CEE 3222
THEORY OF STRUCTURES

- Dr. Lenganji Simwanda

- Lecture 00: Course Content

Dr. Lenganji Simwanda **June 2023**

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Education

2022 PhD in Civil Engineering, Stellenbosch University

Dissertation: Structural reliability of ultra-high-performance fibre reinforced concrete structures

2021 MEng in Structural Engineering, University of Zambia

Dissertation: Finite element modelling of ultra-high-performance fibre reinforced concrete beams exposed to fire

2019 BEng in Civil & Environmental Engineering (Distinction), University of Zambia

Dissertation: A comparative analysis of BS8110:1997 and EN1992:2004 in the design of reinforced concrete structures

Course Main Aim

- The aim of the course is to provide students with a strong foundation in structural analysis, enabling them to analyze and understand the behavior of structures and make informed decisions in the design, construction, and maintenance of safe and efficient structures.

Course Objectives

- ***Understanding Structural Behavior***: The course aims to develop a deep understanding of how structures respond to different types of loads, including static and dynamic loads. Students learn the concepts of equilibrium, stability, deformation, and stress distribution in structures.
- ***Analyzing Structural Systems***: Students learn how to analyze various types of structural systems, such as beams, frames, trusses, and arches. The course covers both determinate and indeterminate structures, introducing methods for solving statically determinate structures and more advanced techniques for analyzing indeterminate structures.
- ***Applying Analysis Methods***: The course aims to familiarize students with different analysis methods and techniques used in structural engineering, such as the stiffness method, flexibility method, and matrix methods. Students learn how to apply these methods to solve structural problems and determine internal forces, displacements, and reactions.

Course Objectives

- **Interpreting Results**: Students develop the ability to interpret analysis results and understand the implications for structural design. They learn to identify critical sections, assess structural safety, and evaluate the performance of structures under different loading scenarios.
- **Integrating Theory and Practice**: The course aims to bridge the gap between theoretical knowledge and practical applications. Students learn how to apply structural analysis concepts and techniques to real-world engineering problems, considering factors such as material properties, structural constraints, and design standards.

Course content

1 *Introduction*

- Historical review. Philosophy of structural design. Structural forms.
- Analysis of structural behaviour. Engineering structures. Types of loads. Allowable Stresses. Factor of safety. Practical and ideal structures
- Equations of static equilibrium. Stability and indeterminacy of structures. Freebody sketches.

2 Analysis of statically determinate systems for stationary and moving loads

- Analysis of trusses (application of method of joints, method of sections and combination). Two dimensional rigid frames. Review of shearing force, bending moment, and axial resisting force diagrams.
- Definition and properties of influence lines. Influence lines for beams and girders (determination of loading positions for maximum bending moment and shear force). Influence lines for trusses. Alternative approach for determination of influence lines. Muller-Brestau’s principal.

3 Energy theorems and principles

- Virtual work concept, Reciprocal theorems. Strains Energy method. Castigliano’s theorems.
- Complimentary energy theorem. Potential energy theorems and applications

4 Force and displacement methods of analysis for statically indeterminate systems

- Compatibility method-Flexibility Method
- Equilibrium (Displacement) Method-Slope deflection Method,
- Deflection superposition- Additional examples involving temperatures, settlements, etc.,
- Direct Displacement Method, Moment Distribution Method (application to beams and frames).
- Influence lines for statically indeterminate Structures

5 Introduction to Matrix methods

- Matrix Force Method-Flexibility Method and Matrix Displacement Method
- Stiffness method applied to trusses, beams, and frames.
- Use of computers in structural analysis.

6 Influence lines for statically indeterminate structures

- Influence line by successive position of unit load force. Muller-Breslau' principle for obtaining
  influence line.

7 Introduction to limit analysis of plane structures

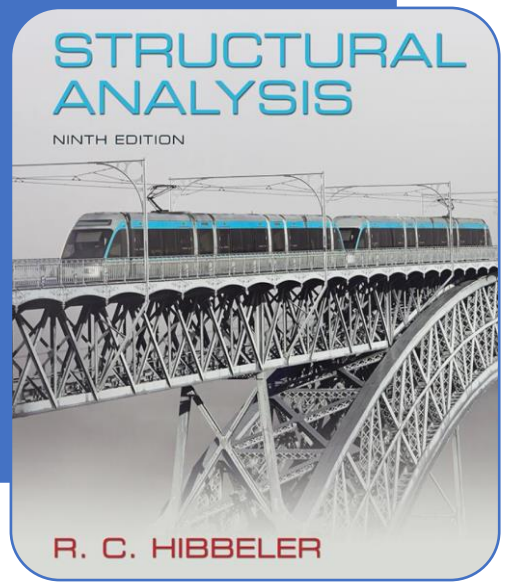
- Elastic-plastic behaviour of structural systems.
- Principle of superposition. General collapse conditions.
- Determination of collapse load: lower limit theorem; upper limit theorem.
- Elementary mechanisms

8 Introduction to Approximate Methods of Analysis

- Indeterminate trusses, Single portals and mill bents, laterally loaded rigid frames (Portal and Cantilever methods), vertically loaded Rigid frames

- Time: 4 hours of lectures + 3 hours of tutorial or lab per week
- Assessment:
  - Continuous Assessment
    - Assignments: 20%
    - Test: 20%
  - Final Examination: 60%

Prescribed Books and Software of Structural analysis



Software:
PROKON

Recommended Reading

- **"Matrix Methods of Structural Analysis" by P. Pandit and S. Gupta**
  - This book focuses on matrix methods of structural analysis, including stiffness method and flexibility method. It provides detailed explanations of matrix formulations and solution techniques.
- **"Structural Analysis: Principles, Methods, and Modelling" by Iain A. MacLeod**
  - This textbook offers a modern approach to structural analysis, emphasizing the principles and methods of analysis using mathematical modeling. It covers both classical and matrix-based methods, as well as computer-aided analysis.
- **"Structural Analysis" by Aslam Kassimali**
  - This book provides a comprehensive treatment of structural analysis, covering both static and dynamic analysis of structures. It includes numerous examples, illustrations, and practical applications.

Recommended Reading

- **"Fundamentals of Structural Analysis" by Harry H. West and Louis F. Geschwindner**
  - This textbook offers a fundamental understanding of structural analysis, focusing on the principles and methods of analyzing determinate and indeterminate structures. It includes step-by-step solution procedures and illustrative examples.
- **"Structural Analysis: A Unified Classical and Matrix Approach" by Amin Ghali, Adam Neville, and Tom G. Brown**
  - This book presents a unified approach to structural analysis, integrating classical methods with matrix-based techniques. It covers both determinate and indeterminate structures and includes numerous solved examples and exercises.
- **"Structural Analysis" by Alan Williams**
  - This textbook provides a comprehensive introduction to structural analysis, covering both classical methods and matrix-based methods. It includes practical applications, design considerations, and computer applications.