MODULE DESCRIPTION FORM

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

CL510 Advanced Structural Analysis and Design

Module Registrar: Dr. O.I.Bylya	**Taught To (Course): SAE, CE, CEE, MSc in Civil Eng.**		
Other Lecturers Involved: Mr. Bhaskaran Krishnamurthy (Teaching Assistant)	**Credit Weighting: 10**	**Semester: 1**	
Assumed Prerequisites: - knowledge of Matlab (or any other codding) or a strong willingness to learn it - Structural Analysis or Mechanics of Solids - Engineering Mathematics - English B2	**Compulsory/ optional**	**Academic Level: 5**	**Suitable for Exchange: Y**

Module Format and Delivery (HOURS i.e. 1 credit = 10hrs of study):

Lecture	Tutorial	Laboratory	Groupwork	External	Online	Project	Assignments	Private Study	**Total**
20	6	14					30	30	100

Educational Aim

This module aims to introduce the students to the Matrix stiffness method (MSM) - a powerful modern method of analysis that forms the basis of Finite Element (FE) modelling of any sophisticated 2D and 3D engineering structures and provides an ability to take into account the different features of structures and loading. This part of the course will be complemented by practical coursework aimed to develop the basic skills for analytical and FE structural modelling. Besides this, one special topic of advanced structural analysis will be covered, i.e., Plastic behaviour of the structures. The purpose of this part of the course is to bring students closer to real-life problems, which they may face in their professional carrier.

Learning Outcomes

On completion of the module the student is expected to be able to

LO1 Understand the basic concepts and approaches of the Matrix Stiffness Method and use it for the analysis of statically indeterminate structures.

LO2 Use Matlab software for the computational analysis of the structures using Matrix Stiffness Method.

LO3 Analyse inelastic behaviour of the structures.

LO4 Use Matlab software for the basic optimisation of elementary structures.

Syllabus

The module will teach the following:

Matrix Stiffness Method (MSM)

Basic Idea and Concepts
Discretisation of the structure
Stiffness Matrices of basic 1D and 2D elements
Generation of the General Stiffness Matrix of the total Structure
Utilisation of the Boundary Conditions for obtaining two basic equations (for unknown displacements and forces)
Analysis of the obtained solution
Optimisation of design.

Plastic Behaviour of Structures

Plastic behaviour of different materials
Idealized Stress–Strain Diagrams
Direct Method of Plastic Analysis
Fundamental Methods of Plastic Analysis
Limit Plastic Analysis of Continuous Beams

Finite Element (FE) Analysis of the Structures

Basic Concepts of FE analysis
Development of a computational code for the MSM in Matlab
Solution of statically indeterminate 1D and 2D structures.

Basics of Computational optimisation of the Structures

Development of a computational code for the basic optimisation of structures in Matlab

Assessment of Learning Outcomes

Criteria

For each of the Module Learning Outcomes the following criteria will be used to make judgements on student learning:

LO1 Ability to understand basic concepts and approaches of the Matrix Stiffness Method and use it for the analysis of the statically indeterminate structures.
C1 Be able to construct the stiffness matrix for the compound beam, truss and frame analytically
C2 Be able to use Boundary Conditions for obtaining two basic equations (for unknown displacements and forces)
C3 Be able to formulate and solve the simplest structural problems in matrix form.

LO2 Ability to use Matlab software for the computational analysis of the structures using Matrix Stiffness Method.
C1 Be able to write a Matlab code generating the General stiffness matrix for basic 1D and 2D structures.
C2 Be able to write a Matlab code utilising Boundary conditions for solving the problem and finding nodal displacements, reactions and stresses in the members of a structure
C3 Be able to write a Matlab code for the graphical representation of the obtained solution.

LO3 Ability to analyse inelastic behaviour of the structures
C1 Be able to explain the principle difference between elastic and inelastic behaviour of basic structural materials and structures and understand the main aims of plastic analysis.
C2 Be able to use the three main methods of plastic analysis (Direct, Kinematic and Static)
C3 Be able to perform plastic analysis of a multi-span beam and predict it's collapse scenario.

LO4 Ability to use Matlab software for the basic optimisation of elementary structures.
C1 Be able to write a Matlab code for finding the shortfalls of a structure (in strength and stiffness)
C2 Be able to write a Matlab code generating the options for the basic optimisation of a structure.
C3 Be able to write a Matlab code for the graphical comparison of the original and optimized design

The standards set for each criterion per Module Learning Outcome to achieve a pass grade are indicated on the assessment sheet for all assessment.

Principles of Assessment and Feedback

(within Assessment and Feedback Policy at:
*https://www.strath.ac.uk/staff/policies/academic/*http://www.strath.ac.uk/learnteach/informationforstaff/staff/assessfeedback/12principles/ *)*

1. The marking criteria are outlined clearly in the assignment hand-out and multiple opportunities for clarifying doubts are available, either in class or through electronic correspondence. Finalisation of each coursework will be done on the basis of verbal discussion (1:1 or in mini-groups).

2. The coursework encourages interaction between peer groups and with the instructor.

3. Tutorial questions are provided to support in student self-assessment and reflection.

4. The departmental policy is to carry out mid-term class assessments and provide feedback to students.

Assessment Method(s) Including Percentage Breakdown and Duration of Exams

	Examinations				Courseworks		Projects	
	Number	Month(s)	Duration	***Weighting***	Number	***Weighting***	Number	***Weighting***
			2 hours	40%	CW1	5%		
					CW2	10%		
					CW3	10%		
					CW4	10%		
					CW5	10%		
					CW6	5%		
					CP	10 %		
L/Outcomes	LO1, LO3				LO1, LO2, LO3, LO4			

Indicate which learning outcomes (L01, L02 etc) are to be assessed by exam/coursework/project as required.

Coursework / Submissions deadlines (*academic weeks*):
CW 1 week 3
CW 2 week 5
CW 3 week 6
CW 4 week 8
CW 5 week 9
CW 6 week 11
CP - Class Performance – no deadline, the marks are given for attendance and active participation (answering questions, participation in discussions) during online class sessions

Resit Assessment Procedures:

2 hr examination in August diet

PLEASE NOTE:
Students must gain a summative mark of 50% to pass the module. Students who fail the module at the first attempt will be re-examined during the August diet. This re-examination will consist entirely of exam. No marks from any previous attempts will be transferred to a new resit attempt.

Recommended Reading

*****Purchase recommended **Highly recommended reading *For reference**

** Advanced Structural Analysis, Devdas Menon, Alpha Science International, UK 2009

** Advanced Methods of Structural Analysis, Igor A. Karnovsky, Olga Lebed, Springer New York Dordrecht Heidelberg London, ISBN 978-1-4419-1046-2 e-ISBN 978-1-4419-1047-9 DOI 10.1007/978-1-4419-1047-9

** Getting Started with Matlab: A Quick Introduction for Scientists and Engineers, Rudra Pratap, Oxford series

* Structural analysis, R. C. Hibbeler, 8th ed.. Boston : Prentice Hall 2012

Additional Student Feedback
(Please specify details of when additional feedback will be provided)

Date	Time	Room No
Week 5	TBC	TBC

Session: Session: mid-term oral feedback.

Approved:

Course Director Signature: Olga Bylya

Date of Last Modifications: 31.08.2022

(Updated May 2018)

MODULE TIMETABLE

Module Code:	**CL510**	**Module Title:**	**Advanced Structural Analysis and Design**

Brief Description of Assessment:

- Coursework (CW) - 50% (CW1 - 5%, CW2 -10%, CW3 -10%, CW4 -10%, CW5 -10%, CW6 -5%)
- Class Performance (CP) -10 %
- Examination – 50%

Assessment Timing:-

Indicate on the table below the start/submission dates for each assignment/project and the timing of each exam/assessment using the dropdowns provided. Dropdowns can be left blank. Add extra notes below the dropdowns.

Please note: Timings can and will change, this should only be used as a guide.

Semester One	W&D Wk	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	Exam Period
	None None	Project Set Lab	Lab None	Course work Submit Lab	Project Set Lab	Course work Submit Project Set	Course work Submit Lab	Course work Set Lab	Course work Submit Course work Set	Course work Submit Lab	Course work Set Lab	Course work Submit Lab	Exam
