DSGN C3502: Structural Design and Analysis I

Module Title:	Structural Design and Analysis I
Credits:	10
NFQ Level:	8
Module Delivered In	1 programme(s)
Teaching & Learning Strategies:	Lectures, Practicals, Projects
Module Aim:	1) To develop an understanding of the stress and strain behaviour of elastic and elastoplastic materials under axial, flexural and torsional loads. (2) To develop the skills required to analyse the force distributions on encastré and continuous beams and statically indeterminate plane trusses. (3) To develop an understanding of behaviour of struts (4) To introduce the concepts of real work, virtual work and strain energy and apply them to finding deflections and analysing statically indeterminate beams and trusses. (5) to extend the learner's knowledge of the application of structural loads; (6) to enable the learner's to design reinforced elements (7) to enable the learners to design steel beams, columns and trusses; (8) to enable the learners to use computer applications in structural design. 9) To understand the implications of long and short term sustainability of selecting a particular material , construction type and method with a view to sustainability

Learning Outcomes	
On successful completion of this module the learner should be able to:	
LO1	Calculate the deflection curve equation and analyse the distribution of shear force and bending moment on statically determinate and indeterminate single span beams using Macauly's method
LO2	Explain the concepts of real work and strain energy and apply Castigliano's theorems to simply beam analysis problems. To apply the method of Virtual Work to calculate deflections and forces in beams and pin jointed structures and resolve forces in statically indeterminate beams and trusses
LO3	Apply stress and strain transformation equations and calculate principle stresses and strains
LO4	To explain the concept of buckling of struts and derive the Euler buckling formula for struts with pinned and encastré ends and to apply these
LO5	To calculate the distribution of shear force and bending moment in continuous beams using the Slope Deflection method and the Moment Distribution method.
LO6	Apply loads to structural elements in accordance with the relevant National and European design standards
LO7	Describe and design structural elements in steelwork in accordance with the relevant National and European design standards
LO8	Use appropriate software tools to analysis and design structural elements to the relevant National and European design standards.
LO9	Describe and design structural elements in reinforced concrete in accordance with the relevant National and European design standards.
LO10	To understand the implications of long and short term sustainability (construction and long term carbon footprint) when selecting a particular material and construction type and method, and the long term implications of construction maintenance.

Pre-requisite learning
Module Recommendations *This is prior learning (or a practical skill) that is recommended before enrolment in this module.*
No recommendations listed
Incompatible Modules *These are modules which have learning outcomes that are too similar to the learning outcomes of this module.*
No incompatible modules listed
Co-requisite Modules
No Co-requisite modules listed
Requirements *This is prior learning (or a practical skill) that is mandatory before enrolment in this module is allowed.*
No requirements listed

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Module Content & Assessment

Indicative Content
Mechanics of Solid - Compound Stresses (i) Superpositions (ii) Combined axial and flexural stresses (iii) The Dam problem (iv) Unsymmetrical bending
Mechanics of Solids - Plane Stress and Strain (i) Equations for the transformation of plane stress and plane strain (ii) Principle stresses and strains (iii) Maximum shearing stress and strain (iv) Mohr's circle of stresses and strain (v) Strain measurements rosettes (vi) Relationship between E, G and u
Mechanics of Solids - Buckling and Related Topics (i) Euler buckling theory of struts (ii) Real behaviour of Struts 1. Initial curvature 2. Eccentric loadings 3. Allowable stress in steel struts- Perry- Robertson formula (iii) The secant formula (iv) Southwell Plot
Structural Analysis - Energy Methods (i) Definition of work and energy in structures (ii) Strain energy and strain energy theorems (Castigliano)
Structural Analysis - Virtual Work / Force Method of Analysis (i) Definition of Virtual Work (ii) Application - Unit load method for deflections - Truss, cantilever, SS beam (iii) Forces in statically indeterminate structures - beams, trusses.
Structural Analysis - Stiffness (i) Stiffness Influence coefficients (ii) Member stiffness and flexibility equations (iii) Transformation of axes (iv) Slope deflection method - continuous beams
Structural Analysis - Introduction to Moment Distribution (i) Terminology, sign convention, theory (ii) Application of moment distribution method to continuous beams
Structures Laboratory (i) Stress Strain plot for steel bar to failure. (ii) Deflection plot for simply supported beam, cantilever and continuous beams (iii) Strain measurements on beam using electronic rosettes (iv) Behaviour of struts (v) Modulus of Rigidity (vi) Law of the Lever
Structural Design - Introduction to Structural Design a) Irish standards b) British standards c) European standards d) Ultimate limit state e) Serviceability limit state f) Characteristic loads g) Design loads h) Load combinations i) Design methods
Structural Design - Design of Reinforced Concrete Elements a) Singly reinforced rectangular section b) Doubly reinforced rectangular section c) Flanged sections d) Minimum and maximum areas of reinforcement e) Cover requirements for durability and fire f) Analysis of continuous members g) Moments redistribution h) Tension reinforcement and curtailment i) Shear reinforcement j) Deflection k) One way and two way spanning reinforced concrete slabs l) Reinforced concrete columns
Structural Design - Design of Structural Steelwork Elements a) Types of steel structures b) Material properties c) Steel sections, dimensions and properties d) Classification of sections e) Moment and shear resistance f) Deflection g) Design of Restrained and unrestrained beams h) Design of tension members i) Design of compression members j) Use and types of steel trusses k) Design of steel trusses l) Simple connections in structural steelwork m) Beam to column connections n) Beam to beam connections
Structural Design - Use of Computers in Structural Design a) Computer packages available b) Reinforced concrete design using a computer package c) Structural steel design using a computer package

Assessment Breakdown	%
Continuous Assessment	50.00%
Project	5.00%
Practical	10.00%
End of Module Formal Examination	35.00%

Continuous Assessment

Assessment Type	*Assessment Description*	*Outcome addressed*	*% of total*	*Assessment Date*
Other	n/a	6,7,8	50.00	n/a

Project

Assessment Type	*Assessment Description*	*Outcome addressed*	*% of total*	*Assessment Date*
Project	Report on a structure	1,2,3,4,5,9,10	5.00	n/a

Practical

Assessment Type	*Assessment Description*	*Outcome addressed*	*% of total*	*Assessment Date*
Practical/Skills Evaluation	3 lab sessions of 2 hours to carry out 6 no experiments.	1,4	10.00	n/a

End of Module Formal Examination				
Assessment Type	*Assessment Description*	*Outcome addressed*	*% of total*	*Assessment Date*
Formal Exam	n/a	1,2,3,4,5	35.00	End-of-Semester

SETU Carlow Campus reserves the right to alter the nature and timings of assessment

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Module Workload

Workload: Full Time		
Workload Type	*Frequency*	*Average Weekly Learner Workload*
Lecture	Every Week	8.00
Independent Learning	Every Week	10.00
	Total Hours	18.00

Module Delivered In

Programme Code	Programme	Semester	Delivery
CW_CMHCE_B	Bachelor of Engineering (Honours) in Civil Engineering	6	Mandatory