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	October 2017
If new, does this module replace another? If so, enter module code and title:	
If revised/discontinued, please outline the rationale for the changes:	Some small adjustments are to be introduced immediately, smoothing the transition to more thorough revisions to approach, syllabus and coursework when a new set book becomes available (expected publication summer 2017).
Confirmation that affected departments have been consulted:	Changes have been made in consultation between the School of Engineering and WMG.

Module Summary	
1. Module Code (if known)	ES442
2. Module Title	Precision Engineering and Microsystems
3a. Lead department:	School of Engineering
3b. Teaching Split (if known):	100% School of Engineering
4. Name of module leader	Professor Derek Chetwynd
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	To provide a rigorous understanding of first-principles design applied at the limits of practical performance and to introduce ideas and methodologies for miniaturization that are essential to modern technology, e.g. in the large UK instrumentation sector, as

Module Summary	
	well as sub-systems for use in aerospace, automotive, *etc*. Additionally, to provide insights into the science and practice of metrology.
8. Principal Learning Outcomes	• Understand the physical limits on achievable precision in advanced mechanical systems, the nature of uncertainties, *etc.,* and thereby assess satisfactorily the plausibility of proposed machine specifications. • Interpret the guidelines for good practice in precision metrology in order to select sound principles for the operation of high-precision mechanical systems. • Evaluate and criticize constructively designs for (electro-) mechanical systems, interpreting their effectiveness. • Produce and defend conceptual design solutions for applications that make unusually high demands for mechanical stability, precise motion control, *etc*. or that benefit from high degrees of miniaturization. • Understand the typical constraints imposed on designs by manufacturing capabilities and make sound judgments on designs that minimize their effect. • Appreciate the range and principles of special manufacturing methods needed for high-precision systems and micro-devices and make informed choices of candidate processes for specific tasks.
9. Timetabled Teaching Activities (summary)	30 lectures (includes 1 or 2 guest speakers, as available) 1x1-hour revision workshop **Total 31 hours**
10. Departmental Web-link	http://www2.warwick.ac.uk/fac/sci/eng/eso/modules/year4/es442
11. Other essential notes	Advice and feedback hours are available for answering questions on the lecture material (theory and examples).
12. Assessment methods (summary)	Formal written 3 hour examination (80%) Coursework 3000 words / 20 pages maximum (20%)

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.

School of Engineering

14. Availability of module

Degree Code	Title	Study Year	C/OC/ A/B/C	Credits
H107	**MEng Engineering (and variants)**	**4**	**A**	
H109	**MEng Engineering with Intercalated Year**	**5**	**A**	
H110	**MEng Engineering with a Year in Research**	**5**	**A**	
H311	**MEng Mechanical Engineering (and variants)**	**4**	**A**	**15**
H312	**MEng Mechanical Engineering with Intercalated Year**	**5**	**A**	
H313	**MEng Mechanical Engineering with a Year in Research**	**5**	**A**	
H341	**MSc Advanced Mechanical Engineering**	**1**	**C**	

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

1 (core module)

16. Pre- and Post-Requisite Modules

n/a

Module Content and Teaching

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

Module duration (weeks)	**10**
Lectures	**30 hours**
Seminars	**-**
Tutorials	**1 hour**
Project Supervision	**-**
Demonstration	-
Practical Class/Workshops	-
Supervised time in studio/workshop	-
Fieldwork	-
External visits	-

Module Content and Teaching		
Work based learning	-	
Placement	**-**	
Year abroad	**-**	
Other activity *(please describe): e.g. distance-learning, intensive weekend teaching etc.*	**Guided Independent Learning 119 hours**	
18. Assessment Method (Standard)		
Type of assessment	**Length**	**% weighting**
Written Examinations	3 hours	80
Practical Examinations	-	-
Assessed essays/coursework	Coursework 3000 words / 20 pages maximum (or equivalent as includes tabulated data and plots).	20
18a. Final chronological assessment *(please see guidance*)	Written examination – 80%	

19. Methods for providing feedback on assessment.

- Class summary of typical strengths/weaknesses (individually annotated);
- Annotations onto submitted script;
- Nominal mark *via* Tabula and feedback (or link to feedback on returned script);
- Student support through advertised Advice and Feedback Hours;
- Cohort level feedback on examinations.

20. Outline Syllabus

1. Introduction: the need for miniaturization; scaling effects; the interactions of precision engineering, micro-mechanics and nanotechnology.
2. Uncertainty, tolerance and the influence of surface topography.
3. Principles of precision mechanism design: loop analysis, alignment principles, kinematics of constraint, mechanism mobility, semi-kinematic design, symmetry, nulling and compensation strategies.
4. Design of sub-systems for precision instruments and machine tools: semi-kinematic slideways and bearings, flexure mechanisms, sensors, actuators and drives, generalized levers, materials selection, vibration isolation.
5. Sub-micrometre metrology, drawing examples from, *e.g.,* optical interferometry, grating technologies, surface metrology instruments, length comparators and their sensors, scanning probe microscopes.
6. Micromechanical manufacture: limits of capability of conventional mechanical manufacturing; concepts and general performance of non-conventional methods such as diamond turning, ductile mode grinding, photo-lithography, LIGA, ion-beam processes, laser ablation.

Module Content and Teaching

7. Micro-Systems Technology: examples of design and fabrication approaches for micro-mechatronic systems (or MEMS).

21. Illustrative Bibliography

1. Set Book: "", ST Smith, S.T., Chetwynd, D.G.,1994, Foundations of Ultraprecision Mechanism Design, Taylor Francis
2. New Set Book (expected June 2017): Leach, R.K., Smith, S.T., Basics of Precision Engineering, Taylor Francis (ISBN 978-1-4987-6085-0)
3. Nakazawa, H., 1994, Principles of Precision Engineering, OUP
4. Norton, R.L., 2012, Design of Machinery: an Introduction to the Synthesis and Analysis of Mechanisms and Machines, McGraw Hill
5. Gardner, J.W. *et al*., 2001, Microsensors, MEMS and Smart Devices, Wiley
6. Beckwith, T.G., Marangon, R.D., Lienhard, J.H., 2009, Mechanical Measurement (6th Ed.), Addison Wesley

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	Professor Derek Chetwynd
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 Coursework 3000 words/20 pages maximum	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?	Yes	
Calculator?	Yes	
Any other special stationery requirements (e.g. Data books, tables etc)?	Engineering Data Book (Additional data sheet is attached to the examination paper)	
A9. Type of examination paper		
Seen?	☐ Yes	☒ No
Open Book?	☐ Yes	☒ No
Restricted?	☐ Yes	☒ No

Examination Information	
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)**
Understand the physical limits on achievable precision in mechanical systems, the nature of uncertainties, etc., and thereby assess satisfactorily the plausibility of proposed machine specifications.	Lectures Specified reading including bespoke handouts as required.	Examination and coursework
Interpret the guidelines for good practice in precision metrology in order to select sound principles for the operation of high-precision mechanical systems.	Lectures Specified reading including bespoke handouts as required.	Examination
Criticize constructively designs for (electro-) mechanical systems, making judgments on their effectiveness.	Lectures Specified reading including bespoke handouts as required.	Examination
Produce and defend conceptual design solutions for applications that make unusually high demands for mechanical stability, precise motion control, etc. or that benefit from high degrees of miniaturization.	Lectures Specified reading including bespoke handouts as required.	Examination
Understand the typical constraints imposed on designs by manufacturing capabilities and make sound judgments on designs that minimize their effect.	Lectures	Examination and coursework
Appreciate the range and principles of special manufacturing methods needed for high-precision systems and micro-devices and make informed choices of candidate processes for specific tasks.	Lectures (Plus seminar with guest speakers if available)	Examination and coursework