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	1/10/2016
If new, does this module replace another? If so, enter module code and title:	No
If revised/discontinued, please outline the rationale for the changes:	
Confirmation that affected departments have been consulted:	N/A

Module Summary

1. Module Code (if known)	ES97J
2. Module Title	Introduction to Systems and Synthetic Biology
3a. Lead department:	Engineering
3b. Teaching Split (if known):	Approximately equally between Declan Bates, Volkan Kulkarni, and Mathias Foo (PDRA)
4. Name of module leader	Professor Declan Bates
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	This module aims to introduce students to the new fields of Systems Biology and Synthetic Biology. In particular, it will focus on how computational and mathematical methods can be used for the modeling, analysis, and design of biological systems. The module aims to give students a hands-on computational experience through Matlab assignments. The module will aim to foster a highly multidisciplinary view of biology, and to describe the recent

Module Summary	
	evolution of the field towards being an engineering science.
8. Principal Learning Outcomes	By the end of this module students will be able to: • appreciate the complexity of models of biological systems; • understand the role of feedback in regulating biological phenomena; • use an array of computational packages and analysis methods on models and available datasets of diverse biological phenomena to get a better insights; • use Matlab toolboxes for analyzing and designing biological systems; • understand how modeling can be used in the design of synthetic biological circuits and systems; • understand fundamental design principles such as modularity, retroactivity, robustness, etc; • combine experimental and theoretical concepts, literature and ideas; • be able to work individually and in small, multi/interdisciplinary groups to tackle complex problems; • communicate with scientists from experimental and/or theoretical backgrounds; • think creatively and beyond traditional discipline boundaries.
9. Timetabled Teaching Activities (summary)	15 hours of formal lectures, 15 hours of hands-on Matlab laboratories, 3 hours of research seminars from practising researchers in the fields of Systems and Synthetic Biology.
10. Departmental Web-link	
11. Other essential notes	Offered to M.Sc. students only. To be run as a short intensive course over three weeks in the Spring term (5 hours of lectures and labs each week).
12. Assessment methods (summary)	Assessment will be via an individual assignment. Due to the computational and research focus of the module, it is not appropriate to examine students via a traditional “pencil and paper” type written exam. Instead, we will assess students’ level of engagement with the research literature and proficiency with Matlab-based computational tools via a report (70%) and presentation (30%) on an individual assignment. The assignment will be based on a problem from current research in the fields of Systems and Synthetic Biology, and will require the use of computational tools introduced during the delivery of the module.

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.
Engineering
14. Availability of module

Degree Code	Title	Study Year	C/OC/ A/B/C	Credits
H800	**M.Sc. Biomedical Engineering**	**1**	**C**	**15**

15. Minimum number of registered students required for module to run
1
16. Pre- and Post-Requisite Modules
Matlab Programming training in Term 1 or equivalent experience

Module Content and Teaching	
17. Teaching and Learning Activities *(totals for module – please see guidance)*	
Module duration (weeks)	**3**
Lectures	**15 (5 hours/week)**
Seminars	**3**
Tutorials	
Project Supervision	
Demonstration	
Practical Class/Workshops	**15 (5 hours/week)**
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.*	**Self-study 117 hr**

Module Content and Teaching

18. Assessment Method (Standard)		
Type of assessment	**Length**	**% weighting**
Written Examinations		
Practical Examinations		
Assessed essays/coursework	Individual Assignment Report Max 6000 words excluding figures Individual Assignment Presentation	70% 3 0%
18a. Final chronological assessment *(please see guidance)*	Individual Assignment Presentation	

19. Methods for providing feedback on assessment.

Hands-on Matlab laboratories will align student expectations with requirements for assessment, and provide preparation for undertaking their individual assignment. Assignments will be marked with detailed individual comments aligned with assessment criteria.

The assignment will consist of a report and an oral presentation. Both will be marked:

1. The report (70% of the module mark) will be marked considering its technical content (i.e., clarity, completeness, references etc.), originality and format (i.e., clear table of contents, consistent format of titles, references, tables and figures etc.). The report will be marked and returned to students with detailed comments.
2. The presentation (30% of the module mark) will be marked considering technical content, format, presentation skills and ability to answer questions.

20. Outline Syllabus

- Modeling biological circuits and systems
- Analysis of biological system models using linear systems theory
- Analysis of biological system models using nonlinear systems theory
- The role of feedback control in biological systems
- Robustness in biological systems
- Reverse engineering biological systems and network models
- Modularity as a design principle in synthetic biological circuits
- Synthetic biological circuits – oscillators, toggle-switches, logic gates, etc
- Retroactivity and insulation devices

21. Illustrative Bibliography

1. Carlo Cosentino and Decslan Bates. "Feedback Control in Systems Biology", Taylor & Francis, 2011. ISBN 9781439816905
2. Domitilla Del Vecchio and Richard Murray. "Biomolecular Feedback Systems", Princeton University Press, 2015. ISBN: 9780691161532
3. Aydin Tozeren and Stephen Byers. "New Biology for Engineers and Computer Scientists", Pearson, 2004. ISBN: 9780130664631
4. Brian Hahn and Dan Valentine. "Essential MATLAB for Engineers and Scientists", Elsevier, 2013 **ISBN**-9780123943989,
5. Nicholas F Britton. "Essential Mathematical Biology", Springer, 2003. **ISBN** 978-**1**-4471-0049-2
6. James D Murray. "Mathematical Biology: An Introduction: Part 1", Springer, 2002. ISBN 978-0387952239
7. Steven H Strogatz. "Nonlinear Dynamics and Chaos", Perseus Books, 2000. 978-0738204536
8. Uri Alon. "An Introduction to Systems Biology: Design Principles of Biological Circuits", Chapman & Hall, 2006. ISBN 9781584886426
9. James Keener and James Sneyd. "Mathematical Physiology", Springer-Verlag, 1998. ISBN 978-0-387-75847-3
10. Edda Klipp et al. "Systems Biology: A Textbook", Wiley VCH Blackwell, 2009. ISBN 978-3527318742

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

Approval	
24. Module leader's signature	
25. Date of approval	14 April 2016
26. Name of Approving Committee (include minute reference if applicable)	School of Engineering Teaching Policy Committee Meeting of 14 April 2016
27. Chair of Committee's signature	
28. Head of Department(s) signature	

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**
	Individual Assignment Report Max 6000 words 70% Individual Assignment Presentation 30%	
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)?		
A6. Is reading time required?	☐ Yes	☐ No
A7. Please specify any special exam timetable arrangements.		
Oral presentation a couple of weeks after the module ends		
A8. Stationery requirements		
No. of Answer books?		
Graph paper?		
Calculator?		
Any other special stationery requirements (e.g. Data books, tables etc)?		
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)**
develop and implement in software computational and mathematical models of a wide range of biological systems, from models of tumour growth to signal transduction networks to cell cycle regulatory networks.	Formal lectures and hands-on Matlab laboratories	Individual marked assignment (report and presentation)
understand the role of feedback in regulating biological phenomena; e.g. the role of integral control in regulating calcium homeostasis in mammals.	Formal lectures and hands-on Matlab laboratories	Individual marked assignment (report and presentation)
analyse models and simulation data of diverse biological phenomena using a range of appropriate computational and analytical tools/techniques; including linear analysis methods (state-space and transfer function models, gain/phase margins, etc) and nonlinear analysis methods (linearization of nonlinear biochemical models, stability analysis, region of attraction estimation, etc)	Formal lectures and hands-on Matlab laboratories	Individual marked assignment (report and presentation)

understand the role of modeling in guiding the design of synthetic biological circuits and systems and be familiar with key synthetic circuits from the field of - Synthetic Biology, e.g. oscillators, toggle-switches, logic gates, etc.	Formal lectures and hands-on Matlab laboratories	Individual marked assignment (report and presentation)
be familiar with fundamental design principles from the field of Synthetic Biology, e.g. modularity, retroactivity, robustness, etc, and be able to apply state-of-the-art computational tools for designing modular synthetic circuits	Formal lectures and hands-on Matlab laboratories	Individual marked assignment (report and presentation)
combine experimental and theoretical concepts, literature and ideas; be able to work individually and in small, multi/interdisciplinary groups to tackle complex problems; communicate with scientists from experimental and/or theoretical backgrounds; think creatively and beyond traditional discipline boundaries.	Formal lectures and hands-on Matlab laboratories, research seminars	Individual marked assignment (report and presentation)