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	01/10/2018
If new, does this module replace another? If so, enter module code and title:	
If revised/discontinued, please outline the rationale for the changes:	Revised to capture module delivery accurately. Assignments changed to 30% assignment 30 pages or equivalent; 10% 1 hour class test
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)	ES4D9
2. Module Title	Heat Transfer Theory & Design
3a. Lead department:	School of Engineering
3b. Teaching Split (if known):	School of Engineering – 100%
4. Name of module leader	Professor Evgeny Rebrov
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 credits
7. Principal Module Aims	To provide a knowledge of heat transfer that is of vital importance in many industrial sectors from process industries, through vehicles, etc., power plant, to building technology.
8. Principal Learning Outcomes	By the end of the module the student should be able to...

Module Summary	
	• Apply comprehensive knowledge of the basic heat transfer processes. • Autonomously evaluate heat transfer rates using correlations of non-dimensional groups, complex analytical techniques or numerical techniques • Autonomously model real-life processes for the purposes of approximate calculation • Evaluate the compromises between effectiveness and cost inherent in the design optimisation of heat transfer equipment. • Examine the roles of numerical techniques in conceptualizing heat transfer designs, and interpret the usefulness of frequently used commercial software packages
9. Timetabled Teaching Activities (summary)	30 x 1 hr Lectures 2 x 1 hr Examples Classes Class quiz 1 hr **Total 33 hours**
10. Departmental Web-link	http://www2.warwick.ac.uk/fac/sci/eng/eso/modules/year4/
11. Other essential notes	Advice and feedback hours are available for answering questions on the lecture material (theory and examples).
12. Assessment methods (summary)	60% Examined (2 hour examination) 40% (30% assignment 30 pages or equivalent; 10% 1 hour class test.) 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.
School of Engineering

14. Availability of module

Degree Code	Title	Study Year	C/OC/ A/B/C	Credits
H341	MSc Advanced Mechanical Engineering	M1	O	
H642	MSc Energy and Power Engineering	M1	O	
H1A0	MSc Sustainable Energy Technologies	M1	O	
H311	MEng Mechanical Engineering (and variants)	4	A	
H320	MEng Mechanical Engineering with Exchange Year	4	A	
H312	MEng Mechanical Engineering with Intercalated Year	5	A	15
H313	MEng Mechanical Engineering with a Year in Research	5	A	
H107	MEng Engineering (and variants)	4	A	
New	MEng Engineering with Exchange Year	4	A	
H109	MEng Engineering with Intercalated Year	5	A	
H110	MEng Engineering with a Year in Research	5	A	

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

10

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	**-**

Module Content and Teaching	
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.*	Class quiz – 1 hour Examples classes – 2 x 1 hours 117 guided independent learning.

18. Assessment Method (Standard)		
Type of assessment	**Length**	**% weighting**
Written Examinations	2 Hours	**60**
Practical Examinations	-	
Assessed essays/coursework	30% 30 pages or equivalent assignment. 10% 1 hour class test.	**40**
18a. Final chronological assessment *(please see guidance)*	Written examination – 60%	

19. Methods for providing feedback on assessment.

- Feedback via written and verbal comments on the assignments;
- the publication of model solutions to class quiz and past examination papers;
- worked examples in examples classes;
- Student support through advice and feedback hours;
- Cohort level feedback on examinations.

20. Outline Syllabus

The theoretical background to heat and mass transfer by conduction, convection, radiation, condensation and boiling is given. The design applications developed concentrate on more realistic mixed mode or complex heat transfer, e.g. fins (heat sinks for electronic components, compact heat exchangers), flat plate solar collectors, heat exchangers.

Introduction: Problems in heat transfer.

Convection: Continuity, momentum, energy equations as applied to boundary layers. Laminar and turbulent flow. Dimensional analysis. Forced convection heat transfer and pressure drops: in tubes, across tube banks, on flat plates. Natural convection.

Conduction: Steady state conduction. 2-D and 3- D conduction with heat generation. 1- , 2 and 3-D transient conduction.
Mixed conduction and convection - fin effectiveness.

Radiation heat transfer.

Condensation, boiling and sublimation heat transfer.

Applications:
Heat exchangers. Heat exchanger types. LMTD and E-NTU design methods. Heat exchanger design optimisation.
Mixed radiation and convection - flat plate solar collector. Heat pipes. Building heat transfer.

CAD methods in heat transfer design - introduction about the role of numerical modelling techniques in heat transfer design and overview of some frequently used commercial software packages.

21. Illustrative Bibliography

1. Introduction to Heat Transfer by Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt, John Wiley & Sons; 6th Edition (14 April 2011)
2. Heat Transfer by Jack P. Holman, McGraw-Hill Higher Education; 10th edition (1 May 2009).
3. Heat Exchangers. Selection, Rating, and Thermal Design, by Sadik Kakac, Hongtan Liu, and Anchasa Pramuanjaroenkij, CRC Press, 3rd Edition (1 March 2012)
4. Foundations of Heat Transfer: International Student Version by Frank P. Incropera, David P. DeWitt, Theodore L. Bergman and Adrienne S. Lavine, John Wiley & Sons; 6th Edition International Student Version edition (27 April 2012).
5. The Engineering Databook, Engineering Student Office, School of Engineering, University of Warwick.
6. Thermodynamic and Transport Properties of Fluids: S. I. Units, by G. F. C. Rogers and Yon R. Mayhew, Wiley-Blackwell; 5th Edition (27 Nov 1994, reprinted: 2004).

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 Evgeny Rebrov
25. Date of approval	25 April 2018
26. Name of Approving Committee (include minute reference if applicable)	School of Engineering and WMG Course and Module Approval Committee (CMAC), Minute 257-17/18
27. Chair of Committee's signature	Professor Gill Cooke
28. Head of Department(s) signature	Professor David Towers

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**
60	30 % coursework 30 pages or equivalent 10% 1 hour class test	2 hours
A3. Will this module be examined together with any other module (sectioned paper)? If so, please give details below.		
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 Data Book Thermodynamic and transport properties of fluids Formula sheet	
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)**
Apply comprehensive knowledge of the fundamental heat transfer processes.	Lectures	Written examination
Autonomously evaluate heat transfer rates using correlations of non-dimensional groups, complex analytical techniques or numerical techniques.	Lectures	Written examination
Autonomously model real-life processes for the purposes of approximate calculation.	Lectures	Written examination
Evaluate the compromises between effectiveness and cost inherent in the design optimisation of heat transfer equipment	Lectures	Assessed coursework and written examination
Examine the roles of numerical techniques in heat transfer design and the frequently used commercial software packges	Lectures	Written examination