# CE 458 Theory of Structures II (3)

2017 Spring Semester — Course Syllabus

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|---|---|---|---|
| Lecture | Mon./Wed. | 5:00p.m. to 6:20 p.m. | KAP 134 |
| Professor | L. Carter Wellford | | |
| Office | KAP 238B | | |
| Phone | (213) 740-0607 Office at USC | (310) 968-1224 cell | |
| Email | wellford@usc.edu | | |
| Office Hours | | | |
| Teaching Assistant | | | |
| Email | | | |
| Office | | | |
| Office Hours | | | |
| Prerequisites | CE 358 | | |
| Textbook | | | |
| Handout | Wellford, L.C., "CE 458 Class Notes", available in USC Bookstore | | |
| Course Description | Typical engineering problems discussed on a physical basis. Setup and solution of problems by means of the existing mathematical tools and computer applications. | | |
| Course Objectives | The course is designed to build on the concepts presented in CE 358 by introducing computer modeling procedure, based on the displacement and force methods. The course considers bar, truss, 2-D beam, 3-D beam, shear wall, and plate components. Structural dynamics, earthquake engineering applications, finite element analysis, nonlinear structural analysis, and buckling behaviors are considered. | | |
| Learning Objectives | | | |
| Policies on | | | |
| Late work | 10% off, no credit if more than a week late | | |
| Make-up work | | | |
| Incomplete work | | | |
| Extra credit | | | |
| Final grade schema is based on the following percentages of graded coursework : | | | |
| Homework | 25 % | Homework assigned weekly, problems are due on the following week | |
| Midterm | 25 % | Date TBD | |
| Final Project | 25 % | Due TBD | |
| Final Exam | 25 % | Date TBD | |
| Total | 100 % | | |

Class Calendar (topic dates are subject to change)

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| Week | Date | Main Lecture Topics | Exams | Due Dates |
|---|---|---|---|---|
| 1 | 1/9 | Lect. 1 Mathematical Preliminaries | | |
| 2 | 1/16 | Lect. 2 Energy Methods of Structural Analysis | | |
| 3 | 1/23 | Lect. 3 Axial Bar Members | | |
| 4 | 1/30 | Lect. 4 2-D Beam Members | | |
| 5 | 2/6 | Lect. 5 2-D Structural Modeling – Miscellaneous Topics | | |
| 6 | 2/13 | Lect. 6 Structural Dynamics – Free Vibration, Time History | | |
| 7 | 2/20 | Midterm Exam | | |
| 8 | 2/27 | Lect. 7 Structural Dynamics – Earthquake Engineering | | |
| 9 | 3/6 | Lect. 8 3-D Structures | | |
| | 3/12-19 | Spring Break | | |
| 10 | 3/20 | Lect. 9 Finite Elements – 1-D Analysis | | |
| 11 | 3/27 | Lecture 10 Finite Elements – 2-D Analysis and Gauss Quadrature | | |
| 12 | 4/3 | Lecture 11 Nonlinear Structural Analysis | | |
| 13 | 4/10 | Lecture 12 Elastic Stability, Buckling | | |
| 14 | 4/17 | Lecture 13 Force-based Methods | | |
| 15 | 4/24 | Lecture 14 Analysis of Deep Beams, Effects of Shear Deformations | | |
| | 5/3 | Final exam 4:30-6:30 PM | | |

# CE 458 Class Notes

## Table of Contents

3.2 Member Displacements -Supported Member
3.3 Approximate Potential Energy
3.4 Member Stiffness Matrix- Supported Member
3.5 Stationary Potential Energy
3.6 Free-Free Bar Member
3. 7 Local versus Global Numbering Systems
3.8 Compatability Relationships
3.9 Assembly of Structural Model- Compatability Method

**4.0 2-D Beam Members**
4.1 Bernoulli Beam Theory
4.2 Energy Formulation
4.3 2-D Beam Element Formulation- Supported Member
4.4 2-D Beam Element Formulation- Free-Free Member
4.5 2-D Beam-Column Element
4.6 Assembly of Models using Beam-Column Members
4. 7 Connections -Moment Releases

**5.0 2-D Structural Modeling- Miscellaneous Topics**
5.1 Inclined Members
5.2 Distributed Loadings- Pressures
5.3 Thermal Loading
5.4 Through the Depth Temperature Distribution- Thermal Bending
5.5 Enforced Displacement- Settlement
5.6 Rigid offsets of Member Nodes
5.7 Displacement-Force Transformations
5.8 Alternative Coordinate Systems, Inclined Supports
5.9 Rigid Diaphragms in 2-D Models

**6.0 Structural Dynamics - Basic formulations, Free Vibration, Time History Analysis**
6.1 Equations of Motion for a Bar Member
6.2 Mass Matrix- Bar Element
6.3 Mass Matrix- 2-D Beam Member
6.4 Assembly of System Stiffness and Mass Matrices
6.5 Inclusion of Concentrated Masses
6.6 Free Vibration Solution
6.7 Dynamic Response, Time History Analysis

**7.0 Structural Dynamics- Earthquake Engineering, Response Spectrum Analysis**
7.1 Effects of Damping
7.2 Earthquake Excitation at Multiple Points
7.3 Free Vibration Solution for Use in Response Spectrum Model
7.4 Response Spectrum Earthquake Dynamic Response Solution
7.5 Example Response Spectrum Calculation

**8.0 3-D Structures**
8.1 Formulation of 3-D Beam Stiffness Matrix
8.2 Orientation of a 3-D Beam Member
8.3 Example Calculation -3D Orientation Matrix
8.4 Construction of an Arbitrarily Oriented 3-D Beam Stiffness Matrix
8.5 Rigid Diaphragms in 3-D Models

**9.0 Finite Elements -1-D Analysis**
9.1 Higher Order 1-D Elements
9.2 Finite Element Analysis with 1-D Elements

**10.0 Finite Elements- 2-D Analysis and Gauss Quadrature**
10.1 Gauss Quadrature P.1
10.2 2-D Elements- Displacement Approximation
10.3 Finite Element Formulations for 2-D Elasticity Problems
10.4 Including Distributed Loading- Pressures, Etc.

**11.0 Nonlinear Structural Analysis**
11.1 Nonlinear Analysis- Geometric Nonlinearity
11.2 Incremental Formulation
11.3 Iterative Solution of Example Problem

**12.0 Elastic Stability - Buckling**
12.1 Elastic Stability- Basic Concepts
12.2 Matrix Methods for Elastic Stability Analysis
12.3 Example Problems- Buckling

**13.0 Force-based Methods**
13.1 The Force Method- Introduction
13.2 The Equilibrium Matrix
13.3 The Members and Associated Flexibility Matrices
13.4 Assembly of the System Flexibility Matrix
13.5 Example- Force Method- Bar Members
13.6 Example- Force Method- Beam Members

**14.0 Analysis of Deep Beams, Effects of Shear Deformations**
14.1 Slender versus Deep Beams
14.2 Transverse Shear Strains and Stresses

14.3 Unit Load Method for Shear Displacements
14.4 Formation of Supported Stiffness Matrix- Deep Beam
14.5 Free-Free Stiffness Matrix- Deep Beam

## STATEMENT ON ACADEMIC INTEGRITY

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own.

All students are expected to understand and abide by these principles. *SCampus,* the Student Guidebook, contains the Student Conduct Code in Section 11.00, while the recommended sanctions are located in Appendix A: http://www.usc.edu/dept/publications/SCAMPUS/gov/. Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The Review process can be found at: http://www.usc.edu/student-affairs/SJACS/.

## STATEMENT FOR STUDENTS WITH DISABILITIES

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible.

### DSP Contact Information

Office location: **STU 301**

Hours open: **8:30 a.m. until 5:00 p.m. —** Monday through Friday.

Phone number: **(213) 740-0776**