UNIVERSITY OF WARWICK

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

Approval information	
Approval Type	☒ New module
Date of Introduction/Change	October 2018
If new, does this module replace another? If so, enter module code and title:	Replaces ES3C3 – Planar Structures and Mechanisms
If revised/discontinued, please outline the rationale for the changes:	
Confirmation that affected departments have been consulted:	Changes have been made following consultation between the School of engineering and WMG.

Module Summary	
1. Module Code (if known)	ES2D5
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 P Denissenko
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

Module Summary	
7. Principal Module Aims	This is a new, stream-specific module for Mechanical Engineers. There are two themes: structures and mechanisms. The first part of the module aims to supply Mechanical Engineers with specific skills related to the calculation of stress and strain and how this impacts on design. The second part of the module aims to develop engineers' understanding of mechanisms and how to describe their state in terms of position, velocity, and acceleration.
8. Principal Learning Outcomes	At the end of the module the student will be able to: • Model the behaviour of some common planar mechanisms (linkages, cranks, hydraulic ram) and calculate the velocities, accelerations (kinematics) and forces, torques (kinetics) associated with their motion. Predict the deflections, stresses, etc. under general loading (axial, bending, torsional) and be able to assess the consequences on design of planar structural systems. • Understand the key role of stiffness under various forms of loading, the effect of dimensional scaling and material property ratios. • Choose between and apply some common (idealized) states of stress and strain and the typical failure criteria that arise from them. Assess material suitability in terms of application criteria. Understand and model stress concentration, and devise ways to reduce this. Appreciate the rationale and limitations for using linear elastic theory under general loading conditions and be able to converse with specialists. • Understand how mechanism inertia can lead to shaking forces and calculate how to compensate for such forces (balance) in some important special cases, e.g. reciprocating engines.
9. Timetabled Teaching Activities (summary)	20 lecture hours. 10 x 1 hr examples classes. 3 x 1 hr revision lectures. Total 33 hrs
10. Departmental Web-link	http://www2.warwick.ac.uk/fac/sci/eng/eso/modules/year2
11. Other essential notes	Advice and feedback hours are available for answering questions on the lecture material and past examination questions. This module will need to be taught alongside ES3C3 Planar Structures and Mechanisms in 2018-19

Module Summary			
12. Assessment methods (summary)	Analysis assignment (20%) followed by examination (80%).		
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
H113	BEng Engineering	2	A/B	15
H114	MEng Engineering	2	A/B	15
H315	BEng Mechanical Engineering	2	C	15
H316	MEng Mechanical Engineering	2	C	15
HH35	BEng Systems Engineering	2	A	15
HH31	MEng Systems Engineering	2	A	15
HN11	BSc Engineering and Business Studies	2	A/B	15

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

1 (core)

16. Pre- and Post-Requisite Modules

Module Content and Teaching

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

Module duration (weeks)	10
Lectures	20 x 1 hr
Seminars	3 x 1 hr revision lectures.
Tutorials	10 x 1 hr examples classes
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	117hrs Guided independent learning.

18. Assessment Method (Standard)

Type of assessment	Length	% weighting

Module Context		
Written Examinations	3 hours	80%
Practical Examinations	0 hours	0%
Assessed essays/coursework	Analysis assignment combining computer simulation, hand calculations and discussion. 10 pages maximum.	20%
18a. Final chronological assessment *(please see guidance*)	Examination (80%).	

19. Methods for providing feedback on assessment.

- Students receive cohort feedback on their assignments;
- Student support through advice and feedback hours;
- Worked examples in revision lectures;
- Model solutions to some past paper questions
- Cohort level feedback on examinations.

20. Outline Syllabus

Analysis of Mechanisms:

i) Revise basic components used in modelling mechanisms: links, sliders, pin-joints, hydraulic ram etc and the number of degrees of freedom of a mechanism.

ii) Analytical techniques for kinematic analysis of mechanisms to obtain position, velocity and acceleration information (both linear and angular terms). Whilst the focus will be on analytical approaches, graphical methods will be referenced as an aid to understanding.

iii) Develop a matrix approach for kinetic analysis of mechanisms; the forces and torques at critical points within a mechanism. Demonstrate the principle of virtual work and show how both direct loads and loads via gears and pulleys can be handled.

iv) Analyse for deflections and stresses due to arbitrary loading including axial, bending and torsional loads. To be able to quantify the stiffness of a link in a mechanism in each case and appreciate how the stiffness scales with dimensional changes of the link and material property ratios.

Strength of Materials:

i) From a basis of the states of stress (and strain) induced from the various forms of loading, be able to identify common idealised states within a material within the context of linear elastic theory and superposition of states of load and hence stress / deflection of a material.

ii) Demonstrate the states of stress and strain present in some typical cases: beams / shafts / columns / discs / pressure vessels.

iii) Introduce failure criteria, von Mises, Tresca, and relate to the states of loading and material suitability.

iv) Demonstrate the connection between link / component geometry and the generation of stress concentrations and hence show mitigation approaches.

v) Discuss material selection in relation to the state of load / stress within a component.

21. Illustrative Bibliography

- Theory of machines and mechanisms, John J. Uicker, Jr., Gordon R. Pennock, Joseph E. Shigley, 4th edition, (Oxford University Press 2011).
- Mechanics of Machines, Cleghorn, W. L. (Oxford University Press 2010).

Module Context

- Design of Machinery: an Introduction to the Synthesis and Analysis of Mechanisms and Machines, Norton, RL, 5th edition (McGraw Hill 2012).
- Dynamics of Mechanical Systems, Prentis JM, 2nd edition (Wiley 1980).
- Strength of Materials and Structures, Case J, Chilver AH & Ross CTF, 4th edition, e-Book (Elsevier 1999).
- Structural and stress analysis, Megson, T. H. G., 3rd edition, e-Book (Elsevier 2014).
- Elasticity. Theory, Applications, and Numerics. Sadd, Martin H., 3rd edition, e-Book (Elsevier 2014). Mechanics of Composite Materials, Kaw, Autar K., 2nd edition, e-Book (CRC Taylor & Francis 2006).

22. Learning outcomes

Successful completion of the module leads to the learning outcomes. The learning outcomes identify the knowledge, skills and attributes developed by the module.

Learning Outcomes should be presented in the format "By the end of the module students should be able to..." using the table at the end of the module approval form:

Resources

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

Approval

24. Module leader's signature	Dr Petr Denissenko
25. Date of approval	Teaching Policy Committee Chair's Action 24 March 2017
26. Name of Approving Committee (include minute reference if applicable)	School of Engineering and WMG Teaching Policy Committee.
27. Chair of Committee's signature	Professor Gillian Cooke
28. Head of Department(s) signature	Professor 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% Analysis Assignment	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 (linkages, cranks, hydraulic ram) and calculate the velocities, accelerations (kinematics) and forces, torques (kinetics) associated with their motion. Predict the deflections, stresses, etc. under general loading (axial, bending, torsional) and be able to assess the consequences on design of planar structural systems.	Lectures; lecture notes and bibliography (private study); examples papers with specimen solutions; online resources via module web page. Coursework (private study)	Analysis assignment and examination
Understand the key role of stiffness under various forms of loading, the effect of dimensional scaling and material property ratios.	Lectures; lecture notes and bibliography (private study); examples papers with specimen solutions; online resources via module web page.	Examination
Choose between and apply some common (idealized) states of stress and strain and the typical failure criteria that arise from them. Assess material suitability in terms of application criteria. Understand and model stress concentration, and devise ways to reduce this. Appreciate the rationale and limitations for using linear elastic theory under general loading conditions and be able to converse with specialists.	Lectures; lecture notes and bibliography (private study); examples papers with specimen solutions; online resources via module web page.	Analysis assignment and examination
Understand how mechanism inertia can lead to shaking forces and calculate how to compensate for such forces (balance) 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