UNIVERSITY OF WARWICK

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

Approval information	
Approval Type	☐ New module ☒ Revised module ☐ Discontinue module
Date of Introduction/Change	01/10/2017
If new, does this module replace another? If so, enter module code and title:	
If revised/discontinued, please outline the rationale for the changes:	Changes as part of the curriculum refresh.
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)	ES97B
2. Module Title	Bioenergy and Biotechnology
3. Lead department:	School of Engineering
4. Name of module leader	Dr Volkan Degirmenci
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 impart a deep understanding of the principles of modern bioenergy and biotechnologies, including biofuels from a variety of sources, biomass chemistry and treatment, conversion of biomass and ethical and practical considerations. Students will gain a thorough understanding of the potential for sustainable biotechnologies for power production as well as the fundamental principles underlying biomass formation/production and energy conversion.

Module Summary	
8. Principal Learning Outcomes	By the end of the module, students should be able to: • Demonstrate an advanced understanding of biomass chemistry and a detailed knowledge of different types of biomass for modern biotechnology applications. Critically evaluate the suitability and feasibility of biofuels for a given application. • Critique the physical treatment and handling of biomass using advanced modern methods. Understand complex thermal biomass conversion processes, including gasification, combustion, pyrolysis and liquefaction. • Perform detailed analyses of the complex underlying principles of biochemical biomass conversion, including biogas and biofuel production from various sources. Perform economic analyses and critically assess the impact on the environment of biomass production and use. • Demonstrate a deep understanding of the modern biorefinery concept, including process such as hydrolysis of biomass, bio-based fuel additives, lignin conversion and levulinic acid and furfural conversion. • Evaluate logistical and ethical considerations in the context of the environment and be able to critically assess the feasibility of biorefineries based on logistical and environmental constraints.
9. Timetabled Teaching Activities (summary)	28 x 1 hour lectures and 2 x 1 hour examples classes Total 30 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)	Written examination 80 % Assignment 3000 words 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
TESA-H1A0	**Sustainable Energy Technologies**	**1**	**C**	**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	**28**
Seminars	**0**
Tutorials	
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.*	**Example classes 2 x 1hr** **Guided independent learning 120 hr**

18. Assessment Method (Standard)

Type of assessment	Length	% weighting
Written Examinations	3 Hours	**80**
Practical Examinations	Hours	

Module Context		
Assessed essays/coursework	**assignment (max 3000 words)**	**20**
18a. Final chronological assessment *(please see guidance*)	**Examination**	

19. Methods for providing feedback on assessment.

Coursework marked with detailed comments.
Cohort level feedback on examinations

20. Outline Syllabus

1. Renewable energy technologies
    - Economic and societal background
    - Energy consumption, reserves, depletion and environmental issues
    - Life cycle analysis of biofuels
2. Biomass chemistry
    - Lignocellulose and Starch-Based Plants, Triglyceride-Producing Plants, Algae, Terpenes and Rubber-Producing Plants
    - Forestry residues, agricultural waste
    - Municipal, commercial and industrial waste
3. Physical treatment of biomass
    - Harvesting and transport, logistics, storage, washing, size reduction, moisture reduction, compaction technologies, pre-treatment steps.
4. Thermal biomass conversion
    - Biomass gasification
        - Gasification chemistry, gasification of dry and wet biomass, gas conditioning, syn-gas utilization.
    - Biomass combustion
        - Equipment and applications
    - Pyrolysis and Liquefaction
        - Fast pyrolysis, kinetics of pyrolysis
        - Bio oil upgrading
5. Biochemical biomass conversion
    - Biogas production by microbial processes
        - Anerobic digestion, microbial hydrogen production
    - Biofuels from microalgea and seaweeds
        - Technologies, economic analysis, environmental impact
    - Biodiesel from vegetable oils
        - Transesterification process, glycerol utilization
    - Bioethanol
    - Aqueous phase reforming
    - Biorefinery concept

- Hydrolysis of biomass for sugar monomer production
- Platform molecules and their conversion into biobased fuel additives
- Lignin conversion
- Levulinic acid and furfural conversion

6. Ethical considerations

21. Illustrative Bibliography

1. Introduction to Chemicals from Biomass, James H. Clark, Fabien Deswarte, John Wiley & Sons, 2014.
2. Catalysis for Renewables: From Feedstock to Energy Production, Gabriele Centi, Rutger A. van Santen (Eds.), Wiley, 2008.
3. Biomass Gasifiation and Pyrolysis Practical Design and Theory, Prabir Basu, Elsevier, 2010.
4. Biogas from Waste and Renewable Resources, Dieter Deublein and Angelika Steinhauser (Eds.), Wiley, 2008
5. Thermochemical Processing of Biomass: Conversion into Fuels, Chemicals and Power, Robert C. Brown, John Wiley & Sons, 2011.
6. Biorefinery: From Biomass to Chemicals and Fuels, Michele Aresta, Angela Dibenedetto, Franck Dumeignil, de Gruyter, 2012.

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.

Approval

24. Module leader's signature	Dr Volkan Degirmenci
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**	**3 hr**
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**	
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)**
Demonstrate an advanced understanding of biomass chemistry and a detailed knowledge of different types of biomass for modern biotechnology applications. Critically evaluate the suitability and feasibility of biofuels for a given application.	Formal lectures and example classes	Exam/assignment
Critique the physical treatment and handling of biomass using advanced modern methods. Understand complex thermal biomass conversion processes, including gasification, combustion, pyrolysis and liquefaction.	Formal lectures and example classes	Exam/assignment
Perform detailed analyses of the complex underlying principles of biochemical biomass conversion, including biogas and biofuel production from various sources. Perform economic analyses and critically assess the impact on the environment of biomass production and use.	Formal lectures and example classes	Exam/assignment
Demonstrate a deep understanding of the modern biorefinery concept, including process such as hydrolysis of biomass, bio-based fuel additives, lignin conversion and levulinic acid and furfural conversion.	Formal lectures and example classes	Exam/assignment
Evaluate logistical and ethical considerations in the context of the environment and be able to critically assess the feasibility of biorefineries based on logistical and environmental constraints.	Formal lectures and example classes	Exam/assignment