UNIVERSITY OF WARWICK

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

Approval information	
Approval Type	☒ Revised module
Date of Introduction/Change	October 2018
If new, does this module replace another? If so, enter module code and title:	
If revised/discontinued, please outline the rationale for the changes:	Removed laboratory class, updated availability.
Confirmation that affected departments have been consulted:	Changes were made in consultations between the School of Engineering and WMG.

Module Summary	
1. Module Code (if known)	ES480
2. Module Title	Dynamic Analysis of Mechanical Systems
3a. Lead department:	School of Engineering
3b. Teaching Split (if known):	100 % School of Engineering
4. Name of module leader	Dr Y Tian
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	The module aims to deliver an overview of important techniques of engineering dynamics, and providing insight into advanced knowledge in kinematics, kinetics, and vibrations. The dynamics of engineering systems important to modern engineering applications such as spatial mechanisms and robots

Module Summary	
	are examined. The complexities of kinematic and kinetic analysis of fully 3D motion will provide an appropriate challenge for the fourth year Master's level course.
8. Principal Learning Outcomes	By the end of the module the student should be able to... • Autonomously identify mobility characteristics of 3D mechanical systems. • Perform advanced kinematic analysis on spatial mechanisms and robots using vector and matrix representations. • Evaluate complex mechanisms sensitivity to design parameters, and interpret usability. • Apply a systematic approach to the approximations of complex engineering problems to enable efficient analysis with acceptable predictive accuracy and so apply a practical treatment to engineering uncertainty. • Use either Newtonian method or virtual work principle to evaluate the motions produces by driving forces, or the reaction forces and driving forces necessary to generate specific motions of 3D mechanical systems, e.g, robotic mechanisms. • Predict forces and motions of important special cases of general motion such as gyroscopes.
9. Timetabled Teaching Activities (summary)	30 hours of lectures 2 hours of examples / revision classes. **Total 32 hours**
10. Departmental Web-link	www2.warwick.ac.uk/fac/sci/eng/eso/modules/year4/es480/
11. Other essential notes	Advice and feedback hours are available for answering questions on the lecture material (theory and examples).
12. Assessment methods (summary)	Computer-based Modelling Assignment 2000 words (20%) Examination (80 % - 3 hour unseen exam.)

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.

14. Availability of module

Degree Code	Title	Study Year	C/OC/ A/B/C	Credits
H331	MEng Automotive Engineering	Final	O	15
H333	MEng Automotive Engineering with a Year in Research			
H33A	MEng Automotive Engineering with Business Management			
H332	MEng Automotive Engineering with Intercalated Year			
H33C	MEng Automotive Engineering with Robotics			
H33B	MEng Automotive Engineering with Sustainability			
H107	MEng Engineering			
H110	MEng Engineering with a Year in Research			
H10C	MEng Engineering with Business Management			
H10G	MEng Engineering with Communications			
H10M	MEng Engineering with Fluid Dynamics			
H109	MEng Engineering with Intercalated Year			
H10K	MEng Engineering with Robotics			
H10D	MEng Engineering with Sustainability			
HH37	MEng Manufacturing and Mechanical Engineering			
HH39	MEng Manufacturing and Mechanical Engineering with a Year in Research			
H37A	MEng Manufacturing and Mechanical Engineering with Business Management			
HH38	MEng Manufacturing and Mechanical Engineering with Intercalated Year			
H37D	MEng Manufacturing and Mechanical Engineering with Robotics			
H37B	MEng Manufacturing and Mechanical Engineering with Sustainability			
H311	MEng Mechanical Engineering			
H313	MEng Mechanical Engineering with a Year in Research			
H30G	MEng Mechanical Engineering with Business Management			
H30P	MEng Mechanical Engineering with Fluid Dynamics			
H312	MEng Mechanical Engineering with Intercalated Year			
H30H	MEng Mechanical Engineering with Sustainability			
HH63	MEng Systems Engineering			
HH65	MEng Systems Engineering with a Year in Research			
H63A	MEng Systems Engineering with Business Management			
HH64	MEng Systems Engineering with Intercalated Year			
H63B	MEng Systems Engineering with Sustainability			
New	MEng Automotive Engineering with Exchange Year			
New	MEng Engineering with Exchange Year			
H320	MEng Mechanical Engineering with Exchange Year			
HH78	MEng Manufacturing and Mechanical Engineering with Exchange Year			
New	MEng Systems Engineering with Exchange Year			
H341	MSc Advanced Mechanical Engineering	M1	Core	15

15. Minimum number of registered students required for module to run
1 (core)
16. Pre- and Post-Requisite Modules
ES386 – Dynamics of Vibrating Systems ES3C3 – Planar Structures and Mechanisms

Module Content and Teaching

17. Teaching and Learning Activities *(totals for module – please see guidance)*	
Module duration (weeks)	10
Lectures	30
Seminars	-
Tutorials	2 hours of revision / examples classes
Project Supervision	-
Demonstration	-
Practical Class/Workshops	-
Supervised time in studio/workshop	-
Fieldwork	-
External visits	-
Work based learning	-
Placement	-
Year abroad	-
Other activity *(please describe): e.g. distance-learning, intensive weekend teaching etc.*	118 hr of self-guided study

18. Assessment Method (Standard)		
Type of assessment	**Length**	**% weighting**
Written Examinations	3 Hours	**80 %**
Practical Examinations	-	**-**
Assessed essays/coursework	Computer-based Modelling Assignment 2000 words	**20 %**
18a. Final chronological assessment *(please see guidance*)	**Written examination**	

19. Methods for providing feedback on assessment.

- Coursework will be returned with marks and detailed feedback.
- Model solutions to exam type questions.
- Support through advice and feedback hours.
- Cohort level feedback on examinations

20. Outline Syllabus

1. **Introduction**
    a. Importance of classical mechanics in 3D formulation
    Main topic in dynamics
    b. Main contents of the module
    c. Key issues in studying dynamics
    d. Course objectives and assignment
2. **Mathematic background**
    a. Vector and matrix operations
    b. Coordinate transformation
3. **Kinematics of 2/3D systems**
    Topology structure of mechanical systems
    a. Mobility analysis of mechanical systems
    b. Vector presentation of kinematics of a single body in 2/3D space
    c. Moving coordinate system
    d. Application to kinematic analysis of rigid body systems, *e.g*. planar/spatial linkages and robotic mechanisms
4. **Kinetics of 2/3D systems**
5. **Newtonian method**
    a. Vector presentation of force and moment equations of a rigid body in 2/3D (Newton-Euler equations)
    b. Application to kinetostatic analysis of planar linkages as a special topic
    c. Formulation of general equations of motion of rigid body systems in moving coordinate system, *e.g*. planar/spatial linkages and robotic mechanisms
6. **Work-Energy method**
    a. Virtual work principle
    b. Application to dynamic analysis of planar/spatial linkage and robotic mechanisms
7. **Gyroscopic motions**
    a. Explanation to procession phenomena
    b. Formulation of Euler's Equation
    c. Steady state procession
    d. Application to satellite and gyro compass, *etc.*

21. Illustrative Bibliography

- Design of Machinery: an Introduction to the Synthesis and Analysis of Mechanisms and Machines, Norton, RL, 5th edition (McGraw Hill 2012).
- Shigley, J.E. Uicker, J.J. Theory of machines and mechanisms, McGraw-Hill Education, 2016.
- J.R. Meriam and L.G. Kraige, Engineering Mechanics, Dynamics (7th Edition), Wiley, 2006.
- Grosjean, J., Kinematics and Dynamics of Mechanisms, McGraw Hill 1991.

- AShabana, A. A., Computational Dynamics, 2nd Ed., Wiley 2001 .

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.

N/A

Approval

24. Module leader's signature	Dr Y Tian
25. Date of approval	25 April 2019
26. Name of Approving Committee (include minute reference if applicable)	School of Engineering and WMG Course and Module Approval Committee (CMAC), Minute 256-17/18
27. Chair of Committee's signature	Professor Gillian Cooke
28. Head of Department(s) signature	Professor David Towers

Examination Information		
A1. Name of examiner (if different from module leader)	N/A	
A2. Indicate all available methods of assessment in the table below		
% Examined	**% Assessed by other methods**	**Length of examination paper**
80 %	Computer-based Modelling Assignment 2000 words **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	
A5. When would you wish the exam take place (e.g. Jan, April, Summer)?	**Summer**	
A6. Is reading time required?	☒ No	
A7. Please specify any special exam timetable arrangements.		
N/A		
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 Data Book**	
A9. Type of examination paper		
Seen?	☒ No	
Open Book?	☒ No	
Restricted?	☒ No	
If restricted, please provide	N/A	

Examination Information	
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 17)**	**Which summative assessment method(s) will measure the achievement of this learning outcome? (reference activities in section 18)**
Autonomously identify mobility characteristics of 3D mechanical systems.	Lectures, private study, laboratory demonstrations	Unseen examination and computer-based modelling assignment
Perform advanced kinematic analysis on spatial mechanisms and robots using vector and matrix representations.	Lectures, private study	Unseen examination and computer-based modelling assignment
Evaluate complex mechanisms sensitivity to design parameters, and interpret usability.	Lectures, private study	Unseen examination and computer-based modelling assignment
Apply a systematic approach to the approximations of complex engineering problems to enable efficient analysis with acceptable predictive accuracy and so apply a practical treatment to engineering uncertainty.	Lectures, private study, laboratory demonstrations	Unseen examination and computer-based modelling assignment
Use either Newtonian method or virtual work principle to evaluate the motions produces by driving forces, or the reaction forces and driving forces necessary to generate specific motions of 3D mechanical systems, *e.g*, robotic mechanisms.	Lectures, private study, laboratory demonstrations	Unseen examination and computer-based modelling assignment
Predict forces and motions of important special cases of general motion such as gyroscopes.	Lectures, private study	Unseen examination and computer-based modelling assignment