CV4101 Structural Analysis III

Academic Year	2023-24	Semester	1
Course Coordinator			
Course Type	Major Prescribed Elective		
Pre-requisites	CV2012 Structural Analysis II		
AU	3		
Grading	Letter Grading		
Contact Hours	39 (26 hours Lecture; 13 hours Tutorial)		
Proposal Date	9 February 2023		

Course Aims

This course aims to equip students with the theory and applications of structural stability analysis.

Intended Learning Outcomes (ILO)

By the end of this course, student will be able to:

1. Construct stiffness matrix and force vectors for trusses, beams and frames.
2. Apply unit displacement method to solve trusses, beams and frames.
3. Analyse stability of simple struts (ideal struts and real struts) using differential equation approach and relate structural stability with EC3.
4. Analyse stability of beam-columns and frames using matrix approach.
5. Understand elastic-plastic stress-strain relationship and plastic bending without axial force.
6. Quantify effect of axial load and shear force on plastic moment
7. Understand collapse loads, collapse mechanisms and combination of mechanisms and apply them for analysis
8. Apply fundamental theorems of plastic collapse for plastic analysis of RC frames and steel frames

Course Content

No	Topic	Lecture (Hour)	Tutorial (Hour)
1	Review of stiffness matrix method. Unit displacement method	4	2
2	Structural stability with EC3. Elastic stability analysis of simple ideal and real struts	6	3
3	Elastic stability analysis of frames	3	2
4	Elastic-plastic stress-strain relationship and plastic bending without axial force. Effect of axial load and shear force on plastic moment	4	2
5	Collapse loads, collapse mechanisms and combination of mechanisms	5	2

6	Fundamental theorems of plastic collapse and their applications in frames.	4	2
	Total	**26**	**13**

Assessment (Includes both continuous and summative assessment)

Component	ILO Tested	EAB Graduate Attributes	Weightage	Team / Individual	Rubrics
1. CA1: Quiz 1	1,2,3	CEE SLOs a, b	20%	Individual	N.A.
2. CA2: Quiz 2	5,6,7	CEE SLOs a, b	20%	Individual	N.A.
3. Final Examination	1, 2, 3, 4,5,6,7,8	CEE SLOs a, b	60%	Individual	N.A.
Total			**100%**		

EAB Graduate Attributes[1]	
a)	**Engineering Knowledge** Apply the knowledge of mathematics, natural science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
b)	**Problem Analysis** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c)	**Design / Development of Solutions** Design solutions for complex engineering problems and design systems, components or processes that meet the specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
d)	**Investigation** Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e)	**Modern Tool Usage** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f)	**The Engineer and Society** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g)	**Environment and Sustainability** Understand the impact of the professional engineering solutions in societal and

[1] *Reference: EAB Accreditation Manual*

	environmental contexts, and demonstrate the knowledge of, and need for the sustainable development.
h)	**Ethics** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i)	**Individual and Team Work** Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
j)	**Communication** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k)	**Project Management and Finance** Demonstrate knowledge and understanding of the engineering management principles and economic decision-making, and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l)	**Life-long Learning** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Formative Feedback

1. Feedback will be through the dissemination of the student's performance in quizzes as well as review of the quiz questions in class.

2. Instructors encourage students to ask questions during the tutorials and lectures.

Learning & Teaching Approach

Approach	How does this approach support students in achieving the learning outcomes?
Lectures	Present the basic theory, problem solving process, and problem based procedure.
Tutorials	Provide examples and discussions, to illustrate detailed problem solving process.

Readings & References

Textbooks

1. Coates, R.C., Coutie, M.G. and Kong, F.K., "Structural Analysis". 3rd edition, Chapman and Hall, 1988.

2. McGuire, W., Gallagher, R.H. and Ziemian, R.D., "Matrix Structural Analysis". 2nd edition, John Wiley and Sons, 2000.

3. M.R. Horne, Plastic Theory of Structures, 2nd edition, Pergamon Textbook

References

1. Kassimali, A. “Matrix Analysis of Structures”. Cengage Learning, 2012

2. Chen, W.F. and Lui, E.M. “Structural Stability: Theory Implementation”. Elsevier, 1987.

3. B.G. Neal, The Plastic Methods of Structural Analysis, 3rd edition. Science Paperbacks

Course Policy & Student Responsibility

Students are expected to attend all classes punctually and take all scheduled assignments. Students are expected to take responsibility to follow up with course notes, assignments and course-related announcements for sessions they have missed. Students are expected to participate in all discussions and activities.

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU’s shared values.

As a student, it is important that you recognise your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain about the definitions of any of these terms, you should refer to the Academic Integrity Handbook for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

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Planned Weekly Schedule

Week	Topic	Course ILO	Readings /Activities
1	Introduction to the course. Review of stiffness matrix method for structural analysis. Unit displacement method.	1,2	Lectures & Tutorial
2	Unit displacement method	1, 2	Lectures & Tutorial
3	Introduction of elastic stability; Euler bucking load. Simple struts and effective buckling length.	3	Lectures & Tutorial
4	Differential equation method for beam-columns (ideal and real). Relate real struts to Perry-Robertson equation in EC3.	3	Lectures & Tutorial
5	Stability effects on beam-columns, Stability functions (s, c functions) Discussion of s,c, functions, Stiffness matrix incorporating s,c, functions.	3,4	Lectures & Tutorial
6	Computing critical load using matrix approach, Elastic stability of plane frames.	1,2,4	Lectures & Tutorial
7	Computing critical load using matrix approach, Elastic stability of plane frames. Elastic-plastic stress-strain relationship	1,2,4,5	Lectures & Tutorial
8	Plastic bending without axial force	5	
9	Effect of axial load and shear force on plastic moment resistance. Collapse loads, collapse mechanisms and combination of mechanisms for continuous beams.	5,6	Lectures & Tutorial
10	Collapse loads, collapse mechanisms and combination of mechanisms for rigid-jointed frames.	7,8	Lectures & Tutorial
11	Collapse loads, collapse mechanisms and combination of mechanisms for rigid-jointed frames.	7,8	Lectures & Tutorial
12	Fundamental theorems of plastic collapse.	5, 6,7,8	Lectures & Tutorial
13	Application of plastic collapse in RC frames and steel frames. Comparison of frames using different methods.	1,2,3,4,5, 6,7,8	Lectures & Tutorial