UNIVERSITY OF WARWICK

Proposal Form for New or Revised Modules (MA1 - version 7 - April 2014)

Approval information	
Approval Type	☐ New module ☒ Revised module ☐ Discontinue module
Date of Introduction/Change	~~September 2015~~1 October 2017
If new, does this module replace another? If so, enter module code and title:	n/a
If revised/discontinued, please outline the rationale for the changes:	This module has been revised following the curriculum review.~~Some of the stress analysis material is now covered a year earlier in ES2B0; similarly, fracture modes and fatigue are covered in ES2B3. The scope of these topics in ES3C3 has therefore been broadened slightly to provide a little new material and to cover existing topics in slightly more depth.~~
Confirmation that affected departments have been consulted:	Changes were made in consultations between the School of Engineering and WMG.~~n/a~~

Module Summary	
1. Module Code (if known)	ES3C3
2. Module Title	Planar structures and mechanisms
3a. Lead department:	School of Engineering
3b. Teaching Split (if known):	100% School of Engineering.
4. Name of module leader	Dr ~~Roger Moss~~Petr Dennissenko
5. Level	UG: ☐ Level 4 (Certificate) ☐ Level 5 (Intermediate) ☒ Level 6 (Honours) PG: ☐ Level 7 (Masters) ☐ Level 8 (Doctoral) See Guidance Notes for relationship to years of study
6. Credit value(s) (CATS)	15
7. Principal Module Aims	All engineers accredited by the IMechE are expected to have a knowledge of stress analysis and an understanding of how stress,

Module Summary	
	strain and strength affect the design of structures. They should also be aware of the dynamical behaviour of some classical cases of mechanisms. This module addresses those requirements. The module lectures are split between two main themes. The first theme is the analysis of planar pin-jointed structures and mechanisms in terms of position, velocity and acceleration and matrix solutions of the equations of motion (geometry, kinematics and dynamics). The approach progresses from simple analysis to complex cases requiring computer modelling. The second set of lectures covers strength of materials topics in linear elasticity i.e. how stresses and strains in the material result from the imposed forces. These topics were introduced in year 2 (ES2B0); the effect of these stresses and strains is now investigated in a number of classical settings including beams, shafts, columns, disks and pressure vessels. Students are introduced to the physical properties of materials and failure criteria so that they can analyse simple systems by hand and choose suitable materials. In particular they are introduced to concepts such as strength, weight, and stiffness with a view to developing understanding to allow interpretation and assessment of computer models in more complicated cases.
8. Principal Learning Outcomes	By the end of the module the students should be able to: Model the behaviour of some common planar mechanisms and calculate the velocities, accelerations (kinematics) and forces (kinetics) associated with their motion. Understand how mechanism inertia can lead to shaking forces an calculate how to compensate for (balance) such forces (balance) i some important special cases (*e.g.,* reciprocating engines). Understand the terminology and rationale for using linea elastic theory and how to apply common formulations to analyse simple systems. Recognise the approximations inherent in linear elastic methods and be able to converse with specialists, e.g., on the use of finite element models. . Understand the cause and effects of stress concentrations. Choose between and apply some common (idealized) states of stress and strain and the typical failure criteria that arise from

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Module Summary	
	them, including von Mises' stresses. Assess material suitability in terms of application criteria. Predict the deflections, stresses, etc. under load and hence design simple cases for planar structural systems ~~including: Statically~~including: statically determinate and indeterminate pin-jointed frames; beams; simple assemblies of planar components; stability of struts; thermal expansion; stresses in pressure vessels and rotating discs. Predict rotation angles and stresses in shafts under torsion, including torques applied via gearing or pulley systems. ~~Understand the cause and effects of stress concentrations.~~
9. Timetabled Teaching Activities (summary)	30 lecture hours. 2 x 1 hr revision seminars.
10. Departmental Web-link	http://www2.warwick.ac.uk/fac/sci/eng/eso/modules/year3/es3c3/
11. Other essential notes	Advice and feedback hours are available for answering questions on the module ~~n/a~~
12. Assessment methods (summary)	Analysis assignment (20%) followed by a 3 hour examination (80%).

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For use by Strategic Planning and Analytics Office only - Do not fill in this section

Level	JACS3 Code	Teaching Split
		If not provided in 3b above

External Credit Level		Scheme	

Module Context

13. Please list all departments involved in the teaching of this module. If taught by more than one department, please indicate percentage split.

100% School of Engineering

14. Availability of module

Degree Code	Title	Study Year	C/OC/ A/B/C	Credits
H106	BEng Engineering	3	O	15
H107	MEng Engineering (plus variants)	3	O	15
H310	BEng Mechanical Engineering	3	Core	15
H311	MEng Mechanical Engineering (plus variants)	3	Core	15

15. Minimum number of registered students required for module to run

1 ~~– as a core module it will have to run if there are students on the route~~(core)

16. Pre- and Post-Requisite Modules

Pre-
ES2A9 Engineering Mathematics and Technical Computing (or equivalent that has the Matlab content)
ES2B0 Mechanics and Thermofluids

Module Content and Teaching

17. Teaching and Learning Activities *(totals for module – please see guidance)*

Module duration (weeks)	10
Lectures	30
Seminars	2 revision lectures.
Tutorials	0
Project Supervision	0
Demonstration	0
Practical Class/Workshops	0
Supervised time in studio/workshop	0
Fieldwork	0
External visits	0
Work based learning	0
Placement	0
Year abroad	0
Other activity	118hrs guided independent learning~~private study~~.

Module Content and Teaching		
18. Assessment Method (Standard)		
Type of assessment	**Length**	**% weighting**
Written Examinations	3 hours	80%
Practical Examinations	0 hours	0%
Assessed essays/coursework	Analysis assignment combining computer simulation, hand calculations and discussion	20%
18a. Final chronological assessment *(please see guidance)*	Examination (80%).	

19. Methods for providing feedback on assessment.

- Students receive both generic feedback and individual mark-up on their assignments;
- Student support through office hours;
- Worked examples in revision classes;
- Model solutions to some past paper questions.
- Cohort level feedback on examinations.

20. Outline Syllabus

The analysis of planar pin-jointed structures and mechanisms in terms of:

- Position
- Velocity
- Acceleration
- Matrix solutions of the equations of motion:
  - Geometry
  - Kinematics
  - Dynamics

(The approach progresses from simple analysis to complex cases requiring computer modelling.)

Strength of materials topics :

- Linear elasticity *i.e.* how stresses and strains in the material result from the imposed forces. (These topics were introduced in year 2 (ES2B0));
- the effect of these stresses and strains is investigated in a number of classical settings including :
  - beams
  - shafts
  - columns
  - discs
  - pressure vessels.
- Students are introduced to the physical properties of materials and failure criteria so that they can analyse simple systems by hand and choose suitable materials. In particular they are introduced to concepts such as strength, weight, and stiffness, with a view to developing understanding to allow interpretation and assessment of computer models in more complicated cases.

21. Illustrative Bibliography

Part 1 Structures and dynamics

- Theory of Machines and Mechanisms, Shigley, JE & Uicker, JJ, McGraw Hill 1995 [ES386,ES480 also] TJ145.S54
- Design of Machinery: an Introduction to the Synthesis and Analysis of Mechanisms and Machines, Norton, RL, McGraw Hill 1992, 1999, 2004, 2008, 2012, TJ175.N58
- Structural and Stress Analysis, Megson, THG, Butterworth-H. 2005, TA645.M43 and e-book

Shigley & Uicker is perhaps the best for analysis, but covers much more than we need. Norton is broadly similar and some may find it an easier read. Megson is good on frame statics.

- Dynamics of Mechanical Systems, Prentis JM, Wiley 1980 [Gear systems, inertial forces in mechanisms, engine balancing; also (not this module) vibrations], TJ170.P74
- An Introduction to the Mechanics of Machines, Morrison, JLM & Crossland, B, Longman 1970 (out of print) TJ170.M67
- Mechanics of Machines, Hannah, J & Stephens, RC, Edward Arnold 1984, TJ170.H38
- Lecture notes and supporting (revision) notes on ES3C3 web page.

Part 2 Strength of materials

- ~~(a)~~ Statics & Mechanics of Materials, Hibbeler RC, 4th edition ~~[includes structural analysis missing from (b)]~~ TA405.H48
- ~~(b) Mechanics of Materials, Hibbeler RC, 2nd edition [includes failure criteria missing from (a)] [many editions e.g. TA405.H47, QC135.H4]~~
- Strength of Materials and Structures, Case J, Chilver AH & Ross CTF, 4th edition, Arnold 1999, QC135.C2
- Mechanics of Materials, Gere JM, 5th edition Brookes Cole 2001, TA405.G47
- Megson, T. H. G. Structural and stress analysis, e-Book (2014)
- Sadd, Martin H. Elasticity. Theory, Applications, and Numerics, e-Book (2014)
- Kaw, Autar K. Mechanics of Composite Materials, e-Book (2006)
- Lecture notes on ES3C3 web page

Coursework:

- Coursework briefing sheet (ES3C3 web page)
- Coursework template (ES3C3 web page)
- Matlab: a Brief Guide for Project and Assignment Students, R.W.Moss 2014 (ES3C3 web page)

22. Learning outcomes

See table on page 6

Resources

23. List any additional requirements and indicate the outcome of any discussions about these.

~~(1) This module currently has no laboratory exercise.~~

Resources
~~The department should plan to allocate resources to develop and deliver at least one laboratory for this module. The Mechanical & Process stream will consider introduction of such a laboratory to the module for 2016/17.~~ ~~(2) The department should also ensure that students gain sufficient Matlab experience from previous modules to produce work of a professional standard in the ES3C3 assignment. This is currently met by the pre-requisite ES2A9.~~

Approval	
24. Module leader's signature	Dr Petr Denissenko~~Dr Roger Moss~~
25. Date of approval	Teaching Policy Committee Chair's Action 6 September 2017~~2 April 2015~~
26. Name of Approving Committee (include minute reference if applicable)	School of Engineering and WMG Teaching Policy Committee ~~School of Engineering Teaching Policy Committee. Approved by Chair's action 2 April 2015.~~
27. Chair of Committee's signature	Professor Gillian Cooke~~Dr David Dyer~~
28. Head of Department(s) signature	Professor David Towers~~Nigel Stocks~~

Examination Information		
A1. Name of examiner (if different from module leader)		
A2. Indicate all available methods of assessment in the table below		
% Examined	**% Assessed by other methods**	**Length of examination paper**
80%	20%	3 hours
A3. Will this module be examined together with any other module (sectioned paper)? If so, please give details below.		
No.		
A4. How many papers will the module be examined by?	☒ 1 paper	☐ 2 papers
A5. When would you wish the exam take place (e.g. Jan, April, Summer)?	**Summer**	
A6. Is reading time required?	☐ Yes	☒ No
A7. Please specify any special exam timetable arrangements.		
A8. Stationery requirements		
No. of Answer books?	**1**	
Graph paper?	**Y**	
Calculator?	**Y**	
Any other special stationery requirements (e.g. Data books, tables etc)?	**Engineering Databook**	
A9. Type of examination paper		
Seen?	☐ Yes	☒ No
Open Book?	☐ Yes	☒ No
Restricted?	☐ Yes	☒ No
If restricted, please provide a list of permitted texts:		

LEARNING OUTCOMES		
(By the end of the module the student should be able to....)	**Which teaching and learning methods enable students to achieve this learning outcome? (reference activities in section 15)**	**Which summative assessment method(s) will measure the achievement of this learning outcome? (reference activities in section 16)**
Model the behaviour of some common planar mechanisms and calculate the velocities, accelerations (kinematics) and forces (kinetics) associated with their motion.	Lectures; lecture notes and bibliography (private study); examples papers with specimen solutions; online resources via module web page. Coursework (private study)	Coursework and examination
Understand how mechanism inertia can lead to shaking forces and calculate how to compensate for (balance) such forces in some important special cases. *e.g.,* reciprocating engines.	Lectures; lecture notes and bibliography (private study); examples papers with specimen solutions; online resources via module web page.	Examination
Understand the terminology and rationale for using linear elastic theory and how to apply common formulations to analyse simple systems. Recognise the approximations inherent in linear elastic methods and be able to converse with specialists, e.g., on the use of finite element models. Understand the cause and effects of stress concentrations.	Lectures; lecture notes and bibliography (private study); examples papers with specimen solutions; online resources via module web page. Coursework (private study)	Coursework and examination

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Choose between and apply some common (idealized) states of stress and strain and the typical failure criteria that arise from them, including von Mises' stresses. Assess material suitability in terms of application criteria.	Lectures; lecture notes and bibliography (private study); examples papers with specimen solutions; online resources via module web page. Coursework (private study)	Coursework and examination
Predict the deflections, stresses, etc. under load and hence design simple cases for planar structural systems including: sStatically determinate and indeterminate pin-jointed frames; beams; simple assemblies of planar components; stability of struts; thermal expansion; stresses in pressure vessels and rotating discs.	Lectures; lecture notes and bibliography (private study); examples papers with specimen solutions; online resources via module web page. Coursework (private study)	Coursework and examination

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