learning outcome. Graduation portfolios are submitted as part of senior design. An incomplete (I) will be given for the course if a student fails to submit their graduation portfolio or if it is deemed that a good faith effort was not made to assemble a graduation portfolio that accurately represents their abilities and that clearly documents their achievement of the program’s student learning outcomes. Refer to the “Student Guide to Developing Your Graduation Portfolio” for additional information regarding requirements and expectations for graduation portfolios.

¹ Students must receive a passing grade on the individual reports to receive a passing grade in the course. Both writing skills and use of appropriate computer applications will be assessed.
Appendix A

The following student questionnaire is to be completed by each student at the beginning of the semester, and it will be used to assist in the selection of both team leaders and the members of each design team.
### SENIOR DESIGN STUDENT SURVEY FORM

**NAME:** ____________________________________________    **TEL:** ___________________________

**PREFERRED EMAIL ADDRESS:** ________________________________________________________

**MAJOR(S) (please highlight):** Civil    Construction    Architectural    Environmental

1. One a scale of 1 to 5, please rate your competencies in the following areas related to your major(s):

<table>
<thead>
<tr>
<th><strong>Low</strong></th>
<th><strong>High</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil Engineering</td>
<td>1  2  3  4  5</td>
</tr>
<tr>
<td>Environmental Engineering</td>
<td>1  2  3  4  5</td>
</tr>
<tr>
<td>Water Resources Engineering</td>
<td>1  2  3  4  5</td>
</tr>
<tr>
<td>Transportation Engineering</td>
<td>1  2  3  4  5</td>
</tr>
<tr>
<td>Structural Engineering</td>
<td>1  2  3  4  5</td>
</tr>
<tr>
<td>Construction Engineering</td>
<td>1  2  3  4  5</td>
</tr>
<tr>
<td>Geotechnical Engineering</td>
<td>1  2  3  4  5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Architectural Engineering</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Building Structures</td>
</tr>
<tr>
<td>Building Mechanical Systems</td>
</tr>
<tr>
<td>Building Electrical Systems</td>
</tr>
<tr>
<td>Construction Engineering Management</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Construction Engineering</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Controls</td>
</tr>
<tr>
<td>Construction Methods</td>
</tr>
<tr>
<td>Materials</td>
</tr>
<tr>
<td>Safety</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Environmental Engineering</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Systems</td>
</tr>
<tr>
<td>Land Systems</td>
</tr>
<tr>
<td>Water Systems</td>
</tr>
<tr>
<td>Associated Health Impacts</td>
</tr>
</tbody>
</table>

2. I have:  ___ Taken and Passed the FE    ___ I plan to take the FE on _______ (date)

3. What technical and non-technical skills do you possess which will benefit you the most in your career?
   In particular, please list experience and skill level with Civil 3D or Revit.
   ___________________________________________________________________________________
   ___________________________________________________________________________________

4. Other than your courses, outline any other engineering related experiences you have had. _________
   ___________________________________________________________________________________
   ___________________________________________________________________________________

5. Would you consider being designated as a “team leader?       ____ Yes      ____ No

6. Recommend at least one person, other than yourself, who you would recommend as a “group leader.”
   ___________________________________________________________________________________

7. I have read “A Guide to Senior Design”       ____ Yes      ____ No (if not, you are encouraged to do so)
Appendix B

Self and peer evaluations are required as part of the individual biweekly, midterm, and final written reports. While the faculty instructor will provide report style and specific content information for the reports, the following evaluation table will be used. Students must complete the table, entering evaluations for each team member, including an evaluation of their own contribution, participation, and attitude. In addition, students must also include both a brief paragraph discussing contributions of each team member, including their own.

<table>
<thead>
<tr>
<th>Name of Design Team Member</th>
<th>Contribution</th>
<th>Participation</th>
<th>Attitude</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Self and Peer Evaluations

Rate both yourself and each of your fellow team members using a scale of 1 to 5
1 = not at all; 2 = improvement needed; 3 = satisfactory; 4 = exceeds expectation; 5 = exemplary

- **Contribution** – Does the team member produce a fair share of useful work?
- **Participation** – Does the team member reliably show-up for meetings, interact productively with the group, and deliver work as agreed and on time?
- **Attitude** – Does the member have a positive and helpful attitude?
Appendix C

Reviewers will evaluate individuals and teams during the Senior Design Expo using the following form. Design teams and individual students should familiarize themselves with this form to assure their presentations address the evaluation criteria.
<table>
<thead>
<tr>
<th>RATINGS</th>
<th>CE 401 or CE 403 (circle one)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - Not Presented</td>
<td></td>
</tr>
<tr>
<td>1 - Significant Improvement Needed</td>
<td></td>
</tr>
<tr>
<td>2 - Slight Improvement Needed</td>
<td></td>
</tr>
<tr>
<td>3 - Satisfactory, Meets Expectations</td>
<td></td>
</tr>
<tr>
<td>4 - Moderately Exceeds Expectations</td>
<td></td>
</tr>
<tr>
<td>5 - Outstanding</td>
<td></td>
</tr>
</tbody>
</table>

Team Name:

1. Introductions and roles
   a. Introductions: Background, resume & name tag for each member
   b. Roles: States each member's role and reason for selection

2. Project description & requirements
   a. Overview of Project
   b. Understanding of Project Scope
   c. Outline of Project Approach and Assumptions
   d. Code Requirements (Building / Zoning / etc.)
   e. Graphics (To Illustrate Project)

3. Project problems and solutions
   a. Preliminary Designs - Brief History
   b. Evolution of Process from Preliminary to Final (Why)
   c. Clear Description(s) of the issues Associated with the Project
   d. Calculations to support the recommended solutions
   e. Confident Explanations of Teams Solutions
   f. Innovative / Sustainable Solutions [Reviewer’s Voluntary Credit]

4. Team responsiveness to questions
   a. Creditable and Knowledgeable Responses
**Individual Presentation Evaluation Form** – Please score each student for both criteria by circling the score using the following 0 – 5 rating scale.  
0 = not presented;  1 = significant improvement needed;  2 = slight improvement needed;  3 = satisfactory;  4 = moderately exceeds expectation;  5 = outstanding

<table>
<thead>
<tr>
<th>Team Name</th>
<th>Student Name</th>
<th>Demonstrated Effective Oral Communication Skills</th>
<th>Exhibited Confidence and Enthusiasm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0 1 2 3 4 5</td>
<td>0 1 2 3 4 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 1 2 3 4 5</td>
<td>0 1 2 3 4 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 1 2 3 4 5</td>
<td>0 1 2 3 4 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 1 2 3 4 5</td>
<td>0 1 2 3 4 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 1 2 3 4 5</td>
<td>0 1 2 3 4 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 1 2 3 4 5</td>
<td>0 1 2 3 4 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 1 2 3 4 5</td>
<td>0 1 2 3 4 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 1 2 3 4 5</td>
<td>0 1 2 3 4 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 1 2 3 4 5</td>
<td>0 1 2 3 4 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 1 2 3 4 5</td>
<td>0 1 2 3 4 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 1 2 3 4 5</td>
<td>0 1 2 3 4 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 1 2 3 4 5</td>
<td>0 1 2 3 4 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 1 2 3 4 5</td>
<td>0 1 2 3 4 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 1 2 3 4 5</td>
<td>0 1 2 3 4 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 1 2 3 4 5</td>
<td>0 1 2 3 4 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 1 2 3 4 5</td>
<td>0 1 2 3 4 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 1 2 3 4 5</td>
<td>0 1 2 3 4 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 1 2 3 4 5</td>
<td>0 1 2 3 4 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 1 2 3 4 5</td>
<td>0 1 2 3 4 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 1 2 3 4 5</td>
<td>0 1 2 3 4 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 1 2 3 4 5</td>
<td>0 1 2 3 4 5</td>
</tr>
</tbody>
</table>

**Read:** Please score each student for both criteria by circling the score using the following 0 – 5 rating scale.  
0 = not presented;  1 = significant improvement needed;  2 = slight improvement needed;  3 = satisfactory;  4 = moderately exceeds expectation;  5 = outstanding.