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:	Revised as part of the curriculum refresh
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)	ES3A8
2. Module Title	Design for Manufacture
3a. Lead department:	WMG
3b. Teaching Split (if known):	100% WMG
4. Name of module leader	Dr Darren Hughes
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 CATS
7. Principal Module Aims	This module establishes the detailed links between design, material, behaviour and process limitations with a view to ensuring design is carried out with manufacturing being considered.

Module Summary	
8. Principal Learning Outcomes	By the end of the module students will be able to: • Analyse the relationship between the tooling geometry and limitations on component design. • Contrast plant requirements for different manufacturing processes. • Relate the effect of material behaviour during processing to the components that can be achieved. • Summarise the differences between solid and liquid manufacturing routes and link them to component design. • Design components given the confines of a particular manufacturing route.
9. Timetabled Teaching Activities (summary)	Lectures 30 x 1hr = 30 hours Revision classes 2 x 1hr = 2 hours **Total contact hours = 32**
10. Departmental Web-link	http://www2.warwick.ac.uk/fac/sci/eng/eso/modules/year3/es3a8
11. Other essential notes	Advice and feedback hours are available for answering questions on the lecture material.
12. Assessment methods (summary)	Examination (3 hours) 70% Individual assignment 2000 words 30% Students must pass the examination and pass the coursework overall.

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% WMG

14. Availability of module

Degree Code	Title	Study Year	C/OC/ A/B/C	Credits
H106	**BEng Engineering**	**3**	**O**	**15**
H107	**MEng Engineering**	**3**	**O**	**15**
H109	**MEng Engineering with Intercalated Year**	**3**	**O**	**15**
H110	**MEng Engineering with a Year in Research**	**3**	**O**	**15**
H330	**BEng Automotive Engineering**	**3**	**Core**	**15**
H331	**MEng Automotive Engineering**	**3**	**Core**	**15**
H332	**MEng Automotive Engineering with Intercalated Year**	**3**	**Core**	**15**
H333	**MEng Automotive Engineering with a Year in Research**	**3**	**Core**	**15**
HH73	**BEng Manufacturing and Mechanical Engineering**	**3**	**Core**	**15**
HH37	**MEng Manufacturing and Mechanical Engineering**	**3**	**Core**	**15**
HH38	**MEng Manufacturing and Mechanical Engineering with Intercalated Year**	**3**	**Core**	**15**
HH39	**MEng Manufacturing and Mechanical Engineering with a Year in Research**	**3**	**Core**	**15**
HN12	**BEng Engineering Business Management**	**3**	**B**	**15**

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

1 (core)

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 x 1 hr**
Seminars	
Tutorials	
Project Supervision	

Module Context		
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.*	**2 x 1 hrs revision class** **118 hrs guided independent learning**	
18. Assessment Method (Standard)		
Type of assessment	**Length**	**% weighting**
Written Examinations	3 Hours	**70%**
Practical Examinations	Hours	
Assessed essays/coursework	**Individual Assignment up to 2,000 words**	**30%**
18a. Final chronological assessment *(please see guidance*)	**Examination**	
19. Methods for providing feedback on assessment.		
Written comments on assignment Cohort level feedback on examinations		
20. Outline Syllabus		

This course selects a number of manufacturing processes and covers the understanding of the behaviour of materials in these processes and thus the design considerations associated with the process limitations. Focus will be given to the differences between solid and liquid processing of both polymers and metals. It will be shown that differences arise both at a macroscopic level (component scale) and at microscopic level (to atomic level) but that both are linked to component design. Six groups of processes are considered. For each process, consideration will be given to links between:

- The manufacturing process
- The material in use
- Design limitations.

- *Casting:* Differences between die casting, sand casting and Investment casting will be discussed. The modulus technique will be introduced and further developed to show its use in design optimisation. The modulus technique will be used

Module Context

particularly for feeding a casting to overcome starvation and macroporosity. Defects in castings will be addressed both in terms of origins and including methods for their reduction.

- *Forging:* Plant requirements for forging will be introduced. Closed die forging will be considered in detail. Folds, laps, etc. will be explained. Detail of forging plant and the relation to component geometry and type of operation will be covered.
- *Heat Treatment:* Basic steel metallurgy will be assumed. The concept of through-thickness hardening will be introduced in terms of austenite decomposition. Tools to understand hardening behaviour in a real component will be discussed (CCT diagrams). Modulus will be revisited as an enabler to understand cooling/hardening.
- *Injection Moulding:* This will be concerned with the flow of material in the mould resulting in air entrapment, residual stress and distortion, polymer and filament alignment, weld lines and sink marks.
- *Joining:* The processes of welding, mechanical and adhesive joining will be covered. Particular focus will be made of automotive sector joining technologies including the current state of the art. The design, preparation and quality of the joint will be featured. Some examples of non-destructive evaluation will also form part of this section.
- *Assembly:* This will cover the DFA techniques developed by Boothroyd and Dewhurst. Methods for improvement of design using DFA will be discussed. Negative aspects of DFA will also be considered.
- At the end of this course, students should have an appreciation, in some depth, of the design considerations needed for manufacture using the above processes and an ability to question other process limitations not covered here.

21. Illustrative Bibliography

DeGarmo's Materials and Processes in Manufacturing, 11th International student edition. J. T. Black, Ronald A. Kohser (2012). ISBN 9780470873755

Product design for manufacture and assembly, 3rd Edition. Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight (2011). ISBN 9781420089271. Warwick library - TS171.4.B66. [Note ebook of 2nd edition available from library)

Introduction to manufacturing processes, Mikell P. Groover (2012). ISBN 9780470632284. Warwick library - TS183.G785.

Introduction to materials science for engineers, James F. Shackelford (2015). ISBN 9780136012603. Warwick library - TA 403.S4.

Manufacturing engineering and technology, Serope Kalpakjian. (2014) ISBN 9789810694067. Warwick library - TS176.K34.

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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:

See table at the end of this form.

Resources

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

Approval

24. Module leader's signature	Dr Darren Hughes
25. Date of approval	Teaching Policy Committee 26 April 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 Gill 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**
70%	**30% written assignment up to 2,000 words**	**3 Hours**
A3. Will this module be examined together with any other module (sectioned paper)? If so, please give details below.		
n/a		
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 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?**	**Which summative assessment method(s) will measure the achievement of this learning outcome?**
Analyse the relationship between the tooling geometry and limitations on component design.	Lectures	Examination and Assignment
Contrast plant requirements for different manufacturing processes.	Lectures	Examination and Assignment
Relate the effect of material behaviour during processing to the components that can be achieved.	Lectures	Examination and Assignment
Summarise the differences between solid and liquid manufacturing routes and link them to component design.	Lectures	Examination and Assignment
Design components given the confines of a particular manufacturing route.	Lectures	Examination and Assignment