UNIVERSITY OF WARWICK

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

Approval information	
Approval Type	☐ Revised module ☒ New 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:	
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)	ES2D6
2. Module Title	Semiconductor Materials and Devices
3a. Lead department:	School of Engineering
3b. Teaching Split (if known):	100% School of Engineering
4. Name of module leader	Prof. Tim Ashley
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	To present, in context, the fundamental properties of semiconductor materials and devices. Students will study fundamental aspects of semiconductor material properties and how these link to device operation, including pn-junction diodes, bipolar transistors, field effect transistors, solar cells, light-emitting diodes and diode lasers, and thermoelectric and piezoelectric devices. Students will study the basic theory that underpins material properties and the device operation. Students will also study basic fabrication methods, basic electronic structure theory and electronic transport theory, and basic principles of low-dimensional nanodevices. Students will also study the basics of semiconductor material and device simulation. To encourage development of problem solving and modelling skills in order that more advanced concepts related to devices can be tackled in later years.
8. Principal Learning Outcomes	By the end of the module the student should be able to: • Understand the electronic properties and behaviour of semiconductor materials. • Explain the operation of electronic devices (diodes, FETs, BJTs, solar cells, thermoelectrics etc.) from the bottom up • Appreciate the fundamental parameters controlling the properties of semiconductor materials. • Understand the operation of realistic devices and the effect of non-idealities. • Appreciate the interaction of different physics in providing new properties and device operation concepts. • Skilfully solve problems in semiconductor materials and devices and acquire basic skills in the numerical solutions of such problems.
9. Timetabled Teaching Activities (summary)	30 hours of lectures, 2 hours of revision lectures, 2 X 4 hours of laboratory exercises, 2 x 1 hour of formative computer-based tests. **Total of 42 hours.**
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 (theory and examples) and past examination questions.
12. Assessment methods (summary)	80% written examination (3 hrs); 20% marked laboratory report (10 pages length).

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
H113	BEng Engineering	2	A	15
H114	MEng Engineering	2	A	15
H605	BEng Electrical and Electronic Engineering	2	C	15
H606	MEng Electrical and Electronic Engineering	2	C	15
H63W	BEng Electronic Engineering	2	C	15
H63X	MEng Electronic Engineering	2	C	15
HN11	BSc Engineering and Business Studies	2	A	15

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

1 (core module).

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	30 x 1 hour
Seminars	None
Tutorials	None
Project Supervision	None
Demonstration	None
Practical Class/Workshops	2 laboratory exercises (2 x 4 hours = 8 hrs)
Supervised time in studio/workshop	None
Fieldwork	None
External visits	None
Work based learning	None
Placement	None
Year abroad	None

Module Content and Teaching

Other activity *(please describe): e.g. distance-learning, intensive weekend teaching etc.*	• 2 x 1 hr = 2 hours revision lectures • 2 x 1hr = 2 hours computer-based formative test • 108 hours of guided independent learning

18. Assessment Method (Standard)

Type of assessment	Length	% weighting
Written Examinations	3 hours	80
Practical Examinations	None	
Assessed essays/coursework	Laboratory Report (10 pages length).	20
18a. Final chronological assessment *(please see guidance*)	Written examination.	

19. Methods for providing feedback on assessment.

- Support through advice and feedback hours.
- Written feedback on marked laboratory report.
- Cohort-level feedback on computer-based formative test.
- Cohort-level feedback on final exam.

20. Outline Syllabus

- Physics of doped semiconductor materials extending beyond silicon
- Energy bands, density of states, Fermi distributions, occupancy
- Description of mobility and generation-recombination effects
- Behaviour of diodes, including optoelectronic devices
- Behaviour of bipolar and field effect transistors
- Growth and fabrication technology for electronic devices
- Drift-diffusion transport including continuity equation
- Ballistic transport
- Introduction to simulation techniques
- Thermoelectric transport, Peltier and Seebeck effects
- Advanced photovoltaic concepts

21. Illustrative Bibliography

W.D. Callister, Materials Science and Engineering, 9th edition, Wiley, 2014.
Ben G. Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, 7th edition, Pearson Education, 2015.
S. O. Kasap, Principles of Electronic Materials and Devices, 4th edition McGraw Hill, to be published 25/04/2017, ISBN: 9780078028182

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:

Please, see 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 Tim Ashley
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 Laboratory Report	3 hours
A3. Will this module be examined together with any other module (sectioned paper)? If so, please give details below.		
No.		

Examination Information		
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.		
N/A		
A8. Stationery requirements		
No. of Answer books?	2	
Graph paper?	Yes	
Calculator?	Yes	
Any other special stationery requirements (e.g. Data books, tables etc)?	Engineering Data Book	
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)**
Understand the electronic properties and behaviour of semiconductor materials.	Lectures, laboratories	Examination, laboratory report
Explain the operation of electronic devices (diodes, FETs, BJTs, solar cells, thermoelectrics etc.) from the bottom up	Lectures, laboratories	Examination, laboratory report
Appreciate the fundamental parameters controlling the properties of semiconductor materials.	Lectures	Examination
Understand the operation of realistic devices and the effect of non-idealities.	Lectures, laboratories	Examination, laboratory report
Appreciate the interaction of different physics in providing new properties and device operation concepts.	Lectures	Examination
Skilfully solve problems in semiconductor materials and devices and acquire basic skills in the numerical solutions of such problems	Lectures	Examination, laboratory report