This Academic Quality Improvement Plan provides details, guidelines and procedure for continuous quality improvement for the undergraduate Bachelor of Science in Construction Management.

1. Strategic Plan for the Educational Unit
The strategic plan for the Washington State University’s Construction Management program is found in a separate document titled “CM Strategic Plan 2015-2020” dated May 5, 2015.

2. Degree Program Assessment Plan
A comprehensive assessment plan provides complete continuous improvement of our undergraduate degree program.

2.1 Undergraduate Program Mission Statement
The WSU Construction Management program’s mission is to educate, prepare, and provide opportunities for our students to become valuable resources to our economy, the construction management profession, and the built environment.

2.2 Degree Program Objectives
The following objectives are part of the strategic plan that relates to the undergraduate program and will be reviewed annually. The framework of these objectives are to provide accessible, challenging, quality, and contemporary educational program that prepares individuals to assume technical and managerial positions in the construction and related industries. Specific objective measurements:
- Number of students admitted each year should be between 50-55
- Placement rate of graduates should be above 95%
- Accreditation by American Council for Construction Education (ACCE) is maintained
- Provide experiential learning opportunities for students.

2.3. Program Learning Outcomes
The program learning outcomes meets and exceeds the student learning outcomes required by ACCE. In addition to the program objectives listed above the Student Learning Outcomes (SLO’s) will be assessed, reviewed, and results acted on annually. Student work will be assessed for a minimum level of conformance and to the standard of the programs performance criteria. A template for the assessment of a SLO is found in Appendix A. Individual assessment tools for specific SLO’s are found in their respective notebooks. Appendix B shows the indirect assessment tool. Appendix C show when each SLO is directly assessed and Appendix D maps the SLO to the Course Learning Outcomes (CLO’s).

Minimum level of conformance is limited to the 20 SLO’s being assessed one direct measure and one indirect measure. Our plan is to directly assess each of the SLO’s at different times during a student’s tenure and measure all SLO’s indirectly.

2.4 Assessment tools and frequency of Student Learning Outcomes Assessment
The following table provides a guide for what class has Student Learning Outcomes assessed. DA = Direct Assessment, IA = Indirect Assessment. This is also shown on a semester by semester basis in Appendix C.
2.4 Assessment Tools for Student Learning Outcomes 2018/19
The following table provides a guide for which class has student learning outcomes assessed. Each student learning outcome is assessed at least twice and at least one of these assessments is a direct assessment. DA = Direct Assessment (30), IA = Indirect Assessment (20)

<table>
<thead>
<tr>
<th>Course</th>
<th>Course Title</th>
<th>Assessment Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>CstM 102</td>
<td>Intro to Built Environment</td>
<td>DA</td>
</tr>
<tr>
<td>CstM 201</td>
<td>Materials I</td>
<td>DA</td>
</tr>
<tr>
<td>CstM 202</td>
<td>Materials II</td>
<td>DA</td>
</tr>
<tr>
<td>CstM 222</td>
<td>Culture of CM</td>
<td>DA</td>
</tr>
<tr>
<td>CstM 252</td>
<td>Admin &amp; Const. Documentation</td>
<td>DA</td>
</tr>
<tr>
<td>CstM 254</td>
<td>Construction Graphics</td>
<td>DA</td>
</tr>
<tr>
<td>CE 302</td>
<td>Intro to Surveying</td>
<td>DA</td>
</tr>
<tr>
<td>CstM 332</td>
<td>Bldg. Science I</td>
<td>DA</td>
</tr>
<tr>
<td>CstM 333</td>
<td>Bldg. Science II</td>
<td>DA</td>
</tr>
<tr>
<td>CstM 356</td>
<td>Earthwork &amp; Equipment</td>
<td>DA</td>
</tr>
<tr>
<td>CstM 362</td>
<td>Law</td>
<td>DA</td>
</tr>
<tr>
<td>CstM 368</td>
<td>Safety</td>
<td>DA</td>
</tr>
<tr>
<td>CstM 370</td>
<td>Estimating I</td>
<td>DA</td>
</tr>
<tr>
<td>CstM 371</td>
<td>Estimating II</td>
<td>DA</td>
</tr>
<tr>
<td>CstM 451</td>
<td>Delivery Systems</td>
<td>DA</td>
</tr>
<tr>
<td>CstM 460</td>
<td>Const. Cost Management</td>
<td>DA</td>
</tr>
<tr>
<td>CstM 462</td>
<td>Schedule</td>
<td>DA</td>
</tr>
<tr>
<td>CstM 473</td>
<td>Human Factors</td>
<td>DA</td>
</tr>
<tr>
<td>CstM 475</td>
<td>Capstone</td>
<td>DA</td>
</tr>
<tr>
<td>Arch 351</td>
<td>Structures I</td>
<td>DA</td>
</tr>
<tr>
<td>Arch 352</td>
<td>Structures II</td>
<td>DA</td>
</tr>
<tr>
<td>Arch 463</td>
<td>Structures III</td>
<td>DA</td>
</tr>
<tr>
<td>Survey</td>
<td>Sr. Exit Survey</td>
<td>DA</td>
</tr>
</tbody>
</table>
Student Learning Outcomes

1. Create written communications appropriate to the construction discipline.
2. Create oral presentations appropriate to the construction discipline.
3. Create a construction project safety plan.
4. Create construction project cost estimates.
5. Create construction project schedules.
6. Analyze professional decisions based on ethical principles.
7. Analyze construction documents for planning and management of construction processes.
8. Analyze methods, materials, and equipment used to construct projects.
9. Apply construction management skills as a member of a multidisciplinary team.
10. Apply electronic-based technology to manage the construction process.
11. Apply basic surveying techniques for construction layout and control.
12. Understand different methods of project delivery and the roles and responsibilities of all constituencies involved in the design and construction process.
13. Understand construction risk management.
15. Understand construction quality assurance and control.
16. Understand construction project control processes.
17. Understand the legal implications of contract, common, and regulatory law to manage a construction project.
18. Understand the basic principles of sustainable construction.
19. Understand the basic principles of structural behavior.
20. Understand the basic principles of mechanical, electrical and piping systems.

2.5. Assessment performance criteria and methodology for Student Learning Outcomes

The following tables list the specifics of the assessment tools that will be used and the performance criteria to measure the achievement of a student learning outcome. Specific learning outcomes assessment tools are attached.

1. Create Written Communication appropriate to the construction discipline

<table>
<thead>
<tr>
<th>Where assessed/ Who</th>
<th>Assessment item</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>CstM 252 - Construction Administration &amp; Documentation / Gunderson</td>
<td>Individual Course Assignment #2 &amp; #5</td>
<td>At least 80% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>Exit Survey/ Program Head</td>
<td>Question on how well students feel they can accomplish SLO</td>
<td>Greater than 3.5 on scale of 1 to 5</td>
</tr>
</tbody>
</table>
### 2. Create oral presentations appropriate to the construction discipline

<table>
<thead>
<tr>
<th>Where assessed/Who</th>
<th>Assessment item</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>CstM 473 - Human Productivity in Construction / Adjunct (Sunleaf)</td>
<td>Oral Negotiations Assignment</td>
<td>At least 70% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>CstM 475 - Senior Capstone / Cherf</td>
<td>Final Team Presentations – each student individually evaluated</td>
<td>At least 80% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>Exit Survey/ Program Head</td>
<td>Question on how well students feel they can accomplish SLO</td>
<td>Greater than 3.5 on scale of 1 to 5</td>
</tr>
</tbody>
</table>

### 3. Create a construction project safety plan

<table>
<thead>
<tr>
<th>Where assessed/Who</th>
<th>Assessment item</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>CstM 368 - Safety &amp; Health / Cherf</td>
<td>Series of Questions on Test #'s 1 and 2 + OSHA Certification</td>
<td>At least 80% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>Exit Survey/ Program Head</td>
<td>Question on how well students feel they can accomplish SLO</td>
<td>Greater than 3.5 on scale of 1 to 5</td>
</tr>
</tbody>
</table>

### 4. Create construction project cost estimates

<table>
<thead>
<tr>
<th>Where assessed/Who</th>
<th>Assessment item</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>CstM 370 - Estimating I / Peschel</td>
<td>Final Exam - complete</td>
<td>At least 80% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>CstM 371 - Estimating II / Peschel</td>
<td>Series of Questions on Final Exam</td>
<td>At least 80% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>Exit Survey/ Program Head</td>
<td>Question on how well students feel they can accomplish SLO</td>
<td>Greater than 3.5 on scale of 1 to 5</td>
</tr>
</tbody>
</table>

### 5. Create construction project schedules

<table>
<thead>
<tr>
<th>Where assessed/Who</th>
<th>Assessment item</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>CstM 102 - Intro to the Built Environment / Cherf</td>
<td>Individual Assignment #1 Test #2</td>
<td>At least 80% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>CstM 462 - Planning &amp; Scheduling / Gunderson</td>
<td>Individual Scheduling Projects B, C, and D</td>
<td>At least 80% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>Exit Survey/ Program Head</td>
<td>Question on how well students feel they can accomplish SLO</td>
<td>Greater than 3.5 on scale of 1 to 5</td>
</tr>
</tbody>
</table>

### 6. Analyze professional decisions based on ethical principles

<table>
<thead>
<tr>
<th>Where assessed/Who</th>
<th>Assessment item</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>CstM 370 - Estimating I / Peschel</td>
<td>Individual Assignment (ia) #6 - Ethics Case Studies</td>
<td>At least 80% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>Exit Survey/ Program Head</td>
<td>Question on how well students feel they can accomplish SLO</td>
<td>Greater than 3.5 on scale of 1 to 5</td>
</tr>
</tbody>
</table>
### Washington State University
#### Construction Management

**Academic Quality Improvement Plan for Bachelor of Science in Construction Management**

7. **Analyze construction documents for planning and management of construction processes**

<table>
<thead>
<tr>
<th>Where assessed/ Who</th>
<th>Assessment item</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>CstM 252 - Construction Administration &amp; Documentation / Gunderson</td>
<td>Individual Lab Quiz #’s 1-5</td>
<td>At least 80% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>Exit Survey/ Program Head</td>
<td>Question on how well students feel they can accomplish SLO</td>
<td>Greater than 3.5 on scale of 1 to 5</td>
</tr>
</tbody>
</table>

8. **Analyze methods, materials, and equipment used to construct projects**

<table>
<thead>
<tr>
<th>Where assessed/ Who</th>
<th>Assessment item</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>CstM 201 - Materials I / Kirk</td>
<td>Series of Questions on Quizzes + Homework + Final Exam</td>
<td>At least 70% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>CstM 201 - Materials I / Adjunct (Lima)</td>
<td>Series of Questions on Quizzes + Homework + Final Exam</td>
<td>At least 70% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>CstM 356 - Earthwork &amp; Equipment / Kirk</td>
<td>Series of Questions on Quizzes + Homework + Final Exam</td>
<td>At least 70% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>Exit Survey/ Program Head</td>
<td>Question on how well students feel they can accomplish SLO</td>
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</tbody>
</table>

9. **Apply construction management skills as a member of a multidisciplinary team**

<table>
<thead>
<tr>
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<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>CstM 475 - Senior Capstone / Cherf</td>
<td>Final Team Presentations – each student individually evaluated</td>
<td>At least 80% of students earn a C (70%) or better</td>
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<tr>
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<td>Question on how well students feel they can accomplish SLO</td>
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</tr>
</tbody>
</table>

10. **Apply electronic-based technology to manage the construction process**

<table>
<thead>
<tr>
<th>Where assessed/ Who</th>
<th>Assessment item</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>CstM 252 - Construction Administration &amp; Documentation / Gunderson</td>
<td>Individual Assignment #2, #5, and #6</td>
<td>At least 80% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>CstM 254 - Construction Graphics / Anderson</td>
<td>Midterm Exam (Lab), Final Project (Lab), and Homework Assignment – Bluebeam Revu</td>
<td>At least 80% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>CstM 462 - Planning &amp; Scheduling / Gunderson</td>
<td>Individual Scheduling Projects B, C, and D</td>
<td>At least 80% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>Exit Survey/ Program Head</td>
<td>Question on how well students feel they can accomplish SLO</td>
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</tbody>
</table>
### 11. Apply basic surveying techniques for construction layout and control

<table>
<thead>
<tr>
<th>Where assessed/ Who</th>
<th>Assessment item</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE 302 - Introduction to Surveying / Olsen</td>
<td>Lab Exam – Exercises 1-3</td>
<td>At least 70% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>Exit Survey/ Program Head</td>
<td>Question on how well students feel they can accomplish SLO</td>
<td>Greater than 3.5 on scale of 1 to 5</td>
</tr>
</tbody>
</table>

### 12. Understand different methods of project delivery and the roles and responsibilities of all constituencies involved in the design and construction process

<table>
<thead>
<tr>
<th>Where assessed/ Who</th>
<th>Assessment item</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>CstM 451 - Delivery Systems / Gunderson</td>
<td>Individual Course Assignment #3 + Series of Questions on Quiz #’s 1-4 &amp; Exam #’s 1 and 2</td>
<td>At least 80% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>Exit Survey/ Program Head</td>
<td>Question on how well students feel they can accomplish SLO</td>
<td>Greater than 3.5 on scale of 1 to 5</td>
</tr>
</tbody>
</table>

### 13. Understand construction risk management

<table>
<thead>
<tr>
<th>Where assessed/ Who</th>
<th>Assessment item</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>CstM 460 - Construction Cost Management / Cherf</td>
<td>Individual Assignment #1 + Series of Questions on Test #’s 1 and 3</td>
<td>At least 80% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>Exit Survey/ Program Head</td>
<td>Question on how well students feel they can accomplish SLO</td>
<td>Greater than 3.5 on scale of 1 to 5</td>
</tr>
</tbody>
</table>

### 14. Understand construction accounting and cost control

<table>
<thead>
<tr>
<th>Where assessed/ Who</th>
<th>Assessment item</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>CstM 460 - Construction Cost Management / Cherf</td>
<td>Individual Assignment #1 + Series of Questions on Test #’s 1 and 3</td>
<td>At least 80% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>Exit Survey/ Program Head</td>
<td>Question on how well students feel they can accomplish SLO</td>
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</tr>
</tbody>
</table>

### 15. Understand construction quality assurance and control

<table>
<thead>
<tr>
<th>Where assessed/ Who</th>
<th>Assessment item</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>CstM 252 - Construction Administration &amp; Documentation / Gunderson</td>
<td>Series of Questions on Exam #2</td>
<td>At least 80% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>Exit Survey/ Program Head</td>
<td>Question on how well students feel they can accomplish SLO</td>
<td>Greater than 3.5 on scale of 1 to 5</td>
</tr>
</tbody>
</table>
### 16. Understand construction project control processes

<table>
<thead>
<tr>
<th>Where assessed/ Who</th>
<th>Assessment item</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>CstM 252 - Construction Administration &amp; Documentation / Gunderson</td>
<td>Series of Questions on Exam #2</td>
<td>At least 80% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>CstM 460 - Construction Cost Management / Cherf</td>
<td>Individual Assignment #1 + Series of Questions on Test #’s 2 and 3</td>
<td>At least 80% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>Exit Survey/ Program Head</td>
<td>Question on how well students feel they can accomplish SLO</td>
<td>Greater than 3.5 on scale of 1 to 5</td>
</tr>
</tbody>
</table>

### 17. Understand the legal implications of contract, common, and regulatory law to manage a construction project

<table>
<thead>
<tr>
<th>Where assessed/ Who</th>
<th>Assessment item</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>CstM 362 - Construction Law / Austin</td>
<td>Three Non-Cumulative Exams and Two Writing Assignments</td>
<td>At least 80% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>Exit Survey/ Program Head</td>
<td>Question on how well students feel they can accomplish SLO</td>
<td>Greater than 3.5 on scale of 1 to 5</td>
</tr>
</tbody>
</table>

### 18. Understand the basic principles of sustainable construction

<table>
<thead>
<tr>
<th>Where assessed/ Who</th>
<th>Assessment item</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>CstM 332 - Building Science I / Day</td>
<td>Series of Questions on Quiz #’s 8 and #9 + Assignment #6</td>
<td>At least 70% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>CstM 333 - Building Science II / Day</td>
<td>Series of Questions on Midterm Exam + Series of Questions on Final Exam</td>
<td>At least 70% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>Exit Survey/ Program Head</td>
<td>Question on how well students feel they can accomplish SLO</td>
<td>Greater than 3.5 on scale of 1 to 5</td>
</tr>
</tbody>
</table>

### 19. Understand the basic principles of structural behavior

<table>
<thead>
<tr>
<th>Where assessed/ Who</th>
<th>Assessment item</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arch 352 - Structures II / Adjunct</td>
<td>Series of Homework Assignments*</td>
<td>At least 70% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>Arch 463 - Structures III / Adjunct</td>
<td>Series of Homework Assignments*</td>
<td>At least 70% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>Exit Survey/ Program Head</td>
<td>Question on how well students feel they can accomplish SLO</td>
<td>Greater than 3.5 on scale of 1 to 5</td>
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</tbody>
</table>

* Assessment has not been performed in this class due to the use of different adjunct faculty over the last 4 semesters.
20. Understand the basic principles of mechanical, electrical and piping systems

<table>
<thead>
<tr>
<th>Where assessed/ Who</th>
<th>Assessment item</th>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>CstM 332 - Building Science I / Day</td>
<td>Series of Questions on Quiz #’s 1-7 and 8-10 + Assignment #’s 2-8 and 10 + Series of Questions on Final Exam</td>
<td>At least 70% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>CstM 333 - Building Science II / Day</td>
<td>Series of Questions on Midterm Exam + Series of Questions on Final Exam</td>
<td>At least 70% of students earn a C (70%) or better</td>
</tr>
<tr>
<td>Exit Survey/ Program Head</td>
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</tr>
</tbody>
</table>

3. Assessment Implementation Plan

Assessment evaluation data is due to the program coordinator by the 15th of each month after a semester. The senior exit survey will be conducted online via Qualtrics and results will be available by July 15th of each year. The program coordinator will collate the program assessment data and degree program objectives data into a report for review at both a fall and spring faculty retreat/meeting and at a fall Construction Management Advisory Board (CMAB) meeting. Recommendations, improvements, corrective actions, and changes will be recorded and reflected in future appendices to this report.

The assessment data is stored on Microsoft OneDrive. The program coordinator will email the link and reminders to faculty to upload the data.
Appendix A
Detailed Direct Assessment Tools

See Attached in the format of the following template:

<table>
<thead>
<tr>
<th>STUDENT LEARNING OUTCOME #</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLO Direct quote from CM Quality Improvement Plan</td>
</tr>
</tbody>
</table>

**Performance Criteria**

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>X % of students earn at least Y %</td>
</tr>
</tbody>
</table>

**Where Assessed**

<table>
<thead>
<tr>
<th>Course: CstM XXX – Course title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semester: Fall / Spring</td>
</tr>
<tr>
<td>Instructor: Name</td>
</tr>
</tbody>
</table>

**Student Work Assessed**

Explain the specific measurement tool. Could be exam questions, assignments, or other student work.

**Rubric Used for Assessment**

Provide the rubric you use to grade or evaluate the student work.
STUDENT LEARNING OUTCOME # 1

Create written communication appropriate to the construction discipline

Performance Criteria
At least 80% of students earn a C (70%) or better

Where Assessed
Course: CstM 252 - Construction Administration & Documentation
Semester: Spring
Instructor: Gunderson

Student Work Assessed
Assignment #2, Submittal Package, Letter of Transmittal, and RFI. Using the plans and specifications for the Riverstone Two Office Building, create a submittal package for Spec. Section 10165, Plastic Laminate Toilet Compartments. Students are also required to create a Letter of Transmittal and a Request for Information.

Assignment #5, Project Controls. Students are required to role play as the General Contractor’s Project Engineer for the Riverstone Two Office Building project and submit a project controls plan for the project. Students are instructed to include:

- A project controls plan narrative describing the controls systems for cost (labor, material, equipment, subcontractor), schedule, submittals, documents (all types), quality control, safety, etc. Graphics and examples should be used to enhance professional presentation.
- A copy of the RFI log with at least five RFI’s listed and the actual copies of those five RFI’s included.
- Submittal Log with the required submittals listed for Divisions 1, 3, 8, and 9. No actual submittals are required for this assignment.
- Transmittal Log listing the submittals that were transmitted to the Owner and/or Architect during the first MONTH on the project.
- Change Order Log with a narrative describing how changes will be incorporated into the project. One change order should be listed on the log: adding the trash enclosure.
Rubric Used for Assessment

Assignment #2 Rubric:
- Professional presentation (10 points)
  - Creative Company Name
  - Creative Company Logo
- Letter of Transmittal content (5 points)
- RFI content and clarity (5 points)
- Submittal cover sheet content (5 points)
- Submittal (35 points)
  - Completeness of submittal package
    - Shop Drawings (specific for this project). Use of Bluebeam is required.
    - Product Data
    - Samples (simply submit a color chart of Architects initial selection)
    - Manufacturer’s Installation Instructions
- Quality and clarity of submittal
- The submittal answers questions before they are asked

Assignment #5 Rubric:
- Professional Presentation .......................... 10 points
- Formal Letter Content & Presentation............. 10 points
- Project Controls Narrative .......................... 15 points
- RFI Log & RFI’s (content & presentation) ....... 10 points
- Submittals Log (content & presentation) ............ 10 points
- Transmittal Log ..................................... 5 points
- Change Order Log ................................. 5 points
- Change Order Narrative ............................ 5 points
STUDENT LEARNING OUTCOME # 2

Create oral presentations appropriate to the construction discipline

Performance Criteria
At least 70% of students earn a C (70%) or better

Where Assessed
Course: CstM 473 - Human Productivity in Construction
Semester: Spring
Instructor: Adjunct (Sunleaf)

Student Work Assessed
Explain the specific measurement tool. Could be exam questions, assignments, or other student work.

Rubric Used for Assessment
Provide the rubric you use to grade or evaluate the student work.
STUDENT LEARNING OUTCOME # 2

Create oral presentations appropriate to the construction discipline

Performance Criteria
At least 80% of students earn a C (70%) or better

Where Assessed
Course: CstM 475 - Senior Capstone
Semester: Spring
Instructor: Cherf

Student Work Assessed

During the team presentations the faculty facilitators filled out a rubric for each student based on the below rubric for their individual role in the presentation.

Rubric Used for Assessment

<table>
<thead>
<tr>
<th>Rubric Used for Assessment</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presentation Skills</td>
<td>10</td>
</tr>
<tr>
<td>Content</td>
<td>10</td>
</tr>
<tr>
<td>Professionalism</td>
<td>10</td>
</tr>
<tr>
<td>Time</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
</tr>
</tbody>
</table>
STUDENT LEARNING OUTCOME # 3

Create a construction project safety plan

Performance Criteria
At least 80% of students earn a C (70%) or better

Where Assessed
Course: CstM 368 - Safety & Health
Semester: Spring
Instructor: Cherf

Student Work Assessed
A class project consists of a Jobsite Safety Hazard Analysis plan for a specific project.

Rubric Used for Assessment
Your grade will also be based on following the JHA format and guidelines identifying:

- Scope (Description) of Work
- Appropriate PPE
- Steps/tasks/hazards/controls
- Safety concerns/potential hazards
- Include review of 11 basic types of hazards
- Required Action or Safety Procedures
- Identification of MSDS for products used
- Training
- Phases of work/basic job steps/sequencing
  - Emergency Routes & Assembly Points
  - Signatures
## STUDENT LEARNING OUTCOME # 4

Create construction project estimates

### Performance Criteria

At least 80% of students earn a C (70%) or better

### Where Assessed

<table>
<thead>
<tr>
<th>Course:</th>
<th>CstM 371 - Estimating II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semester:</td>
<td>Spring</td>
</tr>
<tr>
<td>Instructor:</td>
<td>Peschel</td>
</tr>
</tbody>
</table>

### Student Work Assessed

A select portion of questions on the Final Exam - including, but not limited to, Model Based Estimate (MBE), subcontractor and/or supplier selection, development of unit costs for material and/or labor, and quantification of materials.

### Rubric Used for Assessment

The exam questions were assessed by “correct” or “incorrect” answers using fill in the blank questions and questions requiring students to perform calculations. The questions used are below:

50. *(5 points)* Calculate the gross (no adjustments, factors, etc.) excavation quantity in cubic yards. The area of excavation is as follows:

<table>
<thead>
<tr>
<th>Plan View (NTS)</th>
<th>Elevation/Section (NTS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>65'-0&quot;</td>
<td>65'-0&quot;</td>
</tr>
<tr>
<td>25'-0&quot;</td>
<td>12'-0&quot;</td>
</tr>
<tr>
<td></td>
<td>40'-0&quot;</td>
</tr>
<tr>
<td></td>
<td>25'-0&quot;</td>
</tr>
</tbody>
</table>

51. *(5 points)* You have a crew consisting of one foreman, one carpenter and three laborers who are expected to form and pour 24,500 sf of interior slab on grade concrete. The foreman is paid $42.35/hour, the carpenter is paid $37.67/hour and the laborers are paid $21.45/hour. Based upon historical information we anticipate that they can form and pour 200 sf/hour. What is the average wage rate AND how much will it cost to complete this work?
52. **(5 points)** Calculate the board footage of 2x4 studs and plates for the wood framed walls shown in the floor plan below. Studs shall be 8’-0” tall and with a double top plate condition will create an overall wall height of 8’-4 ½”. The plans and specs state that the required stud spacing for these walls is 2’-0” o.c. The floor plan is as follows:

![Plan View (NTS)](image)

53. **(5 points)** Calculate the gross (no adjustments, factors, etc.) concrete quantity in cubic yards. The area of the 5” thick concrete slab is as follows:

![Concrete Slab](image)

55. **(5 points)** Using the specifications (Attachment #1), partial plans (Attachment #1.2) and the proposals/bids (Attachment #1a through #1f), determine the appropriate window supplier to use in your bid for the project.

   a. Windows by____________________________________$______________.

56. **(5 points)** Using the specifications (Attachment #2) and the proposals/bids (Attachment #2a through #2c), determine the appropriate gypsum board assemblies subcontractor to use in your bid for the project.

   a. Gypsum board assemblies by____________________________________$______________.
60. (25 points) Using the MBE Estimate Worksheet below and the attached RS Model (Attachment #4 & #4a), develop a parametric estimate that indicates the anticipated construction cost for a project with the following parameters:

a. The commander at Fairchild Air Force Base in Spokane, Washington has contacted your firm about the need for a new Repair and maintenance facility on base. The facility is basically a large repair garage and will be CMU block construction with steel framing for the roof structure. The floor area of the facility is 220’ x 60’ and there will be no basement. The single story height of the facility is 16’-0”.

i. Also needed within the estimate are a 5 hp air compressor with dual controls, a 5 ½ ton hoist and 15 single tier lockers. The location modifier for Spokane, Washington is .95 and the location modifier for Seattle, Washington is 1.125.

i. NOTE: Show your math and use whole numbers (round up or down using typical rounding principles) when interpolating areas, heights, etc. All numbers indicating money shall be extended out two decimal places.

1. The formula for linear interpolation is:

\[ d = d_1 + \frac{g - g_1}{g_2 - g_1}(d_2 - d_1) \]
## Detailed Direct Assessment Tools

### Parametric/MBE Estimate Worksheet

<table>
<thead>
<tr>
<th>Source</th>
<th>Page</th>
<th>Model #</th>
<th>Area</th>
<th>sf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exterior Wall Composition:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frame Type:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Adjustments for exterior wall variation:**

**Size Adjustment:**

**Height Adjustment:**

**Adjusted Base Cost per sf:**

\[
\text{Building Cost*: } \quad \$ \quad \times \quad \text{sf} \quad \rightarrow \quad \$
\]

\[
\text{Basement Cost**: } \quad \$ \quad \times \quad \text{sf} \quad \rightarrow \quad \$
\]

* Multiply adjusted base cost per sf by floor area of building.

** Multiply basement cost (from model information) by basement area.

### Lump Sum Additions/Deductions:

\[
\text{SUB-TOTAL BUILDING COST (sum of above costs): } \quad \rightarrow \quad \$
\]

\[
\text{Modifications (complexity, workmanship, size, etc.): } \quad +/- \quad \% \quad \times \quad \$
\]

\[
\text{SUB-TOTAL BUILDING COST (sum of above x percentage): } \quad \rightarrow \quad \$
\]

Location Modifier:  City ___________________________ Date _____________ x

**TOTAL PROJECT COST:**  $ ___________________
STUDENT LEARNING OUTCOME # 5

Create construction project schedules

Performance Criteria
At least 80% of students earn a C (70%) or better

Where Assessed
<table>
<thead>
<tr>
<th>Course:</th>
<th>CstM 102 – Introduction to Built Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semester:</td>
<td>Fall</td>
</tr>
<tr>
<td>Instructor:</td>
<td>Cherf</td>
</tr>
</tbody>
</table>

Student Work Assessed
As a fictitious contractor where students submit a proposal including the following information:

INTRODUCTION COVER LETTER (include proper format and your signature), COMPANY ORGANIZATION/PROJECT ORGANIZATION, NARRATIVE, SITE PLAN, and PRELIMINARY SCHEDULE:
Last, but not least, put a preliminary schedule together for the project. Break-out each building separately. A bar chart format would be sufficient. Include, as a minimum, the following activities:

- Mobilization and Demobilization
- Building shell (where applicable)
- Site grading and preparation
- Abutments for each bridge
- Road and street construction
- Beam and deck construction for each bridge
- The girder material delivery (lead time)
- The bar joist material delivery (lead time)
- Interior finishes for the structures
- Parking lot
- Electrical and mechanical for the appropriate buildings
- Caisson construction (where applicable)
- Foundation construction (where applicable)
- At least one activity for each subcontractor on site

Rubric Used for Assessment

Breakdown for grading:

<table>
<thead>
<tr>
<th>Proposal Format</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover Letter Signed</td>
<td>5</td>
</tr>
<tr>
<td>Clear, Legible, Professional</td>
<td>5</td>
</tr>
<tr>
<td>Organization Structure/Project Organization Chart</td>
<td>20</td>
</tr>
<tr>
<td>Narrative</td>
<td>20</td>
</tr>
<tr>
<td>Site Layout</td>
<td>20</td>
</tr>
<tr>
<td>Schedule</td>
<td>20</td>
</tr>
<tr>
<td>Resume</td>
<td>10</td>
</tr>
<tr>
<td>Grand total points</td>
<td>100</td>
</tr>
</tbody>
</table>
STUDENT LEARNING OUTCOME # 5

Create construction project schedules

Performance Criteria
At least 80% of students earn a C (70%) or better

Where Assessed
Course: CstM 462 – Construction Planning and Scheduling
Semester: Fall
Instructor: Gunderson

Student Work Assessed
In each of the last three assignments (Projects B, C and D), each student was required to create a construction schedule which included:
- Utilize of Create a Work Breakdown Structure
- Estimate activity durations
- Utilize logic to sequence the activities
- Create the CMP network and reports in Primavera P6

Rubric Used for Assessment
Project B Rubric:
- Professional Presentation – 20 points
- Readable Schedule Bar Chart – 20 pts
- Complete Column Reports – 20 points
- Legible, complete & easy to follow worksheets – 20 points
- Scheduling notes – 20 points

Project C Rubric:
- Gantt chart CPM with Base Line – 15 points
- (Evaluation will be based on the logic and the schedule as a communication tool)
- Updated Gantt chart CPM – 15 points
- Column Report for each CPM – 30 points (15 points each)
- One page Manpower Report – 10 points
- One page Cash Flow Chart/Graph – 10 points
- Scheduling and Estimating Notes – 20 points (10 points each)
- All documents should be printed as a PDF, combined, and submitted in Blackboard as a single PDF file. Make this submittal package professional and easy to read.
Project D Rubric

- Cover Sheet and Table of Contents (10 points)
- A bar chart similar to previous lab assignments identifying appropriate WBS, activity IDs, activity description and original duration columns **only** including Gantt Chart. (25 points)
- A column report including activity ID, activity description, original duration, total float, ES/EF, activity codes and predecessor/successor for each activity. (25 points)
- Activity duration notes and calculations (20 points)
- Submit a list of subcontracted work with fictitious names for each subcontractor. Assign an activity code for each subcontractor and for your company for the self-performed work. A minimum of four activity codes must be used. Include a crew makeup report for each of the following self-performed activities: All wood components, and structural steel (includes diaphragms). (20 points)
- Submit your final submittal through Blackboard in the appropriate drop box. Submit one PDF file; combine all pdf files into one file for submission.
STUDENT LEARNING OUTCOME # 6

Analyze professional decisions based on ethical principles

Performance Criteria
- At least 80% of students earn a C (70%) or better

Where Assessed
- Course: CstM 370 - Estimating I
- Semester: Fall
- Instructor: Peschel

Student Work Assessed
- Students are presented with several “real world” case studies centered on issues that have transpired which have ethical implications. To complete the assignment, students are to place themselves in the situation and state their opinion and/or address how the issue should be resolved. The decision making process requires the students to consider the ethical and/or legal implications of their decisions.

Rubric Used for Assessment
- Provide the rubric you use to grade or evaluate the student work.
STUDENT LEARNING OUTCOME # 7

Analyze construction documents for planning and management of construction processes

Performance Criteria
At least 80% of students earn a C (70%) or better

Where Assessed
Course: CstM 252 - Construction Administration & Documentation
Semester: Spring
Instructor: Gunderson

Student Work Assessed
In the beginning of the course, the students are asked to read two chapters from a Print Reading text. They are given the following five quizzes which see if they understand the symbols on construction drawings.

- Quiz 1, Students are asked to identify the names of 10 different lines used in construction drawings.
- Quiz 2, Students are asked to identify the names of 10 types of doors and 5 types of windows used in construction drawings.
- Quiz 3, Students are asked to identify the names of wood framing members and the types of wall framing used in light frame construction.
- Quiz 4: Students are asked to identify the names of wood stick forming members used in concrete wall construction.
- Quiz 5, Students are asked to identify the names of metal framing members

At the end of the semester, students are given a lab final project in which they are asked question about a set of drawings and specifications. There are 45 fill in the blank questions.

Rubric Used for Assessment
Quiz 1: 10 Matching questions
Quiz 2: 15 Matching questions
Quiz 3: 12 fill in the blank, and three short answer questions
Quiz 4: 12 fill in the blank/short answer questions
Quiz 5: 11 fill in the blank/short answer questions

Lab Final Project: 45 fill in the blank/short answer questions
STUDENT LEARNING OUTCOME # 8

Analyze methods, materials, and equipment used to construct projects

Performance Criteria

At least 70 % of students earn a C (70 %) or better

Where Assessed

Course: CstM 201 - Materials I
Semester: Fall
Instructor: Kirk

Student Work Assessed

The sum of scores on weekly quizzes and what I refer to as Mini-Me’s:

Quizzes cover the readings of the textbook and/or lecture material covered in the prior week. These weekly 5 questions are representative of the student's ability to analyze methods and materials used to construct projects. Quizzes are available at the conclusion of the course for examination.

Mini-Me’s look very similar to quizzes, however they are a little more difficult and reflect more of what an exam may be measuring. The difference is they are only five questions in length and allow the student to better direct their student learning in a more rapid method, thus reducing or eliminating test anxiety. In addition, as with the quizzes there is instant feedback. Mini-Me’s may review topics from the beginning of the semester. In other words they can be cumulative. They build from the quizzes.

Note: In the past, I had up to 12 to 15 five-question quizzes and around 10 Mini Me’s given for assessment purposes. The quizzes can vary in the number of true and false and multiple choice type of questions given. In addition, there can be short problems that students must solve. It depends on the subject being taught and how I feel the students are responding.

Final Exam. The final exam will consist of questions similar to questions asked in the quizzes and Mini-Me’s. They are designed for repetition of the subject matter throughout the semester.

Rubric Used for Assessment

Questions on a quiz or Mini Me consist of five questions designed to assess what has been presented the past week. The questions can be true or false, multiple choice, open-ended questions, or problems to solve. Each question is assigned a given amount of points, normally 2 points each. Time length for a five-question quiz is around 5 minutes. Most all quizzes are at the professor’s discretion (pop quizzes), while Mini-Me’s are usually once a week.

Final exam questions usually consist of 20 true and false questions (2 points each), 12- 15 multiple choice questions (3 points each), 15-20 points of short answers and 2 to 3 problems of around 20 points. The quizzes, Mini-Me’s and the final exam are in paper form.
STUDENT LEARNING OUTCOME # 8

Analyze methods, materials, and equipment used to construct projects

Performance Criteria
At least 70% of students earn a C (70%) or better

Where Assessed
Course: CstM 202 - Materials II
Semester: Spring
Instructor: Lima

Student Work Assessed
The sum of scores on weekly quizzes and what I refer to as Mini-Me’s.

Quizzes cover the readings of the textbook and/or lecture material covered in the prior week. These weekly 5 questions are representative of the student's ability to analyze the methods and materials used to construct projects. Quizzes are available at the conclusion of the course for examination.

Mini-Me’s look very similar to quizzes, however, they are a little more difficult and reflect more of what an exam may be measuring. The difference is they are five to ten questions in length and allow the student to better direct their student learning in a more rapid method, thus reducing or eliminating test anxiety. In addition, as with the quizzes, there is instant feedback. Mini-Me’s may review topics from the beginning of the semester. In other words, they can be cumulative. They build from the quizzes.

Note: In the past, I had up to 12 to 15 five-question quizzes and around 10 Mini Me’s given for assessment purposes. The quizzes can vary in the number of true and false and multiple choice type of questions given. In addition, there can be short problems that students must solve. It depends on the subject being taught and how I feel the students are responding.

Final Exam. The final exam will consist of questions similar to questions asked in the quizzes and Mini-Me’s. They are designed for repetition of the subject matter throughout the semester.

Rubric Used for Assessment
Questions on a quiz or Mini Me consist of five to ten questions designed to assess what has been presented the past week. The questions can be true or false, multiple choice, open-ended questions, or problems to solve. Each question is assigned a given amount of points, normally 2 points each. Time length for a five-question quiz is around 5 minutes. Most quizzes are at the professor’s discretion (pop quizzes), while Mini-Me’s are usually once a week.

Final exam questions usually consist of 20 true and false questions (2 points each), 12-15 multiple choice questions (3 points each), 15-20 points of short answers and 2 to 3 problems of around 20 points. The quizzes and Mini-Me’s are administered through learning management software and the final exam is in paper form.
STUDENT LEARNING OUTCOME # 8

Analyze methods, materials, and equipment used to construct projects

Performance Criteria
At least 70 % of students earn a C (70 %) or better

Where Assessed
Course: CstM 356 - Earthwork & Equipment
Semester: Spring
Instructor: Kirk

Student Work Assessed
The sum of scores on weekly quizzes and two exams are representative of the student’s ability to analyze methods, materials and equipment used to construct projects. Quizzes and exams are available at the conclusion of the course for examination.

Note: In the past, I had up to 15 to 20 five-question quizzes and two to three exams for assessment. The quizzes can vary in the number of true and false and multiple choice type of questions given. In addition, there can be short problems that students must solve. It depends on the subject being taught and how I feel the students are responding.

Rubric Used for Assessment
Quizzes consist of five questions designed to assess what has been presented the past week. The questions can be true or false, multiple choice, open-ended questions, or problems to solve. Each question is assigned a given amount of points, normally 2 points each. Time length for a five-question quiz is around 5 minutes. Most all quizzes are at the professor’s discretion (pop quizzes).

Exams usually consist of 20 true or false questions (2 points each), 12-15 multiple choice questions (3 points each), 15-20 points of short answer and 2 to 3 problems of around 20 points. There is no time limit on exams, however over many years teaching this course, I have timed each and every exam. The first exam is usually turned in within 35 minutes and the bulk of the class in 45 minutes. There are a few students that will take up to 2 hours to complete the exam.

All quizzes and exams are in paper form.
Apply construction management skills as a member of a multidisciplinary team

Performance Criteria
At least 80% of students earn a C (70%) or better

Where Assessed
Course: CstM 475 - Senior Capstone
Semester: Spring
Instructor: Cherf

Student Work Assessed
Industry judges evaluation of students during the Capstone Competition.

Rubric Used for Assessment

<table>
<thead>
<tr>
<th>ITEM</th>
<th>POSSIBLE POINTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Specific Design Elements- Was the design communicated and presented professionally?</td>
<td>10</td>
</tr>
<tr>
<td>2. Site Logistics- Did the site logistics reflect the complexity of the site?</td>
<td>10</td>
</tr>
<tr>
<td>3. Value added, unique content and perspective- Research on building and incorporating that into their presentation. Unique value added content.</td>
<td>10</td>
</tr>
<tr>
<td>4. Cost Estimate- Accuracy of cost estimate.</td>
<td>20</td>
</tr>
<tr>
<td>Competitive and realistic. Fees, contingency and general conditions.</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>5. Proposed Project Schedule</strong> - Detailed schedule, realistic, proper detail and well developed. Did their construction sequencing meet your expectations?</td>
<td>20</td>
</tr>
<tr>
<td><strong>6. Presentation Quality</strong> - Did you get a connection with the presenting team? Was it well-rehearsed? Was their presentation materials well done?</td>
<td>10</td>
</tr>
<tr>
<td><strong>7. Question and Answers</strong> - Did they respond well and answer questions correctly?</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total Score</strong></td>
<td>100</td>
</tr>
</tbody>
</table>
STUDENT LEARNING OUTCOME # 10

Apply electronic-based technology to manage the construction process

Performance Criteria
At least 80% of students earn a C (70%) or better

Where Assessed
Course: CstM 252 - Construction Administration & Documentation
Semester: Spring
Instructor: Gunderson

Student Work Assessed
Students are required to do on-line training using Procore Project Management software. Students watch short 2 to 5 minute videos about different aspects of the on-line project management technology. After each video they take a quiz. They may take the quiz as many times as needed to pass the quiz. At the completion of all the videos and quizzes, the students receive a certificate of completion from Procore.

Rubric Used for Assessment
Students use a Letter of Transmittal to submit their Procore Certificates of Completion verifying completion of the on-line training. Therefore, assessment was pass-fail based the correct answers to quiz questions throughout the training. 98% successfully completed the Procore on-line training.
**STUDENT LEARNING OUTCOME # 10**

Apply electronic-based technology to manage the construction process

**Performance Criteria**

At least 80% of students earn a C (70%) or better

**Where Assessed**

<table>
<thead>
<tr>
<th>Course:</th>
<th>CstM 254 - Construction Graphics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semester:</td>
<td>Fall</td>
</tr>
<tr>
<td>Instructor:</td>
<td>Anderson</td>
</tr>
</tbody>
</table>

**Student Work Assessed**

Learning outcome - create 3D building information models using Autodesk Revit. Student work assessed:

- A midterm exam in which students need to complete a Revit model in lab and within the allotted lab time frame. See MIDTERM EXAM RUBRIC below.
- A final project in which students worked together using Collaboration for Revit (cloud-based work-sharing) on a large campus model. Each student modeled specific and identifiable components of the larger model enabling individual assessment. See REVIT FINAL PROJECT rubric below.

Gain familiarity in Bluebeam Revu pdf software to navigate and add markups to construction drawings. Student work assessed:

- In a homework assignment, students extracted *one architectural sheet* from a campus building drawing set and added two photos *with notes (markups)* to the sheet in the plan locations matching the locations where photos were taken. See BLUEBEAM REVU RUBRIC below.

**Rubric Used for Assessment**

**MIDTERM EXAM RUBRIC**

1. (2 pts) Number of levels: 2 + roof (i.e. Level 1, Level 2, Roof)
2. (2 pts) Level height: 10’ (each level)
3. (2 pts) Footprint dimensions as shown below:
4. (3 pts) Floor type/thickness: 8” concrete slab at Level 1 and Level 2
5. (2 pts) Exterior wall type: Exterior - Brick on metal stud; align exterior side of walls with exterior edge of slab
6. (2 pts) Interior wall type and layout: Int. - 5-1/2” partition; three separate rooms on the first floor only
7. (2 pts) Roof type + pitch (if applicable): Steel Truss; “Flat” roof (no pitch)
8. (3 pts) Window number, type and size, and sill height: 10 windows on each level; Fixed 60”x60”; 3’ sill height (height above floor)
9. (2 pts) Exterior and interior door number and types: 2 Exterior doors (any size – be sure the name contains the word “Exterior”) and 2 Interior Single-Flush (any size) on the first level only.
10. (2 pts) Take one snapshot from the exterior looking toward the building. Render and “Save to Project.”
11. (3 pts) Show grid lines at each exterior wall (there should be 3 grid lines in each direction). Align grid lines with exterior face of wall.
12. (Optional: bonus 2 pts) Dimensions between all grid lines
## Detailed Direct Assessment Tools

### REVIT FINAL PROJECT RUBRIC

#### WALLS AND CEILINGS (At your level)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Pts possible</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Exterior walls are in the correct location (below grade: foundation walls) and configured correctly (i.e. layers have correct materials and thicknesses)</td>
<td>6</td>
</tr>
<tr>
<td>2.</td>
<td>Interior walls are in the correct location and configured correctly (i.e. layers have correct materials and thicknesses)</td>
<td>6</td>
</tr>
<tr>
<td>3.</td>
<td>Doors and windows in exterior walls are shown [approximately] in the correct location</td>
<td>5</td>
</tr>
<tr>
<td>4.</td>
<td><strong>EXTRA CREDIT:</strong> Ceilings are shown for all rooms <em>at the correct elevation.</em></td>
<td></td>
</tr>
</tbody>
</table>

#### STRUCTURAL FRAMING AND FLOORS (At your level)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Pts possible</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td>Structural floors are in correct location and are configured/sized correctly (ground floor = slab on grade)</td>
<td>5</td>
</tr>
<tr>
<td>6.</td>
<td>Structural beams are in correct location and are configured/sized correctly (ground floor = footings instead of beams)</td>
<td>4</td>
</tr>
<tr>
<td>7.</td>
<td>Structural columns/pilasters are in correct location and are configured/sized correctly</td>
<td>2</td>
</tr>
<tr>
<td>8.</td>
<td>Openings in slabs are in correct location (At Basement: &quot;openings&quot; are elevator and sump pits)</td>
<td>3</td>
</tr>
</tbody>
</table>

#### MECHANICAL (At your level)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Pts possible</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.</td>
<td>SA diffusers, RA grilles, and SA/RA ducts are shown for one room in correct location (both in plan and elevation). At Basement and Roof: Equipment is shown</td>
<td>5</td>
</tr>
</tbody>
</table>

#### ELECTRICAL (At your level)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Pts possible</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.</td>
<td>Outlets, lighting, switches and associated panel are shown for one room in the correct location (both in plan and elevation)</td>
<td>5</td>
</tr>
</tbody>
</table>

#### MISC. (At your level)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Pts possible</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.</td>
<td>Sheet that includes the following views: Plan view of your floor and a camera view of the room that contains mechanical elements.</td>
<td>3</td>
</tr>
<tr>
<td>12.</td>
<td><strong>EXTRA CREDIT:</strong> Material takeoff schedule for one of the following: steel columns, steel beams, exterior walls, or interior walls. <em>THERE MAY NOT BE ANY DUPLICATES ON ONE TEAM. BE SURE TO DISCUSS WITH YOUR TEAMMATES WHICH MATERIAL TAKEOFF YOU PLAN TO DO.</em> (Rename the schedule to include YOUR last name)</td>
<td>5</td>
</tr>
</tbody>
</table>

#### MISC. (Entire Model, ALL levels)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Pts possible</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.</td>
<td>The model has been combined with all teams' models for a complete building model</td>
<td>See instructions</td>
</tr>
<tr>
<td>14.</td>
<td>Rendering of exterior (rename the rendering to include YOUR last name)</td>
<td>3</td>
</tr>
</tbody>
</table>
| 15. | Walkthrough, shaded or realistic with *at least* 10 key frames, preferably more.  
   Start the walkthrough at the exterior and continue into the interior. Be sure to include the room(s) in which you placed mechanical and electrical elements (rename the walkthrough to include YOUR last name) | 3            |

**TOTAL** 50  
**EXTRA CREDIT** 10  
**TOTAL POINTS POSSIBLE WITH EXTRA CREDIT** 60
BLUEBEAM REVU RUBRIC

(1 pt) One architectural sheet was extracted from the pdf drawing set
(2 pt) Photos were placed in the correct location (on the correct floor, in the correct plan location)
(1 pt) Room number for photo 1 and identifiable object for photo 2 appear in photos
(1 pt) A note (markup) accompanied each photo
STUDENT LEARNING OUTCOME # 10

Apply electronic-based technology to manage the construction process

Performance Criteria

At least 80% of students earn a C (70%) or better

Where Assessed

<table>
<thead>
<tr>
<th>Course:</th>
<th>CstM 462 - Planning &amp; Scheduling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semester:</td>
<td>Fall</td>
</tr>
<tr>
<td>Instructor:</td>
<td>Gunderson</td>
</tr>
</tbody>
</table>

Student Work Assessed

In each of the last three assignments (Projects B, C and D), each student was required to create a construction schedule which included:

- Utilize of Create a Work Breakdown Structure
- Estimate activity durations
- Utilize logic to sequence the activities
- Create the CMP network and reports in Primavera P6
- Use Bluebeam to combine the CMP Bar Chart and Column Reports into a single PDF file

Rubric Used for Assessment

**Project B Rubric:**

- Professional Presentation – 20 points
- Readable Schedule Bar Chart – 20 pts
- Complete Column Reports – 20 points
- Legible, complete & easy to follow worksheets – 20 points
- Scheduling notes – 20 points

**Project C Rubric:**

- Gantt chart CPM with Base Line – 15 points
- (Evaluation will be based on the logic and the schedule as a communication tool)
- Updated Gantt chart CPM – 15 points
- Column Report for each CPM – 30 points (15 points each)
- One page Manpower Report – 10 points
- One page Cash Flow Chart/Graph – 10 points
- Scheduling and Estimating Notes – 20 points (10 points each)
- All documents should be printed as a PDF, combined, and submitted in Blackboard as a single PDF file. Make this submittal package professional and easy to read.
Project D Rubric

- Cover Sheet and Table of Contents (10 points)
- A bar chart similar to previous lab assignments identifying appropriate WBS, activity IDs, activity description and original duration columns only including Gantt Chart. (25 points)
- A column report including activity ID, activity description, original duration, total float, ES/EF, activity codes and predecessor/successor for each activity. (25 points)
- Activity duration notes and calculations (20 points)
- Submit a list of subcontracted work with fictitious names for each subcontractor. Assign an activity code for each subcontractor and for your company for the self-performed work. A minimum of four activity codes must be used. Include a crew makeup report for each of the following self-performed activities: All wood components, and structural steel (includes diaphragms). (20 points)
- Submit your final submittal through Blackboard in the appropriate drop box. Submit one PDF file; combine all pdf files into one file for submission.

In each of the last three assignments (Projects B, C and D), each student was required to create a construction schedule which included:
STUDENT LEARNING OUTCOME # 11

Apply basic surveying techniques for construction layout and control

Performance Criteria

41.2% of students earn at least 70%

Where Assessed

<table>
<thead>
<tr>
<th>Course:</th>
<th>CE 302 - Introduction to Surveying</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semester:</td>
<td>Fall</td>
</tr>
<tr>
<td>Instructor:</td>
<td>Olsen</td>
</tr>
</tbody>
</table>

Student Work Assessed

Explain the specific measurement tool. Could be exam questions, assignments, or other student work.

Lab Exam – Instructions

| Lab Work: | The 60 minute lab exam will be performed individually in the field. Students will have 35 minutes of time on the total station and 25 minutes extra for calculations. |
| Submission: | The student will fill out the grade sheet (attached) and submit the page at the end of the 60 minute period. |

Exercise #1 - Determine location of a prism in the center of the field

For this exercise the student will setup the total station (see appendix A for control point locations) and determine the location and azimuth (relative to the total station) of a prism in the middle of the field. The location must include the (1) northing, (2) easting, and (3) elevation of the point. The azimuth measurement will be for line AB between the total station (point A) and the prism in the field (point B) as shown below. The TA will provide the instrument height for CP9 CP10 and the prism, all other measurements and setup are the responsibility of the student.
Exercise #2 - Determine the dimension of a given building geometry

For exercise 2 you will need to determine the dimension between specific points on the Communication Addition building. The points A-H are marked on the image below, each student will be assigned 2 sets of 2 points and use the total station to determine all measurements necessary to calculate the distance between each set of points. The student will then perform the necessary calculations to find the final distance between the two points and record their answer on the grading sheet.
Exercise #3 - Determine the elevation of an unknown point using the auto level
For this exercise the student will use the auto level to locate the elevation of an unknown point in the field. For this exercise 2 graduated rods will be set up, one at the known location and one at the unknown location. The elevation of the known point will be provided by the TA. The student must make all necessary measurements with the auto level necessary to determine the elevation of the unknown point. To receive full credit all measurements must be labeled on the grade sheet and all calculations must be shown. The final elevation will be recorded at the bottom of the grade sheet.
Calculations for Elevation of Unknown Point:

Appendix A: Law of Cosines

\[
\cos A = \frac{b^2 + c^2 - a^2}{2bc} \quad \text{or} \quad a^2 = b^2 + c^2 - 2bc \cos A
\]

\[
\cos B = \frac{c^2 + a^2 - b^2}{2ca} \quad \text{or} \quad b^2 = c^2 + a^2 - 2ca \cos B
\]

\[
\cos C = \frac{a^2 + b^2 - c^2}{2ab} \quad \text{or} \quad c^2 = a^2 + b^2 - 2ab \cos C
\]

Rubric Used for Assessment

Each of the three components of the lab exam are assessed based on the error from the actual coordinate, distance, or elevation. A linear scale is applied to give points with the further away receiving larger deductions.
Understand construction project control processes

Performance Criteria
At least 80% of students earn a C (70%) or better

Where Assessed
Course: CstM 252 - Construction Administration & Documentation
Semester: Spring
Instructor: Gunderson

Student Work Assessed
Assignment #5, Project Controls. Students are required to role play as the General Contractor’s Project Engineer for the Riverstone Two Office Building project and submit a project controls plan for the project. Students are instructed to include:

- A project controls plan narrative describing the controls systems for cost (labor, material, equipment, subcontractor), schedule, submittals, documents (all types), quality control, safety, etc. Graphics and examples should be used to enhance professional presentation.
- A copy of the RFI log with at least five RFI’s listed and the actual copies of those five RFI’s included.
- Submittal Log with the required submittals listed for Divisions 1, 3, 8, and 9. No actual submittals are required for this assignment.
- Transmittal Log listing the submittals that were transmitted to the Owner and/or Architect during the first MONTH on the project.
- Change Order Log with a narrative describing how changes will be incorporated into the project. One change order should be listed on the log: adding the trash enclosure.

Rubric Used for Assessment
Assignment #5 Rubric:

- Professional Presentation .................................. 10 points
- Formal Letter Content & Presentation ................. 10 points
- Project Controls Narrative ................................ 15 points
- RFI Log & RFI’s (content & presentation) .......... 10 points
- Submittals Log (content & presentation) .......... 10 points
- Transmittal Log ............................................. 5 points
- Change Order Log ....................................... 5 points
- Change Order Narrative .................................. 5 points
Assignment 3 was a fictitious case study about a company, Semicon, wants two projects constructed, a manufacturing facility and an office building. After reading the case study information, the students were required to consider themselves program managers for Semicon and make project delivery, procurement and contract recommendations to Semicon.

Assignment 4 was a list of project conditions which would impact a construction company’s decision as to whether or not to submit a proposal to provide design-build services. Each student had to write a paragraph about the top three “No-go” and the top three “Go” issues listed. All of the issues were to be prioritized.

Rubric Used for Assessment

Each question in Exam 1, Exam 2 and the Final Exam had one best answer.

Assignment 3 Rubric:
Letter to Semicon transmitting backup: out of 5 points
Brief Description of the problem/situation: out of 5 points
Project Delivery Matrix (2): out of 10 points
Team Selection Matrix: out of 10 points
Recommendation for Semicon: out of 10 points
Question 2: out of 5 points
Question 3: out of 5 points
Professional Presentation: out of 10 points
Total Points Possible: 60 points

Assignment 4 Rubric:
Professional Presentation: 5 points
Red Flag Lists: 5 points
Content of the Paragraphs: 10 points
Total Points Possible: 20 points
STUDENT LEARNING OUTCOME # 13

Understand construction risk management

Performance Criteria
At least 80% of students earn a C (70%) or better

Where Assessed
Course: CstM 460 - Construction Cost Management
Semester: Fall
Instructor: Cherf

Student Work Assessed
In-class slides where 30 specific risk identification, evaluation, assessment and management questions are asked to:
- Understand the unique risk characteristics in construction
- Understand the importance of managing resources
- Defining and assigning work scope
- By looking at the Owner-Designer-Constructor relationship identifying risk to each player

The Key Takeaway assignment is the second in-class assessment identifying the unique risk in the design and construction industry.

Rubric Used for Assessment

1. Identify understanding of risk assessment tool- 5 points
2. When is risk analyzed? 5 points
3. Identify potential risks for deep water bridges- 20 points
   i. Russky Bridge Russia
   ii. Bay Bridge Eastern Span
   iii. Tacoma Narrows
   iv. Hong Kong-Zhuhai-Macao Bridge
   v. State Route 520 Floating Bridge
4. Identify two risks associated with glass elevators on exterior renovation of building 10 points
5. Supertall Buildings Technical Risk Issues 30 points
   i. Pumping and placing at extreme heights
   ii. Crane and lifting items
   iii. Significant variation in wind speeds
   iv. Maintaining verticality as height increases
   v. Elastic shortening of building elements
   vi. Maintenance and repair of external elements
   vii. Building services provisions
   viii. Turnover Characteristics
6. Songjiang Hotel Risk Identification 15 points
   i. Risk # 1
   ii. Risk # 2
   iii. Risk # 3
7. Big Blue Crane Incident 15 points
   i. Root cause # 1
   ii. Root cause # 2
   iii. Root Cause # 3
8. What is the difference between risk management and assessment? 5 points
9. The key tool for management and assessment 5 points
10. Bertha Tunnel Boring Machine Analysis 15 points
    i. Item 1
    ii. Item 2
    iii. Item 3
11. Analysis of 12 story building failure in China 15 points

Total 140 points
STUDENT LEARNING OUTCOME # 14

Understand construction accounting and cost control

Performance Criteria
At least 80 % of students earn a C (70 %) or better

Where Assessed
Course: CstM 460 - Construction Cost Management
Semester: Fall
Instructor: Cherf

Student Work Assessed
Exams were assessed by “correct” or “incorrect” answers using a mix of multiple choice, true/false and fill in the blank questions. The exam covers the overview of various tools and methods for managing budgets, project estimates, and costs; identifying roles and responsibilities for controlling and monitoring project cost; developing methods for creating valid project budgets; and exploring cost management, development, and monitoring systems for use throughout all phases of construction. Exam content includes:

1. Six true and false questions covering project controls regarding cost and schedule, transparency in reimbursable contracts, the definition of cost type and overhead allocations, non-committed costs and establishing a baseline for cost codes.
2. Three multiple choice questions regarding the purpose of cost accounting systems, the importance of quantity adjusted budgets, defining committed costs and the essentials of successful cost engineering and total cost management.
3. Twenty fill in the blank questions covering:
   a. The backbone of field cost control
   b. Resource categories for control budgets
   c. Contract types
   d. Revenue and cost of sales
   e. Field system for tracking requirements
   f. Detailed estimate to budget controls
   g. Budget baseline cost reporting
   h. Account payable and receivable definitions
   i. Cost of Sales definition
   j. Productivity forecasting
   k. Difference between cost accounting and cost control
   l. Five elements of the cost control system
   m. Feeding the cost report
   n. Procedures for physical percent complete
   o. Baseline definitions for cost control
   p. Managing risk in cost control
   q. Transparency in different contract types
   r. Supply chain performance
   s. Predictive versus procurement processes
   t. Standard of care in designer’s definition

Rubric Used for Assessment
Each question has a distinct answer. There are 100 points possible in this first midterm examination.
STUDENT LEARNING OUTCOME # 15

Understand construction quality assurance and control

Performance Criteria

At least 80% of students earn a C (70%) or better

Where Assessed

<table>
<thead>
<tr>
<th>Course:</th>
<th>CstM 252 - Construction Administration &amp; Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semester:</td>
<td>Spring</td>
</tr>
<tr>
<td>Instructor:</td>
<td>Gunderson</td>
</tr>
</tbody>
</table>

Student Work Assessed

There was only one question on Exam 2 about QA/QC. That question was a True-False question meant to reinforce learning. 98% of the students selected the correct “True” response. This assessment is insufficient. Additional assessment tools will be developed to check for deep understanding of the QA/QC process required for construction projects. Assignment 2 tied the beginning of QA/QC to the submittal process.

Assignment #2, Submittal Package, Letter of Transmittal, and RFI. Using the plans and specifications for the Riverstone Two Office Building, create a submittal package for Spec. Section 10165, Plastic Laminate Toilet Compartments. Students are also required to create a Letter of Transmittal and a Request for Information.

Assignment #5, Project Controls. Students are required to role play as the General Contractor’s Project Engineer for the Riverstone Two Office Building project and submit a project controls plan for the project. Students are instructed to include:

- A project controls plan narrative describing the controls systems for cost (labor, material, equipment, subcontractor), schedule, submittals, documents (all types), quality control, safety, etc. Graphics and examples should be used to enhance professional presentation.
- A copy of the RFI log with at least five RFI’s listed and the actual copies of those five RFI’s included.
- Submittal Log with the required submittals listed for Divisions 1, 3, 8, and 9. No actual submittals are required for this assignment.
- Transmittal Log listing the submittals that were transmitted to the Owner and/or Architect during the first MONTH on the project.
- Change Order Log with a narrative describing how changes will be incorporated into the project. One change order should be listed on the log: adding the trash enclosure.
Rubric Used for Assessment

Assignment #2 Rubric:
- Professional presentation (10 points)
  - Creative Company Name
  - Creative Company Logo
- Letter of Transmittal content (5 points)
- RFI content and clarity (5 points)
- Submittal cover sheet content (5 points)
- Submittal (35 points)
  - Completeness of submittal package
    - Shop Drawings (specific for this project). Use of Bluebeam is required.
    - Product Data
    - Samples (simply submit a color chart of Architects initial selection)
    - Manufacturer’s Installation Instructions
- Quality and clarity of submittal
- The submittal answers questions before they are asked

Assignment #5 Rubric:
- Professional Presentation .......................... 10 points
- Formal Letter Content & Presentation .............. 10 points
- Project Controls Narrative .......................... 15 points
- RFI Log & RFI’s (content & presentation) ........ 10 points
- Submittals Log (content & presentation) .......... 10 points
- Transmittal Log ..................................... 5 points
- Change Order Log ................................... 5 points
- Change Order Narrative ............................. 5 points
STUDENT LEARNING OUTCOME # 16

Understand construction project control processes

Performance Criteria
At least 80 % of students earn a C (70 %) or better

Where Assessed
Course: CstM 252 - Construction Administration & Documentation
Semester: Spring
Instructor: Gunderson

Student Work Assessed
Assignment #5, Project Controls. Students are required to role play as the General Contractor’s Project Engineer for the Riverstone Two Office Building project and submit a project controls plan for the project. Students are instructed to include:

- A project controls plan narrative describing the controls systems for cost (labor, material, equipment, subcontractor), schedule, submittals, documents (all types), quality control, safety, etc. Graphics and examples should be used to enhance professional presentation.
- A copy of the RFI log with at least five RFI’s listed and the actual copies of those five RFI’s included.
- Submittal Log with the required submittals listed for Divisions 1, 3, 8, and 9. No actual submittals are required for this assignment.
- Transmittal Log listing the submittals that were transmitted to the Owner and/or Architect during the first MONTH on the project.
- Change Order Log with a narrative describing how changes will be incorporated into the project. One change order should be listed on the log: adding the trash enclosure.

Rubric Used for Assessment
Assignment #5 Rubric:

- Professional Presentation .............................. 10 points
- Formal Letter Content & Presentation .............. 10 points
- Project Controls Narrative ............................. 15 points
- RFI Log & RFI’s (content & presentation) ........ 10 points
- Submittals Log (content & presentation) .......... 10 points
- Transmittal Log ........................................... 5 points
- Change Order Log ...................................... 5 points
- Change Order Narrative ................................. 5 points
STUDENT LEARNING OUTCOME # 16

Understand construction project control processes

Performance Criteria
At least 80 % of students earn a C (70 %) or better

Where Assessed
Course: CstM 460 - Construction Cost Management
Semester: Fall
Instructor: Cherf

Student Work Assessed
Establish and define a framework for project controls in the construction management of complex projects. The student should be able to understand and address the topics including project reporting, scope management, resource planning, cost engineering, change management, risk assessment and forecasting methods. The first key takeaway addresses the project control aspect regarding cost and schedule for construction projects. The key takeaway is an interactive in-class exam where students respond to slides and questions relating to the specific topic. The following are the twenty-five questions regarding the cost and schedule side of project controls.

1. Difference between committed and invoice costs
2. Key forecasting requirements for tracking costs
3. The elements of a cost control system
4. The importance of a quaintly adjusted budget
5. The steps for setting up a cost control system.
6. Identifying cost type
7. General conditions, direct costs and overhead
8. Job chargeable definitions
9. Predictive processes versus procurement processes
10. Difference between cost codes and schedule activities
11. Defining baselines
12. CBS vs OBS vs WBS
13. Changes to cost plus contracts
14. Contracting parties cost and time requirements
15. Motivation between the designers, contractors and owner
16. What is work in place (WIP)
17. How do we track WIP?
18. Physical percent complete
19. How do we separate construction costs?
20. Managing and the distribution of cost types
21. Defining project controls
22. The estimating and job cost process
23. Developing a project controls system
24. Project Control Spider chart
   ▪ Schedule
   ▪ Earned Value
   ▪ Productivity
   ▪ Cash flow
   ▪ Forecasting
   ▪ Cost
   ▪ Payment
   ▪ Change management
   ▪ Contracts

25. Industry sector differences

Rubric Used for Assessment
   Each question has a distinct answer.
STUDENT LEARNING OUTCOME # 17

Understand the legal implications of contract, common, and regulatory law to manage a construction project

Performance Criteria
At least 80% of students earn a C (70%) or better

Where Assessed
Course: CstM 362 - Construction Law
Semester: Fall 18
Instructor: Austin

Student Work Assessed
Student work is assessed in two ways: three non-cumulative exams and two writing assignments.

Each exam is a combination of short essay, fill in the blank and true and false questions.

This is a WSU Writing in the Major course. Each writing assignment has two parts. The first part requires short answers to be written based on a thorough reading of the material, which is a construction law legal case. The second part of the assignment requires a response developed from an alternative scenario.

Rubric Used for Assessment
Each exam is graded with an instructor created key.

Each writing assignment is evaluated according to the rubric below:
### RUBRIC FROM LEGAL ISSUES IN CONSTRUCTION WRITING IN THE MAJOR ASSIGNMENTS

<table>
<thead>
<tr>
<th>Exceeds Assignment Expectations</th>
<th>Meets Assignment Expectations</th>
<th>Approaching Expectations</th>
<th>Below Expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Completeness</strong></td>
<td>Paper fully meets the parameters of the assignment but does not exceed them.</td>
<td>Paper does not address some aspects of the assignment.</td>
<td>Paper does not address the assignment.</td>
</tr>
<tr>
<td>Paper goes beyond the assignment to explore the implications of arguments or evidence in new contexts or in particularly thoughtful, insightful, and/or original ways.</td>
<td>(and/or...) Paper demonstrates a good grasp of legal principles but some awkwardness applying them.</td>
<td>(and/or...) Paper demonstrates a somewhat shaky grasp of legal principles.</td>
<td>(and/or...) Paper is inconsistent with legal principles.</td>
</tr>
<tr>
<td>Paper shows a nuanced grasp of legal principles and the ability to apply these principles with facility.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **Legal Correctness**                                                                           | Evidence used to support the central points is well chosen, though not particularly rich or detailed. | Connection between argument and evidence is not clearly articulated in all cases.        | Evidence used does not clearly support the main argument.                            |
| Evidence used to support the central points is rich, detailed and well chosen.                  | The connection between argument and evidence is clearly and compellingly articulated in all cases. | (and/or...) (Where applicable) Consideration of opposing evidence is cursory or the evidence is not convincingly refuted. | (and/or...) (Where applicable) Important opposing evidence is ignored, thereby weakening the central argument. |
| Evidence sections employ appropriate examples                                                  | (Where applicable) Some opposing evidence is considered and refuted.                          |                                                                                          |                                                                                  |
| The connection between argument and evidence is clearly and compellingly articulated in all cases. |                                                                                               |                                                                                          |                                                                                  |
| (Where applicable) Important opposing evidence (i.e. evidence that might seem to contradict your argument) is considered and convincingly refuted. |                                                                                               |                                                                                          |                                                                                  |
| Writing Quality | Organization of paper as a whole is logical and quickly apparent. Transitions between paragraphs are smooth. Throughout the paper, wording is precise and unambiguous. Sentence structure is consistently clear and lucid. There are no incomplete or run-on sentences. Every paragraph makes one distinct and coherent point, expressed in a clear topic sentence; the parts of each paragraph connect logically and persuasively, and internal transitions are smooth. | Organization of paper as a whole is logical and apparent, but transitions between paragraphs are not consistently smooth. Every paragraph makes one distinct and coherent point and, for the most part, the parts of each paragraph connect logically and effectively. Paper is for the most part precisely worded and unambiguous. Sentence structure is mostly clear. In all but a few cases, the paragraph’s point is expressed in a clear topic sentence. | Wording is imprecise or ambiguous fairly often. (and/or…) Sentence structure is often confusing. (and/or…) Organization of the paper as a whole can only be discerned with effort. (and/or…) Not all parts of the paper fit the organizational structure. (and/or…) Not all the parts of the paper are effectively integrated. In a number of paragraphs, there is not a distinct or coherent point. (and/or) Topic sentences are missing or unclear in a number of paragraphs. (and/or) In a number of paragraphs, the parts do not connect logically. (and/or) | Organization of the paper as a whole is not logical or discernable. Throughout the paper, wording is imprecise or ambiguous. (and/or…) Sentence structure is consistently confusing. |
| Format | Paper is clean and appropriately formatted per the assignment requirements. Quotes are all properly attributed and cited. There are virtually no spelling or grammatical errors. | Paper is clean and appropriately formatted per the assignment requirements. There are a few minor spelling or grammatical errors. Quotes are all properly attributed and cited. | Paper does not conform to all of the assignment format requirements. There are a number of spelling and grammatical errors. (and/or) In a few places, quotes are not attributed and cited. | Paper does not conform to the assignment format requirements. |
STUDENT LEARNING OUTCOME # 18

Understand the basic principles of sustainable construction

Performance Criteria
At least 70% of students earn a C (70%) or better

Where Assessed
Course: CstM 332 - Building Science I
Semester: Fall
Instructor: Day

Student Work Assessed
A select portion of questions on the Midterm and Final Exam - including, but not limited to the following concepts:

- CLO1: Develop a fundamental knowledge of thermodynamics as applied to building envelopes and the building materials / assemblies.
- CLO4: Recall different types of passive heating and cooling strategies and applications.
- CLO5: Understand different types of heating and cooling system types and applications.

EXAMS
Exams were assessed by “correct” or “incorrect” answers using a mix of multiple choice, true/false and fill in the blank questions.

- M – Midterm and Questions Copied Below. Note: the blackboard exam was arranged by topic question pools from the list below, and students’ questions were selected randomly from each topic pool:
  - A package terminal air conditioner (PTAC) would be found in these applications:
  - A single, large capacity boiler will only operate at full capacity 50% of the time.
  - Air conditioners typically worsen indoor air quality because they take polluted air from the outdoors and put it into your home.
  - Air-cooled Condensers are used in areas where water is plentiful.
  - All of the following are ways that a house gain heat, EXCEPT for ... :
  - An advantage of dedicated/directed outside air systems (DOAS) is that the amount of air is tailored to individual space requirements.
  - An increase in occupancy can directly result in an increase in:
  - As our homes become more energy efficient and more tightly sealed, we must rely more and more on ventilation for healthy air quality.
  - ASHRAE (Standard 55-2010) defines thermal comfort as:
  - Building Related Illness (BRI) and Sick Building Syndrome (SBS) are terms to describe diseases or illnesses contracted from buildings, both of which originate from unknown sources within a building.
  - Can surface textures and colors affect Mean Radiant Temperature?
Chilled beams take up more space than most other HVAC systems.

CO2 can be considered a pollutant by itself. What are some things that we can use to regulate the amount in a space?

Cool Water Systems are a cheap and effective way to cool residential homes and small offices.

Danger level 1 contaminants, called toxic compounds, do NOT include:

Evaporative Cooling units use an average of one fourth of the energy that a typical AC unit uses.

Fire tube boilers are mainly used in residential and industrial applications.

For cross- and stack ventilation methods of natural ventilation to work, there does not need to be a significant difference between indoor and outdoor temperatures.

In a Cool Thermal Energy Storage System (TES) thermal energy is created in off peak energy periods to utilize cheaper cost of electricity.

In a wall assembly, which material would heat travel through the slowest?

In an electric system, the Recovery Rate refers to:

In climates where the temperature difference between the inside and outside is extreme, a higher U-factor is desired.

In which of these scenarios would the house be sealed well and considered “tight.”

It is possible to add R-values of different materials to understand the total R value of an entire assembly?

Large buildings are made up of interior and perimeter spaces. Interior spaces experience heat gains year-round due to lights, appliances and people.

Natural ventilation is making a strong comeback in commercial buildings for which of the following reasons?

One strategy used to prevent thermal bridging and heat loss/gain through the building envelope is to install continuous insulation around the whole building without breaks.

Operative temperature is a simplified measure of human thermal comfort, which is derived from air temperature, mean radiant temperature and air speed.

Operative temperature is best described as:

Problems with poor indoor air quality in buildings seem to be increasing because:

R-Values of materials cannot be added together to determine the total R value for a wall assembly.

Radiant floor systems that use antifreeze are typically used for _______.

Sick building syndrome (SBS) is best described as:

Similar to natural ventilation, mechanical ventilation uses fans to move air, typically through ductwork.

The building envelope can directly affect the lighting, heating, and cooling needs of the building.

The crack estimation method of infiltration calculations uses the length of known cracks in the building envelope to estimate the amount of air infiltration in a building.

The energy efficiency of refrigeration processes is measured as the coefficient of _______.

The EPA says that indoor air pollutants can be how much higher than outdoor air?

The primary reason for using ground source heat pumps is energy savings.

The sun strikes the outside of a 10 thick, exterior stone wall. Several hours later, a spike in temperature is recorded on the interior of the wall surface. This lag time in temperature within the material is a result of its:
There are known and avoidable contributors to moisture, mold, and microbial growth problems in all areas of professional and personal responsibilities. Which of the following classifies as such?

- Thermal bridging can be prevented by which of the following methods:
  - Thermal bridging through steel studs can cause considerable heat loss, even if batt insulation is placed in between the studs.
- To calculate the heat loss through an opaque wall at any given time generally requires which of the following information sets:
  - To perform a heat loss calculation (using the most common method), it is necessary to (1) determine the relevant areas, (2) calculate U-factors, and (3) calculate the exfiltration heat loss.
  - Trombe walls are usually used for just commercial structures.
- U factor is represented by: Btu / hr x ft² x ______
- U-factor (the overall coefficient of thermal transmission) is calculated by which of the following: equations:
  - U-Factor is the amount of heat in British thermal units (Btu) that flows each hour through 1 sq.ft of surface area when there is a 1°F temperature difference between the inside and outside air.
- Under what surface does radiant flooring work best?
- Unlike refrigeration, systems that utilize conduction, convection and radiation move heat from ...
- Up flow, or vertically configured furnace installations, are among the most common in North American homes.
- Ventilation can be accomplished either naturally or mechanically.
- Ventilation is best described as:
  - VRF is used extensively in the far east and is gaining popularity in the US due to its ______.
  - Wet Bulb temperature is measured by taking the temperature of the air in the room with a regular thermometer, just like dry bulb temperature.
- What are the 7 variables that are depicted on a Psychrometric chart?
- What are the advantages of electric boilers?
- What are the main components of a chiller?
- What axis of the Psychrometric chart is Dry Bulb Temperature displayed on?
- What best describes off-gassing?
- What direction of line represents the Wet Bulb Temperature (WBT) on the Psychrometric chart?
- What does wet bulb temperature include?
- What is one ton of air conditioning equivalent to?
- What is Relative Humidity?
- What is the difference between the outdoor design temperature and the indoor design temperature?
- What temperature range is ideal for mold growth?
- When accounting for thermal mass impact we also need to look at the heat capacity of building materials.
- Where do you generally see Air-cooled Condensers (PTAC)?
- Which environmental variable affects thermal comfort?
- Which is a type of heat pump?
Which is the best description of ventilation?
Which of the below are benefits of an up-flow furnace?
Which of the following ASHRAE standards addresses ventilation and IAQ?
Which of the following best describes the sources of pollutants normally found in buildings?
Which of the following contaminants can be removed by filtration equipment?
Which of the following is NOT a Human Adaptation Strategy in response to thermal stimuli?
Which of the following materials is the least conductive?
Which of the following, non-environmental, thermal comfort parameters can be most easily adjusted?
Why are studs so much less thermally resistant than other wall section areas?
With an electric boiler, electrical energy is converted directly to heat energy with nearly...
Within building materials, heat energy transfers from cold surfaces to hot surfaces.

FE – Final Exam and Questions Copied Below. The Final exam included the same questions from the midterm above (randomly selected from topical question pools), in addition to the following questions and heat load calculations (see images below):
What percent of the earth's water is made up of freshwater?
What percent of earth's water is actually usable (as-is)?
Why is design of water distribution systems critical?
STUDENT LEARNING OUTCOME # 18

Understand the basic principles of sustainable construction

Performance Criteria
At least 70% of students earn a C (70%) or better

Where Assessed
Course: CstM 333 - Building Science II
Semester: Spring
Instructor: Day

Student Work Assessed
A select portion of questions on the Midterm and Final Exam - including, but not limited to the following concepts:

- CLO2: Understand the basic principles of natural and electrical lighting design
- CLO3: Understand strategies for using and controlling natural light
- CLO4: Understand building energy use factors, energy code best practices, energy monitoring and management systems, and energy efficient strategies for HVAC & lighting systems

EXAMS
Exams and quizzes were assessed by “correct” or “incorrect” answers using a mix of multiple choice, true/false and fill in the blank questions.

- M – Selected Midterm Questions Copied Below
  - It is estimated that electric lighting consumes ____________ of the total electric power generated in the United States:
  - Lighting power density is expressed using which of the following units:
  - Based on ASHRAE standard 90.1, and recent energy code changes, values for LPD are:

- FE – Selected Final Exam and Questions Copied Below.
  - “Energy” is the technical term for this common expression:
  - Power factor represents:
  - Efficacy of a light source is best defined as:
  - The basic principle of operation of an incandescent lamp is best described as:
  - Lighting power density is expressed in terms of:
  - Based on ASHRAE standard 90.1, and recent energy code changes, values for LPD are:
  - What are the most desired orientations for daylight (for visual comfort and energy efficiency)?
  - A closed loop daylight sensor (or photocell) only accounts for illumination from daylight.
  - Which of these controls is required by (most) codes to allow for occupant overrides of lighting conditions?
  - An open loop daylight sensor (or photocell) only accounts for illumination from daylight.
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- Which of these controls would dim the lights automatically in a conference room with windows?
- Which of these controls would probably not be used in a private office (for energy efficiency)?
- Which of these controls would be best to use first in a copy room (for energy efficiency)?
- Which of these controls would be best to use first in an open office area (for energy efficiency)?
- Lighting can be directly related to health, productivity and visual comfort
- What is a good way to estimate the depth of the daylight zone?
STUDENT LEARNING OUTCOME # 19

Understand the basic principles of structural behavior

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<td>X % of students earn at least Y %</td>
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<td><strong>Course:</strong> Arch 352 - Structures II</td>
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<tr>
<td><strong>Semester:</strong> Spring</td>
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<td><strong>Instructor:</strong> Adjunct</td>
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</table>

**Student Work Assessed**

*Explain the specific measurement tool. Could be exam questions, assignments, or other student work.*

**Rubric Used for Assessment**

*Provide the rubric you use to grade or evaluate the student work.*
### STUDENT LEARNING OUTCOME # 19

Understand the basic principles of structural behavior

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<td><strong>Instructor:</strong> Adjunct</td>
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**Student Work Assessed**

*Explain the specific measurement tool. Could be exam questions, assignments, or other student work.*

**Rubric Used for Assessment**

*Provide the rubric you use to grade or evaluate the student work.*
STUDENT LEARNING OUTCOME # 20

Understand the basic principles of mechanical, electrical, and piping systems

Performance Criteria
At least 70 % of students earn a C (70 %) or better

Where Assessed

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Student Work Assessed
A select portion of questions on the Midterm and Final Exam - including, but not limited to the following concepts:

- CLO2: Understand the fundamentals of human thermal comfort and indoor air quality.
- CLO3: Understand the fundamentals of indoor air quality and ventilation as related to both HVAC and human health outcomes.
- CLO5: Understand different types of heating and cooling system types and applications.
- CLO6: Identify ASHRAE climate zones and differences in HVAC requirements, respectively.
- CLO7: Understand the fundamentals of plumbing systems, building water supply, systems, sanitary and waste water systems, and waste water treatment and storm water management.
- CLO8: Understand the differences between different types of fire protection systems, fire sprinklers, fire alarms, and applications.
- CLO9: Understand the fundamentals of vertical circulation in buildings -- e.g. escalators and elevators.

Exam Questions Used for Assessment
See below.

EXAMS - exams were assessed by “correct” or “incorrect” answers using a mix of multiple choice, true/false and fill in the blank questions. The final exam also had heat calculations.

- **M – Midterm and Questions Copied Below.** Note: the blackboard exam was arranged by topic question pools from the list below, and students’ questions were selected randomly from each topic pool:
  - ____________ heat is the energy required to change the phase of a substance, in this case of moist air, water vapor.
  - ____________ heating and cooling occur by a change dry bulb temperature alone; that is, moisture is not added or removed.
  - A _______ is an area for which temperature is controlled by a single thermostat.
  - A chilled beam is a flush mounted ceiling device containing _______.
  - A CLO is a unit that measures the insulating value of clothing. A single CLO is equivalent to which of the following:
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- a MET is a unit of measure that is related to:
  - A package terminal air conditioner (PTAC) would be found in these applications:
  - A single, large capacity boiler will only operate at full capacity 50% of the time.
  - A water tube boiler is heated through hot gasses passing through the tubes which are surrounded by water.
  - Air conditioners typically worsen indoor air quality because they take polluted air from the outdoors and put it into your home.
  - Air-cooled Condensers are used in areas where water is plentiful.
  - All HVAC systems require some form of controls, either manual or automatic.
  - All objects absorb and emit thermal radiation.
  - All of the following are ways that a house gain heat, EXCEPT for … :
  - An activity level of 1 met is roughly equivalent to:
  - An advantage of dedicated/directed outside air systems (DOAS) is that the amount of air is tailored to individual space requirements.
  - An increase in occupancy can directly result in an increase in:
  - As our homes become more energy efficient and more tightly sealed, we must rely more and more on ventilation for healthy air quality.
  - ASHRAE (Standard 55-2010) defines thermal comfort as:
  - ASHRAE does not provide specific requirements for infectious disease control in schools, prisons, shelters, transportation, and other public facilities other than general ventilation and air quality requirements.
  - At 100% relative humidity:
  - At saturation, the dew point temperature is equivalent to the wet bulb temperature.
  - Building Related Illness (BRI) and Sick Building Syndrome (SBS) are terms to describe diseases or illnesses contracted from buildings, both of which originate from unknown sources within a building.
  - Can surface textures and colors affect Mean Radiant Temperature?
  - Cast Iron Sectional Boilers are rarely installed because their very high initial costs.
  - Chilled beams take up more space than most other HVAC systems.
  - CO2 can be considered a pollutant by itself. What are some things that we can use to regulate the amount in a space?
  - Conduction is best described as:
  - Conduction, convection, and radiation are examples of which type of heat transfer?
  - Cool Water Systems are a cheap and effective way to cool residential homes and small offices.
  - Danger level 1 contaminants, called toxic compounds, do NOT include:
  - Enthalpy is the total amount of heat energy of the moist air and therefore includes the amount of heat of the dry air and the water vapor in the air. Which is measured in BTU per pound of dry air.
  - Evaporative Cooling units use an average of one fourth of the energy that a typical AC unit uses.
  - Fire tube boilers are mainly used in residential and industrial applications.
  - For cross- and stack ventilation methods of natural ventilation to work, there does not need to be a significant difference between indoor and outdoor temperatures.
  - Heat for HVAC systems is commonly produced by …
  - Heat is the same thing as temperature.
Heat moves from hot to cold during heat transfer.

Heated molecules and heated space are less dense compared to cooler molecules and cooler spaces, which means heat will rise above the cooler spaces.

Heating and cooling loads vary with time; so, the amount of heating or cooling supplied must _____.

Humans spend close to XX% of their time indoors.

If refrigerant is used in the coil, the system is generally termed ...

In a Cool Thermal Energy Storage System (TES) thermal energy is created in off peak energy periods to utilize cheaper cost of electricity.

In a wall assembly, which material would heat travel through the slowest?

In an electric system, the Recovery Rate refers to:

In climates where the temperature difference between the inside and outside is extreme, a higher U-factor is desired.

In which of these scenarios would the house be sealed well and considered “tight.”

Is Building Related Illness (BRI) diagnosable?

Is thermal comfort a lack of discomfort?

It is possible to add R-values of different materials to understand the total R value of an entire assembly?

Large buildings are made up of interior and perimeter spaces. Interior spaces experience heat gains year-round due to lights, appliances and people.

Natural ventilation is making a strong comeback in commercial buildings for which of the following reasons?

One of the Simple Physical Measures of thermal comfort is:

One strategy used to prevent thermal bridging and heat loss/gain through the building envelope is to install continuous insulation around the whole building without breaks.

Operative temperature is a simplified measure of human thermal comfort, which is derived from air temperature, mean radiant temperature and air speed.

Operative temperature is best described as:

Problems with poor indoor air quality in buildings seem to be increasing because:

R-Values of materials cannot be added together to determine the total R value for a wall assembly.

Radiant floor systems that use antifreeze are typically used for ______.

Radiation is emitted through particles, rather than waves.

Refrigerant turns liquid into gas by:

Sick building syndrome (SBS) is best described as:

Similar to natural ventilation, mechanical ventilation uses fans to move air, typically through ductwork.

Specific Volume is the inverse of density, or in other words, specific volume is inversely proportional to density.

The ASHRAE definition of comfort is:

The building envelope can directly affect the lighting, heating, and cooling needs of the building.

The crack estimation method of infiltration calculations uses the length of known cracks in the building envelope to estimate the amount of air infiltration in a building.

The energy efficiency of refrigeration processes is measured as the coefficient of ______.

The EPA says that indoor air pollutants can be how much higher than outdoor air?
The following could be a source of latent heat:
- The primary reason for using ground source heat pumps is energy savings.
- The psychrometric chart shows the relationship between:
- The refrigeration process most often used in HVAC systems is called the vapor compression cycle.
- The study of psychometrics is important when dealing with buildings because people have a fairly small thermal comfort range when it comes to temperature and humidity.
- The sun strikes the outside of a 10 thick, exterior stone wall. Several hours later, a spike in temperature is recorded on the interior of the wall surface. This lag time in temperature within the material is a result of its:
- The terms heat and temperature mean the same thing.
- The Vapor-Compression Refrigeration Cycle system is not used in which of the following?
- There are known and avoidable contributors to moisture, mold, and microbial growth problems in all areas of professional and personal responsibilities. Which of the following classifies as such?
- Thermal bridging can be prevented by which of the following methods:
- Thermal bridging through steel studs can cause considerable heat loss, even if batt insulation is placed in between the studs.
- Thermal comfort is assessed by a numbered scale subjective evaluation. How many scales are used?
- Thermal comfort is assessed by subjective evaluation through what standard?
- These two measurements are necessary in order to derive relative humidity:
- To calculate the heat loss through an opaque wall at any given time generally requires which of the following information sets:
- To perform a heat loss calculation (using the most common method), it is necessary to (1) determine the relevant areas, (2) calculate U-factors, and (3) calculate the exfiltration heat loss.
- Trombe walls are usually used for just commercial structures.
- U factor is represented by: Btu / hr x ft² x ______
- U-factor (the overall coefficient of thermal transmission) is calculated by which of the following equations:
- U-Factor is the amount of heat in British thermal units (Btu) that flows each hour through 1 sq.ft of surface area when there is a 1°F temperature difference between the inside and outside air.
- Under what surface does radiant flooring work best?
- Unlike refrigeration, systems that utilize conduction, convection and radiation move heat from ...
- Up flow, or vertically configured furnace installations, are among the most common in North American homes.
- Ventilation can be accomplished either naturally or mechanically.
- Ventilation is best described as:
- VRF is used extensively in the far east and is gaining popularity in the US due to its ______.
- Wet Bulb temperature is measured by taking the temperature of the air in the room with a regular thermometer, just like dry bulb temperature.
- What are the 7 variables that are depicted on a Psychrometric chart?
- What are the advantages of electric boilers?
What are the main components of a chiller?
What axis of the Psychrometric chart is Dry Bulb Temperature displayed on?
What best describes off-gassing?
What direction of line represents the Wet Bulb Temperature (WBT) on the Psychrometric chart?
What does wet bulb temperature include?
What is one ton of air conditioning equivalent to?
What is Relative Humidity?
What is the difference between the outdoor design temperature and the indoor design temperature?
What is the First Law of Thermodynamics?
What is the number 1 thermal sensory organ for the indoor environment?
What is Thermal Comfort?
What temperature range is ideal for mold growth?
What is Latent Heat?
What is Sensible Heat?
When accounting for thermal mass impact we also need to look at the heat capacity of building materials.
When designing and installing HVAC, human safety is not really a concern.
When heat is transferred through convection, the heat is transferred through a current type of motion.
Where do you generally see Air-cooled Condensers (PTAC)?
Which environmental variable affects thermal comfort?
Which is a type of heat pump?
Which is the best description of ventilation?
Which of the below are benefits of an up-flow furnace?
Which of the following ASHRAE standards addresses ventilation and IAQ?
Which of the following best describes the sources of pollutants normally found in buildings?
Which of the following contaminants can be removed by filtration equipment?
Which of the following is NOT a Human Adaption Strategy in response to thermal stimuli?
Which of the following materials is the least conductive?
Which of the following, non-environmental, thermal comfort parameters can be most easily adjusted?
Which of these equations is used to calculate heating loads?
Why are studs so much less thermally resistant than other wall section areas?
Why does an HVAC system interface with fire alarm system to activate stair pressurization/exhaust fans?
With an electric boiler, electrical energy is converted directly to heat energy with nearly...
Within building materials, heat energy transfers from cold surfaces to hot surfaces.

FE – Final Exam: The Final exam included the same questions from the midterm above (randomly selected from topical question pools), in addition to the following questions and heat load calculations (see images below):
What percent of the earth's water is made up of freshwater?
What percent of earth's water is actually usable (as-is)?
What are distribution mains for?
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Construction Management
Detailed Direct Assessment Tools

- Why is design of water distribution systems critical?
- Which of the following drainage system materials offers fair noise absorptions and good corrosion resistance?
- A is the main vertical pipe that carries away clear water waste from equipment and non-sanitary fixtures.
- What is the primary purpose of a plumbing trap?
- What is the primary purpose of a plumbing vent line?
- The difference between moving stairways, ramps, and walks is basically defined by:
- Which of the following is NOT a type of elevator?
- What would be the best option (by code) for an elevator in a commercial building of 3 floors or less?
- According to the National Fire Protection Association, sprinklers always go off all at once.
- Fire "suppression" systems started in the 19th Century, textile mills started installing perforated piping systems, which could be manually flooded with water to help put out fires.
- A piece of steel with tungsten is used to hold back the water in modern day sprinkler heads.
- In wet and dry sprinkler systems, only the sprinklers that detect the desired amount of heat will go off during a fire.
- There is one type of system that will have all sprinklers go off at once in areas such as hazardous building or utility buildings. Which one?
- Where would you install a "dry" sprinkler system?
- What do the colors mean in the glass bulb beads?
- The three elements of the fire triangle of needs are:
- Match each of the four main types of sprinkler systems noted (column 1) with its typical application (column 2).
- An ionization type fire detector will be used to sense:

- Calculate the number of plumbing fixtures you would need if you are designing restrooms for an occupant load of 78 in a frat house. Counts are based on the 2015 International Building Code and Plumbing Code. Provide answers in numbers (i.e. "4"), not text (i.e. "four").
  - Drinking fountains? [E] Total
  - Bathtub / Showers? [F] Total
  - Service sinks? [G] Total

- Calculate the number of plumbing fixtures you would need if you are designing restrooms for an occupant load of 145 in an office building. Counts are based on the 2015 International Building Code and Plumbing Code. Provide answers in numbers (i.e. "4"), not text (i.e. "four").
  - Drinking fountains? [E] Total
  - Bathtub / Showers? [F] Total
  - Service sinks? [G] Total
• Calculate the number of plumbing fixtures you would need if you are designing restrooms for an **occupant load of 420 in a school**. Counts are based on the 2015 International Building Code and Plumbing Code. Provide answers in numbers (i.e. "4"), not text (i.e. "four").
  o How many water closets do you need (in total)? [A] Male [B] Female
  o How many lavatories do you need? [C] Male [D] Female
  o Drinking fountains? [E] Total
  o Bathtub / Showers? [F] Total
  o Service sinks? [G] Total

• Calculate the number of plumbing fixtures you would need if you are designing restrooms for an **occupant load of 122 in an ice skating rink**. Counts are based on the 2015 International Building Code and Plumbing Code. Provide answers in numbers (i.e. "4"), not text (i.e. "four").
  o How many water closets do you need (in total)? [A] Male [B] Female
  o How many lavatories do you need? [C] Male [D] Female
  o Drinking fountains? [E] Total
  o Bathtub / Showers? [F] Total
  o Service sinks? [G] Total

• What is the total occupant load of the building below? [A] The means of egress from the central hall needs to accommodate what occupant load? [B]
Final Exam Heat Load Calculations

PROBLEM 1:
Use the heating load calculation analysis worksheet to solve the following problem.

A home in Spokane, WA has a 12 ft by 14 ft family room as shown in the diagram below. The temperature in the space is to be maintained at 72 °F. The room is exposed to the outside on two adjacent sides with three windows and a swing door on the south exterior wall, and a window on the east exterior wall. The room is located above a finished (heated) basement. The space also has the following characteristics. What is the total heating load in Btu/hr?

Initial Problems (10 points)

• Ceiling / roof is well insulated (R = 38 hr x ft² x °F / Btu, U = _______ ___ __________ (units).
  The ceiling is 9 ft high.
• Exterior walls are well insulated (R = 19 hr x ft² x °F / Btu, U = _______ ___ __________ (units).
• South windows are 3 ft by 4 ft with low-e double glass (R = 3.2 hr x ft² x °F / Btu, U = _______ ___ __________ (units).
• East window is 2 ft 6 in by 4 ft with low-e double glass (U = 0.25 Btu / hr x ft² x °F).
• Door is steel with urethane foam core that is 1 3/4" thick (R = 5.5 hr x ft² x °F / Btu, U = _______ ___ __________ (units).
• The house is well built and sealed properly, considered “tight”; the infiltration rate is 0.5 ACH. Would the house be more or less “tight” if the ACH was 1.5? (circle the answer).
• No mechanical ventilation (q_{vent}) is needed for this particular calculation. Why?

Show work here for U factors.
Heat Loss Calculations (15 points). Find the heating load at design conditions for the room described above using the sheet below — show your work!! Upload a clean scan or LEGIBLE/READABLE cell phone image for each of these two pages for this question.

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<td>Basement Floors</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slab Description</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exposed Slab Edge</td>
<td>&lt;3ft below grade</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Heat Capacity Bltuhr/(\text{hr}^\circ))</th>
<th>Air change/hr ACH</th>
<th>Volume (\text{ft}^3)</th>
<th>(\Delta T) (\text{(\text{F}^\circ)})</th>
<th>Subtotal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infiltration</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Occupant Load No. of occupants</th>
<th>Outdoor Air Requirements Btu/(\text{cfm/\text{ occupant}})</th>
<th>Heat Flow Rate Btu/(\text{ft}^3/\text{ (\text{F}^\circ)})</th>
<th>(\Delta T) (\text{(\text{F}^\circ)})</th>
<th>Subtotal</th>
</tr>
</thead>
<tbody>
<tr>
<td>VENTILATION (non residential)</td>
<td></td>
<td></td>
<td></td>
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</table>

| TOTAL HEATING LOAD (Bltuhr) |
### STUDENT LEARNING OUTCOME # 20

Understand the basic principles of mechanical, electrical, and piping systems

<table>
<thead>
<tr>
<th>Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>At least 70% of students earn a C (70%) or better</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Where Assessed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course:</strong> CstM 333 - Building Science II</td>
</tr>
<tr>
<td><strong>Semester:</strong> Spring</td>
</tr>
<tr>
<td><strong>Instructor:</strong> Day</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Student Work Assessed</th>
</tr>
</thead>
<tbody>
<tr>
<td>A select portion of questions on the Midterm and Final Exam - including, but not limited to the following concepts:</td>
</tr>
<tr>
<td>• CLO1: Understand different types of power systems and building electrical systems</td>
</tr>
<tr>
<td>• CLO2: Understand the basic principles of natural and electrical lighting design</td>
</tr>
<tr>
<td>• CLO3: Understand strategies for using and controlling natural light</td>
</tr>
<tr>
<td>• CLO4: Understand building energy use factors, energy code best practices, energy monitoring and management systems, and energy efficient strategies for HVAC &amp; lighting systems</td>
</tr>
<tr>
<td>• CLO5: Comprehend building acoustics and standards (ACCE, n/a)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rubric Used for Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No rubric:</strong> EXAMS – exam questions were assessed by “correct” or “incorrect” answers using a mix of multiple choice, calculations, true/false and fill in the blank questions.</td>
</tr>
</tbody>
</table>

**Exam Questions Used for Assessment are outlined in the following links (including student responses)**

Also, see [midterm attachment + final exam attachment](#) for more detail.

- FE – Selected Final Exam and Questions Copied Below.
  - Current is the electrical term used to describe:
  - Ohm’s law establishes the relationship between:
  - Which of the following electric circuit arrangements is most common in buildings?
  - Which of the following statements best reflects the use of direct current in buildings?
  - Power and energy differ as follows:
  - Match the following electrical units (column 1) with the parameter (column 2) they quantify:
  - “Energy” is the technical term for this common expression:
  - Power factor represents:
  - A conductor is best described as:
  - A switchboard typically contains:
  - A panelboard is typically installed:
Which of the following system voltages is most likely to be used as the primary distribution system in a large commercial or institutional building?

Which of the following system voltages is most likely to be used in a single-family residence?

The National Electrical Code:

“Romex” is a type of:

A cable tray is best described as:

Light is best described as:

Match the lighting terminology below (column 1) with the parameter (column 2) it describes:

The relationship between illuminance and luminance for an opaque surface is best described as:

An illuminance meter will provide readouts in which of the following units:

The inverse square law states that, for a point source:

Illuminance levels and illuminance categories are used to:

Room illuminance values are typically measured:

Glare caused by light sources in the field of vision is known as:

Color temperature is measured in what?

Efficacy of a light source is best defined as:

The basic principle of operation of an incandescent lamp is best described as:

Lighting power density is expressed in terms of:

Luminaire is the technical name for:

Coefficient of utilization (CU) expresses:

The following lamp type would be ideal for an industrial application:

A luminaire that directs only 0%–10% of its light output toward the floor is best classified as:

Lighting power density is expressed using which of the following units:

Based on ASHRAE standard 90.1, and recent energy code changes, values for LPD are:

A 250 candela light source (a source that gives off 250 lm of luminous flux in one direction) emits a beam of light. Determine the illuminance (E) in footcandles, on a surface held perpendicular to and in line with the light beam at the following: Held at 1 foot away.

A 300 candela light source (a source that gives off 300 lm of luminous flux in one direction) emits a beam of light. Determine the illuminance (E) in footcandles, on a surface held perpendicular to and in line with the light beam at the following: Held at 100 ft away.

If a single-phase AC electrical resistance load operates at 120 volts with a power factor of 1, how much current is required to consume 450 watts of power? **Just provide the number (to two decimals) and not the unit for the answer.

An extension power cord made of #12 copper wire (with a resistance of 1.588 Ω) is powering a lamp 300 feet from the source. The lamp resistance is 72 Ω and the source voltage is 120 V. Find the voltage drop across the light bulb in volts (to one decimal point).

What are the most desired orientations for daylight?

A closed loop daylight sensor (or photocell) only accounts for illumination from daylight.

Which of these controls is required by (most) codes to allow for occupant overrides of lighting conditions?

An open loop daylight sensor (or photocell) only accounts for illumination from daylight.

Which of these controls would dim the lights automatically in a conference room with windows?

Which of these controls would probably not be used in a private office (for energy efficiency)?

Which of these controls would be best to use first in a copy room (for energy efficiency)?
Detailed Direct Assessment Tools

- Which of these controls would be best to use first in an open office area (for energy efficiency)?
- As we get older, we need less light to perform tasks than when we were younger.
- When choosing a light source for a grocery store produce and/or meat section, a lamp with a higher CRI would be best for product sales.
- Luminance can be thought of as a measurement of the light we see.
- A higher color temperature means that a light source has a “warmer” appearance.
- Lighting can be directly related to health, productivity and visual comfort.
- What is a good way to estimate the depth of the daylight zone?
- What are the three most common voltages?
- What is used to convert DC to AC?
- A 100 ft by 140 ft conference center lobby area will have luminaires for ambient lighting hung 48 ft above the floor. The ceiling cavity reflectance is 0.80 and the average wall reflectance is about 0.30. The space will be illuminated with high bay, intermediate distribution reflector luminaires, as shown in the attached figure.
  - 400 W clear metal halide lamps with an initial output of 36,000 lm will be used. The target illuminance is 50 fc at the floor plane. The LLF will be assumed to be 0.60.
  - \[ \text{Number of luminaires} = \frac{E \times A}{n \times LM \times CU \times LLF} \]
  - Where, A: area of the space to be illuminated, sq.ft; CU: coefficient of utilization of luminaire; E: illuminance, in footcandles (or lux); n: number of luminaires; LM: lamp output, in lumens
  - Determine the number of luminaires required to perform uniform illumination in the space. The CR must first be calculated before finding the CU, which is
  - How many luminaires do you need?
This portion of the survey is designed to determine graduating senior’s opinion/perspective on how well they accomplished the SLO.

On a scale of 1 to 5, please rate your level of agreement with each of the 21 statements below as to how well the CM program prepared you with the necessary knowledge and skill. Select the most appropriate rating/number for each statement (with 1 = strongly disagree, 2 = disagree, 3 = mixed feelings, 4 = agree, and 5 = strongly agree):

1. The CM program of study was very good preparation for my career.
2. I am able to create written communications appropriate to the construction discipline.
3. I am able to create oral presentations appropriate to the construction discipline.
4. I am able to create a construction project safety plan.
5. I am able to accurately estimate and price work to create a construction project estimate.
6. I am able to create a construction project schedule using CPM and computer/software.
7. I am able to analyze professional decisions based on ethical principles.
8. I am able to analyze (read & interpret) construction documents for the planning and management of construction processes.
9. I am able to analyze methods, materials, and equipment used to construct projects.
10. I am able to apply construction management skills as an effective member of a multi-disciplinary team.
11. I am able to apply electronic-based technology to manage the construction process (e.g., Procore, Bluebeam, etc.).
12. I am able to apply basic surveying techniques for construction layout and control.
13. I understand different methods of project delivery and the roles and responsibilities of all constituencies (parties) involved in the design and construction process.
15. I understand construction accounting and cost control.
16. I understand construction quality assurance and control.
17. I understand construction project control processes.
18. I understand the legal implications of contract, common, and regulatory law to manage a construction project.
19. I understand the basic principles of sustainable construction.
20. I understand the basic principles of structural behavior.
21. I understand the basic principles of mechanical, electrical and plumbing systems.
### Fall Semester:

<table>
<thead>
<tr>
<th>No</th>
<th>ACCE Student Learning Outcome</th>
<th>ACCE Direct Assessment</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Create construction project cost estimates.</td>
<td>CstM 370 - Estimating I (DA), CstM 371 - Estimating II (DA)</td>
<td>FALL</td>
</tr>
<tr>
<td>5</td>
<td>Create construction project schedules.</td>
<td>CstM 102 - Introduction to the Built Environment (DA), CstM 462 - Planning &amp; Scheduling (DA)</td>
<td>FALL</td>
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<tr>
<td>6</td>
<td>Analyze professional decisions based on ethical principles.</td>
<td>CstM 370 - Estimating I (DA)</td>
<td>FALL</td>
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<tr>
<td>8</td>
<td>Analyze methods, materials, and equipment used to construct projects.</td>
<td>CstM 201 - Materials I (DA)</td>
<td>FALL</td>
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<tr>
<td>10</td>
<td>Apply electronic-based technology to manage the construction process.</td>
<td>CstM 254 - Construction Graphics (DA), CstM 462 - Planning &amp; Scheduling (DA)</td>
<td>FALL</td>
</tr>
<tr>
<td>11</td>
<td>Apply basic surveying techniques for construction layout and control.</td>
<td>CE 302 - Introduction to Surveying (DA)</td>
<td>FALL</td>
</tr>
<tr>
<td>12</td>
<td>Understand different methods of project delivery and the roles and responsibilities of all constituencies involved in the design and construction process.</td>
<td>CstM 452 - Delivery Systems (DA)</td>
<td>FALL</td>
</tr>
<tr>
<td>13</td>
<td>Understand construction risk management.</td>
<td>CstM 460 - Construction Cost Management (DA)</td>
<td>FALL</td>
</tr>
<tr>
<td>14</td>
<td>Understand construction accounting and cost control.</td>
<td>CstM 460 - Construction Cost Management (DA)</td>
<td>FALL</td>
</tr>
<tr>
<td>15</td>
<td>Understand construction quality assurance and control.</td>
<td>CstM 252 - Construction Administration &amp; Documentation (DA)</td>
<td>FALL</td>
</tr>
<tr>
<td>16</td>
<td>Understand construction project control processes.</td>
<td>CstM 252 - Construction Administration &amp; Documentation (DA)</td>
<td>FALL</td>
</tr>
<tr>
<td>17</td>
<td>Understand the legal implications of contract, common, and regulatory law to manage a construction project.</td>
<td>CstM 362 - Construction Law (DA)</td>
<td>FALL</td>
</tr>
<tr>
<td>18</td>
<td>Understand the basic principles of sustainable construction.</td>
<td>CstM 332 - Building Science I (DA)</td>
<td>FALL</td>
</tr>
<tr>
<td>19</td>
<td>Understand the basic principles of structural behavior.</td>
<td>Arch 352 - Structures II (DA)</td>
<td>FALL</td>
</tr>
<tr>
<td>20</td>
<td>Understand the basic principles of mechanical, electrical and plumbing systems.</td>
<td>CstM 332 - Building Science I (DA)</td>
<td>FALL</td>
</tr>
</tbody>
</table>
### Spring Semester:

<table>
<thead>
<tr>
<th>No</th>
<th>ACCE Student Learning Outcome</th>
<th>ACCE Direct Assessment</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Create written communications appropriate to the construction discipline.</td>
<td>CstM 252 - Construction Administration &amp; Documentation (DA)</td>
<td>SPRING</td>
</tr>
<tr>
<td>2</td>
<td>Create oral presentations appropriate to the construction discipline.</td>
<td>CstM 473 - Human Productivity in Construction (DA), CstM 475 - Senior Capstone (DA)</td>
<td>SPRING</td>
</tr>
<tr>
<td>3</td>
<td>Create a construction project safety plan.</td>
<td>CstM 368 - Safety &amp; Health (DA)</td>
<td>SPRING</td>
</tr>
<tr>
<td>4</td>
<td>Create construction project cost estimates.</td>
<td>CstM 371 - Estimating II (DA)</td>
<td>SPRING</td>
</tr>
<tr>
<td>5</td>
<td>Create construction project schedules.</td>
<td>CstM 102 - Introduction to the Built Environment (DA)</td>
<td>SPRING</td>
</tr>
<tr>
<td>6</td>
<td>Analyze professional decisions based on ethical principles.</td>
<td>CstM 473 - Human Productivity in Construction (DA)</td>
<td>SPRING</td>
</tr>
<tr>
<td>7</td>
<td>Analyze construction documents for planning and management of construction processes.</td>
<td>CstM 252 - Construction Administration &amp; Documentation (DA)</td>
<td>SPRING</td>
</tr>
<tr>
<td>8</td>
<td>Analyze professional decisions based on ethical principles.</td>
<td>CstM 473 - Human Productivity in Construction (DA)</td>
<td>SPRING</td>
</tr>
<tr>
<td>9</td>
<td>Analyze methods, materials, and equipment used to construct projects.</td>
<td>CstM 202 - Materials II (DA), CstM 356 - Earthwork &amp; Equipment (DA)</td>
<td>SPRING</td>
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<tr>
<td>10</td>
<td>Apply construction management skills as a member of a multi-disciplinary team.</td>
<td>CstM 475 - Senior Capstone (DA)</td>
<td>SPRING</td>
</tr>
<tr>
<td>11</td>
<td>Apply electronic-based technology to manage the construction process.</td>
<td>CstM 252 - Construction Administration &amp; Documentation (DA)</td>
<td>SPRING</td>
</tr>
<tr>
<td>18</td>
<td>Understand the basic principles of sustainable construction.</td>
<td>333 - Building Science II (DA)</td>
<td>SPRING</td>
</tr>
<tr>
<td>19</td>
<td>Understand the basic principles of structural behavior.</td>
<td>Arch 463 - Structures III (DA)</td>
<td>SPRING</td>
</tr>
<tr>
<td>20</td>
<td>Understand the basic principles of mechanical, electrical and plumbing systems.</td>
<td>CstM 333 - Building Science II (DA)</td>
<td>SPRING</td>
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</tbody>
</table>
# Washington State University
## Construction Management
### Academic Quality Improvement Plan for Bachelor of Science in Construction Management

**Appendix D**
**Map SLO to CLO**

<table>
<thead>
<tr>
<th>ACCE SLO</th>
<th>ACCE Direct and Indirect Assessment</th>
<th>Course Learning Outcomes (CLO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Create written communications appropriate to the construction discipline.</td>
<td>CstM 252 - Construction Administration &amp; Documentation (DA) / Exit Survey</td>
</tr>
<tr>
<td>2</td>
<td>Create oral presentations appropriate to the construction discipline.</td>
<td>CstM 473 - Human Productivity in Construction (DA), CstM 475 - Senior Capstone (DA) / Exit Survey</td>
</tr>
<tr>
<td>3</td>
<td>Create a construction project safety plan.</td>
<td>CstM 368 - Safety &amp; Health (DA) / Exit Survey</td>
</tr>
<tr>
<td>5</td>
<td>Create construction project schedules.</td>
<td>CstM 102 - Introduction to the Built Environment (DA), CstM 462 - Planning &amp; Scheduling (DA) / Exit Survey</td>
</tr>
<tr>
<td>9</td>
<td>Apply construction management skills as a member of a multi-disciplinary team.</td>
<td>CstM 475 - Senior Capstone (DA) / Exit Survey</td>
</tr>
<tr>
<td></td>
<td>Apply basic surveying techniques for construction layout and control.</td>
<td>CE 302 - Introduction to Surveying (DA) / Exit Survey</td>
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<tr>
<td>---</td>
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<td>11</td>
<td>Understand different methods of project delivery and the roles and responsibilities of all constituencies involved in the design and construction process.</td>
<td>CstM 452 - Delivery Systems (DA) / Exit Survey</td>
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<td>Understand construction risk management.</td>
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<td>Understand the legal implications of contract, common, and regulatory law to manage a construction project.</td>
<td>CstM 362 - Construction Law (DA) / Exit Survey</td>
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<td>17</td>
<td>Understand the basic principles of sustainable construction.</td>
<td>CstM 332 - Building Science I (DA), CstM 333 - Building Science II (DA) / Exit Survey</td>
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<td>18</td>
<td>Understand the basic principles of structural behavior.</td>
<td>Arch 352 - Structures II (DA), Arch 463 - Structures III (DA) / Exit Survey</td>
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<tr>
<td>19</td>
<td>Understand the basic principles of mechanical, electrical and plumbing systems.</td>
<td>CstM 332 - Building Science I (DA), CstM 333 - Building Science II (DA) / Exit Survey</td>
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</tbody>
</table>