WEST VIRGINIA UNIVERSITY
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Course No. & Title: **CE 561 - STATICALLY INDETERMINATE STRUCTURES (MATRIX METHOD OF STRUCTURAL ANALYSIS)**
Sec. 01
Fall Semester, 2013

Time & Place: Tuesday & Thursday, 9:30 - 10:45 A.M.
Room G84 ESB

Instructor: **Dr. Udaya B. Halabe**, Professor, CEE, Structures Group
Room 613 ESB, Phone: 304-293-9934, E-mail: udaya.halabe@mail.wvu.edu

Office Hours: Tuesday & Thursday, 11:00 A.M. - 12:00 Noon (or by appointment)

Textbooks:

For Matrix Method of Structural Analysis (80% of the course)

(1) Kassimali, A., *Matrix Analysis of Structures*, 2nd Edition, Cengage Learning, 2012.

For Review of Basic Structural Analysis Concepts (20% of the course)

(2) Kassimali, A., *Structural Analysis*, 4th Edition, Cengage Learning, 2010.

(3) Hibbeler, R. C., *Structural Analysis*, Pearson, 8th Edition, 2012.

(4) Leet, K. M., Uang, C. M., and Gilbert, A., *Fundamentals of Structural Analysis*, 4th Edition, McGraw-Hill, NY, 2011.

Computer Program: Risa Technologies, *RISA-2D / 3D: Rapid Interactive Structural Analysis in 2 and 3 Dimensions*, Latest Versions (Demo Versions can be downloaded for free from *www.risatech.com*).

References:

(1) Holzer, S. M., *Computer Analysis of Structures*, Elsevier, NY, 1985.

(2) Weaver, W., Jr., and Gere, J. M., *Matrix Analysis of Framed Structures*, Van Nostrand Reinhold, NY, 3rd Edition, 1990.

(3) Sack, R. L., *Matrix Structural Analysis*, Waveland Press, Inc, IL, 1989.

(4) Hsieh, Y., and Mau, S. T., *Elementary Theory of Structures*, Prentice Hall, Inc., NJ, 4th Edition, 1995.

(5) McCormac, J. C., and Nelson, J. K., *Structural Analysis: A Classical and Matrix Approach*, John Wiley & Sons, 4th Edition, 2007.

Objective: The primary objective of this course is to study the Matrix Displacement Method for the analysis of Indeterminate Structures. The matrix formulation lends itself to systematic computer programming. The course will also include a discussion on Nonlinear Structural Analysis and Influence Line Diagrams (*time permitting*).

Policies and Guidelines:

Grading:

Attendance	**
Homework	16%
Exam I	28%
Exam II	28%
Exam III (Take Home)	28%
TOTAL	100%

** Attendance record will be used to decide the grades for borderline cases.

Final grades will be based on the following scale: 90% and above - A, between 80% and 90% - B, between 70% and 80% - C, between 60% and 70% - D, and below 60% - F. However, the instructor reserves the right to curve up (i.e., lower the grade cut-off boundaries and award higher grades than earned on this scale).

Homework: **You are not allowed to copy**. Identical homework will be given a score of zero. Late homework will not be accepted unless prior approval of the instructor is obtained.

All submitted work should be neat, concise, clear and well organized, and should be presented on standard size paper (8.5" x 11"). No off-size papers will be accepted. Please staple all sheets together before submitting.

Exams: Two exams (60 to 70 minutes each) will be given during class hours on pre-announced days. These exams (I and II) will be closed book, but you will receive some handouts containing tables and equations with Exam II questions (details will be given in the class). Calculators will be permitted during exams. Any unexcused absence during exam days will result in a score of zero. Make-up exams will be permitted only for medical reasons or in case of emergencies.

Exam III will be a take home exam where you will have access to your books and class notes, **but you are not allowed to discuss the exam problems and solutions with others and no copying is permitted.** Identical solutions will be given score of zero.

Academic Honesty: You are bound by the University Honor Code. It is your responsibility to know the code and the risks of violations (please see WVU Graduate Catalog).

Some Suggestions: You are encouraged to ask questions in the class to clarify any doubts. Review your class notes as soon as possible. Try to be up-to-date on all lectures. Lack of understanding of current topics may hinder future learning as well. So get help wherever you can, from fellow students, senior students, libraries, and your instructor.

Social Justice Statement: The West Virginia University community is committed to creating and fostering a positive learning and working environment based on open communication, mutual respect and inclusion.

Days of Special Concern: WVU recognizes the diversity of its students and the needs of those who wish to be absent from class to participate in Days of Special Concern, which are listed in the web site of WVU's Office of Social Justice. ***Students should notify their instructors by the end of the second week of classes or prior to the first Day of Special Concern, whichever is earlier, regarding Day of Special Concern observances that will affect their attendance.*** Further, students must abide by the attendance policy of their instructors as stated on their syllabi. Faculty will make reasonable accommodation for tests or field trips that a student misses as a result of observing a Day of Special Concern.

Topics:

(1) Review (from Textbook # 2):

- Bending Moment, Shear Force, and Axial Force Diagrams
- Free Body Diagrams
- Fundamental Assumptions in Structural Analysis
- Method of Virtual Work (Unit Load Method), Conjugate Beam Method, Differential Equation Method (Direct Integration Method), Maxwell's Reciprocal Theorem, etc.
- External Stability and Determinacy
- Internal Stability and Determinacy
- Force versus Displacement Method
- Matrix Algebra (Chapter 2 of Textbook #1)

(2) Matrix Displacement Method (from Textbook #1):

- Background Preparation (Chapter 1)
- Formulation of Element and Structure Stiffness Matrix for Plane (2-D) Structures (Chapters 3, 4, 5 and 6)
  - Plane Trusses
  - Beams and Plane Frames Neglecting Effect of Axial Deformation
  - Beams and Plane Frames Considering Effect of Axial Deformation
- Application of Nodal Forces and Boundary Conditions (at Element level versus Structure level)
- Discussion of Computer Programming Issues (also see Section 9.9)

(3) Advanced Topics (from Textbook #1):

- Matrix Displacement Method for Space (3-D) Structures (Chapter 8)
- Special Cases - prescribed displacements (settlements), initial and thermal strains, inclined roller supports, shear deformation, etc. (Chapters 7 and 9)
- Special Purpose Elements - Nonprismatic Members (Section 9.8)
- Static Condensation (Section 9.3)
- Matrix versus Finite Element Formulation (Section 1.2)

(4) Introduction to Nonlinear Structural Analysis (from Textbook # 1 - time permitting)

- Basic Concept of Geometrically Nonlinear Analysis (Section 10.1)
- Geometrically Nonlinear Analysis of Plane Trusses (Section 10.2)

(5) Influence Line Diagrams (from Textbook # 2 + handouts - time permitting)

- Construction of Influence Line Diagrams for Beams, Trusses, Frames, and Arches
- Computing Forces and Moments from Influence Diagrams
- Moving Loads: Load Positioning for Absolute Maximum
- Muller-Breslau Principle, and Construction of Influence Line Diagrams from Computer Analysis