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	02/10/2017
If new, does this module replace another? If so, enter module code and title:	
If revised/discontinued, please outline the rationale for the changes:	Revised to make available to Year 4 MEng
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)	ES97K
2. Module Title	Computational Intelligence in Biomedical Engineering
3a. Lead department:	School of Engineering
3b. Teaching Split (if known):	100% Engineering
4. Name of module leader	Professor Christopher James
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 further enhance the students' skills in biomedical signal and data processing with the principles of computational intelligence as applied to biomedical engineering including cardiology, neurology, biomechanics and movement sciences.

Module Summary	
	The module will provide the student with a firm grounding in methods and tools for extracting information from biomedical signals and data. The module will introduce the practical implementation of computational intelligence techniques applied to digitally acquired biomedical signals.
8. Principal Learning Outcomes	At the end of the module, students will be able to: • demonstrate a systematic knowledge of the complex physical and physiological principles that underpin the measurement of biomedical signals/ data. • demonstrate an advanced understanding of the principles of computational intelligence. • systematically apply computational intelligence techniques to extract relevant information from biomedical signal measurements/ data. • critically assess the appropriateness of different computational intelligence techniques for various problems in the field. • evaluate the effectiveness of techniques applied to biomedical signals/ data against specific benchmarks. • participate in a multidisciplinary working group for the systematic design and development of an innovative solution to a practical problem.
9. Timetabled Teaching Activities (summary)	20 lectures, 4 x 2hr computer laboratories, 2 x 1hr revision classes (**Total 30 hrs**)
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) and past examination questions.
12. Assessment methods (summary)	The module will be assessed as following: 1. 2 hour examination (60%) 2. Assignment 4000 words (40%) 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
H800	**MSc Biomedical Engineering**	**1**	**O**	**15**
H107	**MEng Engineering and variants**	**4**		
H109	**MEng Engineering with Intercalated Year**	**5**		
H110	**MEng Engineering with a Year in Research**	**5**		
HH63	**MEng Systems Engineering and variants**	**4**		
HH64	**MEng Systems Engineering with Intercalated Year**	**6**		
HH65	**MEng Systems Engineering with a Year in Research**	**5**		

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

1 Limited option choice for MSc Biomedical Engineering

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	**20x 1 hour**
Seminars	**0**
Tutorials	
Project Supervision	
Demonstration	
Practical Class/Workshops	**4 x 2hr**
Supervised time in studio/workshop	
Fieldwork	

Module Content and Teaching	
External visits	**0**
Work based learning	
Placement	
Year abroad	
Other activity *(please describe): e.g. distance-learning, intensive weekend teaching etc.*	**2 x 1hr example/revision classes** **Guided Independent Learning 120 hrs**

18. Assessment Method (Standard)		
Type of assessment	**Length**	**% weighting**
Written Examinations	2 Hours	**60%**
Practical Examinations		
Assessed essays/coursework	**Assignment 4000 words**	**40%**
18a. Final chronological assessment *(please see guidance*)	**Examination**	

19. Methods for providing feedback on assessment.

Coursework marked with detailed comments
Face-to-face feedback in practicals
Cohort level feedback on examinations

20. Outline Syllabus

- *Introduction*
  - *Fundamentals*
  - *Basic Signal Processing Techniques*
  - *The need for Computational Intelligence (CI) in BME*
- *Artificial Neural Networks (ANNs)*
  - *Basics*
  - *Architectures*
  - *Optimization and Learning*
  - *Popular ANN architectures and learning algorithms*
- *Support Vector Machines (SVM)*
  - *Classifiers and Classification*
  - *Support Vector Classifiers*
  - *Support Vector Regression*
  - *Training SVMs*
- *Hidden Markov Models (HMMs)*

- *The Markov Chain*
- *The Hidden State*
- *Types of HMMs*

- *Fuzzy Sets and Fuzzy Logic*
  - *Fuzzy Sets*
  - *Fuzzy Membership Functions*
  - *Fuzzy Operations*
  - *Applications of Fuzzy Systems*
- *Applications of CI to BME case studies:*
  - *Cardiology – ECG feature extraction, disease diagnosis*
  - *Neurophysiology – disease detection and diagnosis, EMG & neuromuscular disease*
  - *Biomechanics and Gait Analysis – recognition of pathological/ageing and falls-risk, aligned to gait*

21. Illustrative Bibliography

1. R. Begg, D.T.H. Lai and M. Palaniswami, Computational Intelligence in Biomedical Engineering, CRC Press, 2008,ISBN-13: 978-0-8493-4080-2
2. A V Oppenheim & R W Schafer, Discrete-time Digital Signal Processing, 2009, ISBN-13: 978-0131988422 ISBN-10: 0131988425 Edition: 3rd, Prentice-Hall: Englewood Cliffs, NJ
3. M. Hagan, H.B. Demuth and M. Beale, Neural Network Design, PWS Publishing Company, ISBN-13: 0-534-94332-2
4. Selected articles from scientific journals, including:
   a. IEEE Transactions of Biomedical Engineering, ISSN: 0018-9294
   b. Medical Biological Engineering and Computing, ISSN: 1741-0444 (electronic version)

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 Christopher James
25. Date of approval	Teaching Policy Committee Chair's Action 5 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 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**
60 (	**40 assignment 4000 words**	**2 hour**
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.		
Examinations for MSc and MEng students should be scheduled together		
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

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)**
Demonstrate a systematic knowledge of the complex physical and physiological principles that underpin the measurement of biomedical signals/ data.	Formal lectures, laboratories	Examination/coursework
Demonstrate an advanced understanding of the principles of computational intelligence.	Formal lectures, laboratories	Examination/coursework
Systematically apply computational intelligence techniques to extract relevant information from biomedical signal measurements/ data.	Formal lectures, laboratories	Examination/coursework
Critically assess the appropriateness of different computational intelligence techniques for various problems in the field.	Formal lectures, laboratories	Examination/coursework
Evaluate the effectiveness of techniques applied to biomedical signals/ data against specific benchmarks.	Formal lectures, laboratories	Coursework
Participate in a multidisciplinary working group for the systematic design and development of an innovative solution to a practical problem.	Formal lectures, laboratories	Coursework