

The Hong Kong University of Science and Technology

UG Course Syllabus

[Course Title] Computer Methods of Structural Analysis

[Course Code] CIVL4370

[No. of Credits] 3

[Any pre-/co-requisites] CIVL 3310

Name: Xiao PAN

Email: cexiaopan@ust.hk

Office Hours: [Thursday 14:30 am - 16:30 pm; RM2455]

Course Description

Computer methods are of fundamental importance for modern structural analysis. The purpose of this course is, on one hand, to present the stiffness method for matrix structural analysis, which provides an introduction to the finite element method. On the other hand, the course also illustrates how these tools are realized in structural analysis software. The focus is on planar and spatial trusses, continuous beams, planar and spatial frames, with a brief discussion on grid and shell structures. This course is on intermediate level, which aims to provide future structural engineers with the tools to analyse realistic civil engineering structures. Moreover, the course provides an opportunity for the students to build an intuition for structural behaviour under static and dynamical loading.

Intended Learning Outcomes (ILOs)

On successful completion of this course, students are expected to be able to:

ILO-1. Idealize a civil engineering structure into a mechanical model (suitable for structural analysis)

ILO-2. Form the stiffness and loading matrices of an idealized structure, with a focus on building and bridge structures.

ILO-3. Perform a matrix structural analysis of an idealized structure with the help of mathematical software.

ILO-4. Simulate and analyse a realistic civil engineering structure using a (commercially available) structural analysis software

Assessment and Grading

This course will be assessed using criterion-referencing and grades will not be assigned using a curve. Detailed rubrics for each assignment are provided below, outlining the criteria used for evaluation.

Assessments:

Assessment Task	Contribution to Overall Course grade (%)	Due date (tentative)
Attendance/quizzes	5%	-
Assignment 1	10%	29/09/2026
Assignment 2	10%	27/10/2026
Assignment 3	10%	26/11/2026
Mid-term exam	25%	29/10/2026
Final exam	40%	tbd

Mapping of Course ILOs to Assessment Tasks

Assessed Task	Mapped ILOs	Explanation
In-class Q&A and quizzes about the fundamental knowledge and engineering principles	ILO-1, ILO-2, ILO-3	Review and consolidate fundamental knowledge and principles in mathematics and engineering science required for this course, such as the stiffness method, 1D/2D trusses, 1D beams, 2D frames, and boundary conditions. Learn to establish the stiffness matrix for 1D/2D/3D structures, and solve the system of equations with releases, rigid offsets, symmetries, initial/thermal strains, multi-DOF-constraints, center of rotation, etc. Recognize more advanced finite element methods not covered in this course, and what future courses can be taken to address these topics.
Hand calculation practice through Assignment 1, Assignment 2, Assignment 3, and Assignment 4.	ILO-1, ILO-2, ILO-3, ILO-4	Acquire an ability to apply engineering philosophies and principles to establish stiffness matrix methods and solve equilibrium equations for trusses and frames by hands. Learn to use professional computer programs or engineering software such as Python, Matlab, and SAP 2000, to implement the theory knowledge with computers efficiently and validate the hand calculation results.
Integrated problem-solving in mid-term and final exam.	ILO-1, ILO-2, ILO-3	Develop an integrated ability to identify and formulate structural systems, and propose feasible hand-based solutions with an appreciation of their underlying assumptions and constraints. Develop technical competency and solid foundation to study future courses on more advanced structural analysis.

Grading Rubrics

[Detailed rubrics for each assignment will be provided. These rubrics clearly outline the criteria used for evaluation. Students can refer to these rubrics to understand how their work will be assessed.]

Ratings Components	Exemplary (5)	Competent (3)	Needs Work (1)
Define the problem: Idealize a civil engineering structure into a mechanical model (suitable for structural analysis)	Understands completely the applicability and the limitations of the key modeling assumptions and idealizes correctly a civil engineering structure into a mechanical model. Is able to choose the most appropriate finite elements for the problem at hand.	Understands partially the key modeling assumptions of matrix structural analysis and idealizes a civil engineering structure into a mechanical model correctly if the structure is not complex.	Does not understand the key modeling assumptions of matrix structural analysis and cannot idealize a civil engineering structure into a mechanical model correctly.
Solve the problem: Derive the stiffness and loading matrices of a structure	Shows competency in deriving the stiffness and loading matrices of a mechanical model. Can minimize the size of the problem (e.g., choosing the minimum number of required degrees of freedoms). Can extend the tools of matrix structural analysis to non-conventional structures.	Is able to derive the stiffness and loading matrices of a mechanical model with some difficulty.	Is not able to derive the stiffness and loading matrices of a mechanical model.
Solve the problem: Conduct structural analysis using structural analysis or mathematical software	Is able to conduct structural analysis using either structural analysis software or mathematical software, correctly and timely.	Is able to conduct structural analysis using structural analysis software correctly.	Is not able to conduct structural analysis using either structural analysis software or mathematical software.
Assess the procedure: Outcome prediction and evaluation	Shows a deep understanding of the static or dynamic behavior of a civil engineering structure (building or bridge). Can estimate a priori qualitatively the response and the order of magnitude of the critical magnitudes (e.g. bending moments). Tests for errors in reasoning or calculation, using physical arguments.	Understands partially the static or dynamic behavior of a civil engineering structure (building or bridge). Estimates a priori qualitatively the response and the order of magnitude of the critical magnitudes (e.g. bending moments) with minor errors. Tests for errors in reasoning or calculation.	Does not understand the static or dynamic behavior of a civil engineering structure (building or bridge). Cannot estimate a priori qualitatively the response and the order of magnitude of the critical magnitudes (e.g. bending moments). Does not test for errors in reasoning or calculation.

Final Grade Descriptors:

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	Demonstrates a comprehensive grasp of subject matter, expertise in problem-solving, and significant creativity in thinking. Exhibits a high capacity for scholarship and collaboration, going beyond core requirements to achieve learning goals.
B	Good Performance	Shows good knowledge and understanding of the main subject matter, competence in problem-solving, and the ability to analyze and evaluate issues. Displays high motivation to learn and the ability to work effectively with others.
C	Satisfactory Performance	Possesses adequate knowledge of core subject matter, competence in dealing with familiar problems, and some capacity

		for analysis and critical thinking. Shows persistence and effort to achieve broadly defined learning goals.
D	Marginal Pass	Has threshold knowledge of core subject matter, potential to achieve key professional skills, and the ability to make basic judgments. Benefits from the course and has the potential to develop in the discipline.
F	Fail	Demonstrates insufficient understanding of the subject matter and lacks the necessary problem-solving skills. Shows limited ability to think critically or analytically and exhibits minimal effort towards achieving learning goals. Does not meet the threshold requirements for professional practice or development in the discipline.

Course AI Policy

Students may use generative artificial intelligence tools to assist the learning process, such as lecture comprehension and practice of additional problem sets beyond the lecture content. However, the students are required to develop the ability to independently solve problems given in lectures and assignments without the use of generative artificial intelligence tools.

Communication and Feedback

Assessment marks for individual assessed tasks will be communicated via Canvas within two weeks of submission. Students who have further questions about the graded marks should consult the instructor and TAs within five working days after the feedback is received.

Resubmission Policy

N/A

Required Texts and Materials

Lewis P. Felton & Richard B. Nelson, Matrix Structural Analysis, John Wiley & Sons, 1997.

Aslam Kassimali, "Matrix Analysis of Structures, 2nd Edition", Cengage Learning, 2012.

W. McGuire, R. H. Gallagher & Ronald D. Ziemian, Matrix Structural Analysis, 2nd Edition, John Wiley & Sons, 2000.

Academic Integrity

Students are expected to adhere to the university's academic integrity policy. Students are expected to uphold HKUST's Academic Honor Code and to maintain the highest standards of academic integrity. The University has zero tolerance of academic misconduct. Please refer to [Academic Integrity | HKUST – Academic Registry](#) for the University's definition of plagiarism and ways to avoid cheating and plagiarism.