General Catalogue Course Description: The course involves rehabilitation concepts and requirements for performance regarding strength and ductility of reinforced concrete buildings. The course covers criteria for rehabilitation of structures for the operational, life safety, and collapse prevention levels, including local and global rehabilitation. The course includes condition assessment and structural evaluation of existing structures, in terms of expected performance, strength, and ductility requirements. It is required that a nonlinear analysis of the structure be performed to determine load paths, weak links, and rehabilitation strategies for strength and ductility. Selected rehabilitation strategies will be covered including conventional materials, advanced composite materials and seismic energy absorption devices using rehabilitation of an actual building as a project assignment.

Prerequisites: CVEEN 5220/6220 Concrete II, CVEEN 6250 Dynamics of Structures

Textbooks: ASCE/SEI 41-13 (2013) Seismic Rehabilitation of Existing Buildings

Class Schedule: 3 hour lecture/week

Professor Chris Pantelides, Ph.D., S.E., FACI, 2115 MEB

Email: c.pantelides@utah.edu TEL: 801.585.3991

Class Meeting times: T, TH 2:00 pm – 3:20 pm Room WEB 1450

Grading and Evaluation: Homework, test, final, journal paper review and the project will make up the grade. Homework = 15%, Midterm = 20%, Final = 30%, Project = 30%, Journal Article Review = 5%.

Final Exam: Wed., May 1, 2019, 1:00 pm - 3:00 pm, Room WEB 1450

Office Hours: Mon., Tue., Wed. 11:00 am – noon, Room MEB 2115 or by appointment.

Course Requirements: The seismic rehabilitation project will be carried out in small groups and will be a central focus of the entire course. The course will contain written assignments in terms of homework problems and journal papers. In addition, there will be a midterm and a final.

Homework: All Homework will be assigned on the lectures shown in the Course Outline and will be due in one week.
# COURSE OUTLINE

<table>
<thead>
<tr>
<th>Lecture</th>
<th>Topics</th>
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| 1       | **Issues in Seismic Rehabilitation**  
(Historic Performance of Buildings in Earthquakes, Rehabilitation Process) |
| 2       | **Overview of the Prestandard and Commentary for the Seismic Rehabilitation of Buildings**  
FEMA 356 and ASCE/SEI 41-13 (2013) Seismic Rehabilitation of Existing Buildings  
(New Building Design Compared to Rehabilitation Design, Basic Concepts of the *Prestandard*, Performance Levels and Ranges, Philosophy of *Prestandard*, Seismic Hazard Maps, Rehabilitation Objective Definitions, Systematic Rehabilitation Method) |
|         | **Homework #1** |
| 3       | **Design Project**  
(Visit to Project Building and Collection of Data) |
| 4       | **Design Project**  
(Details of Reinforced Concrete Building and Rehabilitation Objectives  
– Introduction of PERFORM 3D) |
|         | **Homework #2** |
| 5       | **Simplified Rehabilitation**  
(Basis, Limitations, Procedural Steps) |
| 6       | **Systematic Rehabilitation**  
(Choice of Systematic Rehabilitation Method, Determination of As-Built Conditions,  
Determination of Site Hazards, Selection of Rehabilitation Objective and Strategy,  
Selection of Analysis Procedure, Modeling and Acceptance Criteria, Primary and Secondary Components, Rehabilitation Design Process) |
|         | **Homework #3** |
| 7       | **Basics of Structural Dynamics, Nonlinear Response, and Acceptance Criteria**  
(Seismic Hazard, Linear Response Spectra, Design Response Spectra, Inelastic Response, Multi-Story Structures, Local Demands and Capacities) |
| 8       | **Analysis Techniques**  
(Building Performance Levels, Target Displacement, Acceptability Criteria, FEMA 356 Analysis Procedures, Nonlinear Static Procedure, Pushover Curve) |
|         | **Homework #4** |
Foundations and Geotechnical Considerations
(Site hazards other than ground shaking, modeling fixed and flexible foundations,
Effects of Foundations on Performance, Foundation Rehabilitation)

Rehabilitation of Concrete Components and Buildings
(Framing Types, Materials Properties and Condition Assessment, General Assumptions
and Requirements)

Homework #5

Rehabilitation of Concrete Components and Buildings
(Example Building)

MIDTERM

Nonlinear Analysis as a Rehabilitation Design Tool
(Force-Deformation Relationships, Strength- vs Deformation-Based Design,
Performance-Based Design, Capacity Design)

Homework #6

Nonlinear Analysis as a Rehabilitation Design Tool
(Pushover Principles, Software as a Tool for Rehabilitation)

DESIGN PROJECT REVIEW #1

Homework #7

Rehabilitation Techniques for RC Concrete Buildings
(Reinforced Concrete Shearwalls)

Rehabilitation Techniques for RC Concrete Buildings
(Reinforced Concrete Jackets)

Homework #8

Rehabilitation Techniques for RC Concrete Buildings
(Steel Jackets and Steel Bracing)

Rehabilitation Techniques for RC Concrete Buildings
(Anchorage of Steel Members to Reinforced Concrete)

Homework #9

Rehabilitation Techniques for RC Concrete Buildings
(Anchorage of Steel Members to Reinforced Concrete)
Homework #10

DESIGN PROJECT REVIEW #2

Rehabilitation Techniques for RC Concrete Buildings (Fiber Reinforced Polymer Jackets - Shear)

Rehabilitation Techniques for RC Concrete Buildings (Fiber Reinforced Polymer Jackets - Confinement)

Rehabilitation Techniques for RC Concrete - Examples (Energy Dissipation Devices)

Rehabilitation Techniques for RC Concrete - Examples (Combination of rehabilitation techniques for RC structures)

Rehabilitation Techniques for RC Concrete - Examples (Combination of rehabilitation techniques for RC structures)

Rehabilitation Techniques for Unreinforced Masonry Buildings

Rehabilitation Techniques for Steel Buildings

Summary and Review

ORAL PRESENTATION OF DESIGN PROJECTS

Final Exam
Policy Concerning Homework Assignments

This policy reflects the mission of the Department of Civil and Environmental Engineering (CVEEN) to promote high professional standards. Its purpose is three-fold: (1) instill ethical work principles, (2) cultivate professional presentation of engineering calculations, and (3) develop problem-solving skills.

Ethics
If you are having difficulty understanding a homework assignment, you should seek help from the course's instructor or teaching assistant. You may work with others in order to understand the concept(s) covered on a homework assignment. However, inappropriate assistance, such as copying solutions from others or from previous years' homework assignment solutions, is unacceptable. You are not discouraged from studying together, but each student is expected to do their own work and submit their own assignments. Plagiarism of any sort will not be tolerated. Students should also familiarize themselves with the University regulations regarding academic misconduct. Failure to comply with this policy will result in either reduced credit, rejection of homework which will be considered as non-submittal, or receipt of a failing grade at the discretion of the instructor. Student code of conduct violations will be pursued in accordance with University Policy.

Format
Your homework assignment solution must adhere to the following formatting rules.
1. Use only one side of 8.5 X 11 inch paper. Use engineering paper and pencil for handwritten solutions. Computer printouts must be on white paper. Each problem must be started on a separate piece of paper.

2. All solutions must be neatly written (or electronically generated), well organized, and logical. For engineering homework problems, the following sequence of categories should be used and will be required in your classes:
   a) Statement of Problem
   b) Required
   c) Assumptions
   d) Solution
   e) Summary of Answers

3. Number, title, and label each graph or table required by the assignment.

4. Generally, graphs should be drawn on a separate piece of paper (one graph per page) and should take up most of the page.

5. Use the same justification (left, center, right, or decimal) for all data in a table.

6. Sample calculations must accompany computer spreadsheet solutions.

7. Your name, the course number, assignment number, and problem number must appear on the top of each sheet of the assignment. Number the pages.

8. Bind the assignment with one metal staple in the upper left hand corner of the pages. Do not use paper clips or dog-eared pages.