Wrexham glyndŵr UNIVERSITY

MODULE SPECIFICATION

Module Title:	**Structures Analysis**	**Level**:	5	**Credit Value**:	20

Module code:	ENG52J	**Is this a new module?**	yes	**Code of module being replaced**:	ENG552

Cost Centre:	GAME	**JACS3 code**:	H142

Trimester(s) in which to be offered:	1, 2	**With effect from:**	September 17

School:	Applied Science, Computing & Engineering	**Module Leader:**	Dr. Olaf Niestroj

Scheduled learning and teaching hours	60 hrs
Guided independent study	140 hrs
Placement	0 hrs
Module duration (total hours)	200 hrs

Programme(s) in which to be offered	Core	Option
BEng (Hons) Aeronautical & Mechanical Engineering	✓	
BEng (Hons) Mechanical Manufacturing	✓	
BEng (Hons) Applied Product Design	✓	
BEng (Hons) Automotive Engineering	✓	
BEng (Hons) Renewable and Sustainable Engineering	✓	
BEng (Hons) Aerospace and Modern Optics	✓	

Pre-requisites
None

Office use only

Initial approval February 17

APSC approval of modification — Version 1

Have any derogations received Academic Board approval? — Yes ✓ No ☐

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Module Aims
To support the development of the student in the following areas: • To develop an understanding and an overall appreciation of the processes that lead to developing an appropriate structure to satisfy given requirements. Design considerations include the assessment: of bucking of struts in structures with various end conditions; of beams deriving equations relating to the Engineer's Theory of Bending and also bending in symmetric and asymmetric structures; leading on to the consideration of shear stress distributions in beams and introducing the concept of shear flows; • Develop the theory of linear elastic fracture mechanics along with concepts of plane stress and plane strain at the crack-tip; • To develop an understanding of fast fracture leading onto fatigue with S/N diagrams and crack growth laws to determine component life are considered; • To gain a basic theoretical and practical understanding of the technique of finite elements with knowledge of how to apply the technique to simple problems.

Intended Learning Outcomes

Key skills for employability

KS1	Written, oral and media communication skills
KS2	Leadership, team working and networking skills
KS3	Opportunity, creativity and problem solving skills
KS4	Information technology skills and digital literacy
KS5	Information management skills
KS6	Research skills
KS7	Intercultural and sustainability skills
KS8	Career management skills
KS9	Learning to learn (managing personal and professional development, self-management)
KS10	Numeracy

At the end of this module, students will be able to		Key Skills	
1	Relate an overall design philosophy to the design of structures	KS1	KS4
		KS10	KS6
2	Use a range of analysis techniques, namely: buckling analysis on simple struts, E.T.B. on symmetric and asymmetric structures, flexural and shear stress distributions on beams subjected to combinations of loads	KS3	
		KS9	
		KS10	

3	Ascertain where failure might occur, including the conditions that might produce the failure and evaluate the relevance of results	KS3	
		KS6	KS5
4	Simulate with an appropriately specified finite element model a very simple structure and be able to interpret the results. An appreciation of whether the model offers a converged solution should be gained	KS1	
		KS4	
		KS6	
		KS9	

Derogations

A derogation from regulations has been approved for this programme which means that whilst the pass mark is 40% overall, each element of assessment (where there is more than one assessment) requires a minimum mark of 30%.

Assessment:

Assessment One: is an examination covering outcomes 1 to 3. It is an unseen time-constrained examination.
Assessment Two: is by means of a written assignment covering outcome 4.

Assessment number	Learning Outcomes to be met	Type of assessment	Weighting (%)	Duration (if exam)	Word count (or equivalent if appropriate)
1	1,2,3	Examination	60	2hrs	
2	4	Report	40		2000

Learning and Teaching Strategies:

Detailed printed lecture notes provided for the student will allow the optimisation of lecture time, with good opportunity for self-study and tutorials. The module will also contain practical laboratory based exercises supported by introductory lectures and demonstrations.
The finite element work will be primarily computer laboratory based with practical exercises supported by introductory lectures and demonstrations. The emphasis will be directed towards on hand-on learning via a commercial software package. It is probable that a problem-based learning exercise will provide the basis for Assessment One.

Syllabus outline:

- **Structural Instability:** Classical theory considering Euler buckling of perfect columns. Equations giving theoretical critical buckling loads for given end conditions. The concept of equivalent strut length. Limitations of the theory of Euler buckling.
- **Engineers Theory of Bending:** Formal derivation and assumptions of equations of ETB are made with a revision of the concepts of 1^{st}, 2^{nd} moments of area, including parallel axis theorem. The concept of product moment of area is introduced. ETB is extended to the derivation of the curvature-bending moment relationship.
- **Asymmetric Bending:** The theory and method of identifying the location of the principal axes of an unsymmetrical section. Magnitude of the principal and product moments of
    - area and their orientation. Skew loading applied to the section and the position/orientation of the neutral axes. Stresses within a section.
- **Shear Stress**: The shear stress distribution due to bending for a given section. Thin-walled sections. Position of the shear centre for open thin-walled sections. The concept of shear flow.
- **Fatigue:** The concept of a Griffith crack and Linear Elastic Fracture Mechanics. Fast fracture, strain energy release rate, stress intensity factors. Conditions of plane stress and plane strain at the crack tip. Crack growth laws such as Paris and their use in crack growth rate predictions.
- **Finite Element Analysis:** Introductory lecture(s) into the technique of finite elements. An initial experience with proprietary finite element software package such as ANSYS and its use to solve (a) simple problem(s).

Bibliography:

Essential reading

Case, J. Et al. (1999) *Strength of Materials and Structures*, 4^{th} ed., London: Arnold

Hibbeler, R.C. (2014) Mechanics of Materials, 9^{th} ed., Singapore: Pearson

Other indicative reading

Megson, T.H.G. (2013) *Aircraft Structures for Engineering Students*, 5^{th} ed., Boston: Elsevier

Ashby, M.F. (2011) *Materials Selection in Mechanical Design*, 4^{th} ed., Burlington: Butterworth-Heinemann

Zienkiewicz, O.C.,Taylor, R.L. (2013) *The Finite Element Method: Its Basis and Fundamentals*, 7^{th} ed., Amsterdam: Elsevier