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	1 October 2017
If new, does this module replace another? If so, enter module code and title:	N/A
If revised/discontinued, please outline the rationale for the changes:	Revised to bring into a consistent format following the curriculum review.
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)	ES97H
2. Module Title	Biomedical Signal Processing
3a. Lead department:	School of Engineering
3b. Teaching Split (if known):	100% Engineering
4. Name of module leader	Dr Igor Khovanov
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 introduce students to the principles of signal processing techniques when applied specifically to biomedical signals, including: ECG, MEG, EEG, SPO2, heart rate etc. The module will provide the student with a firm grounding in methods and tools for extracting information from digitally acquired biomedical signals.

Module Summary	
	The module will introduce the practical implementation of signal processing techniques to digitally acquired biomedical signals.
8. Principal Learning Outcomes	At the end of the module, students will be able: • Demonstrate a systematic knowledge of the complex physical and physiological principles that underpin biomedical signals. • Demonstrate an advanced understanding of the principles of digital signal processing. • Systematically apply methods to extract relevant information from biomedical signal measurements. • Critically assess the appropriateness of biomedical signal processing techniques for various problems in the field. • Evaluate the effectiveness of techniques applied to biomedical signals against specific benchmarks.
9. Timetabled Teaching Activities (summary)	20 lectures, 3*3hr laboratories, 2*2hr revision classes (total 33 hrs)
10. Departmental Web-link	http://www2.warwick.ac.uk/fac/sci/eng/eso/modules/year4/es97h
11. Other essential notes	Advice and feedback hours are available for answering questions on the lecture material, theory and lab exercises.
12. Assessment methods (summary)	The module will be assessed as following: 1. 2 hour Written examination (50%) 2. Coursework – worksheet based on laboratory classes (15%) 3. Data analysis assignment (35%)

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**	**C**	**15**

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

1

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	**20**
Seminars	**0**
Tutorials	
Project Supervision	
Demonstration	
Practical Class/Workshops	**3*3hr**
Supervised time in studio/workshop	
Fieldwork	
External visits	**0**
Work based learning	
Placement	
Year abroad	
Other activity *(please describe): e.g. distance-learning, intensive weekend teaching etc.*	**Revision Classes 2*2 hrs** **Guided independent learning 117 hrs**

18. Assessment Method (Standard)

Type of assessment	Length	% weighting
Written Examinations	2 Hours	**50%**

Module Content and Teaching		
Practical Examinations		
Assessed essays/coursework	**Worksheet based on Laboratory Classes (coursework)** **Individual data analysis Assignment. Functioning Code with Report; max 5000 words**	**15%** **35%**
18a. Final chronological assessment *(please see guidance*)	**Examination**	

19. Methods for providing feedback on assessment.
Coursework marked with detailed comments Feedback during revision classes Face-to-face feedback on coursework in Laboratory Classes Cohort level feedback on examinations
20. Outline Syllabus

• *Introduction to Biomedical Signals*
  ○ *The Nature of Biomedical Signals*
  ○ *Examples of Biomedical Signals*
  ○ *Objectives and Difficulties of Biomedical Signal Analysis*
• *Signal Processing by Linear Time Invariant Systems*
  ○ *Laplace Transform and Transfer function*
  ○ *System Stability*
  ○ *Impulse and Frequency response*
• *Digital Linear Systems*
  ○ *Z transform and Transfer function*
  ○ *System Stability*
  ○ *Impulse and Frequency response*
• *Random Physiological Signals*
  ○ *Signal as a realization of a Stochastic Process*
  ○ *Stationarity and Ergodicity*
  ○ *General procedure for analysing single time series*
• *Frequency Domain Characterization of Biomedical Signals*
  ○ *Fourier Spectrum, Magnitude and Phase Response.*
  ○ *Sampling, Edge and Aliasing Effects, Fast Fourier Transform*
  ○ *Spectral Power Density*
• *Digital Filtering for Removal of Artifacts*
  ○ *Frequency Domain and Time Domain Filters*
  ○ *Digital FIR and IRR Filters*
  ○ *MATLAB functions for Analogue Filter Designs*
  ○ *Case Study. Filtering Artifacts in ECG Signal*

- *Case Study. Envelope Extraction in EMG Signal*
- *Data Driven Modelling of Biomedical Signals via ARMA processes*
  - *Auto-regressive moving-average models*
  - *MATLAB functions for estimating parameters of ARMA models*
  - *Parametric Calculation of Spectra*
  - *ARMA modelling EEG and EMG signals*
- Advanced Methods of Biomedical Signal Processing

21. Illustrative Bibliography

1. Ramgaraj M. Rangayyan, Biomedical Signal Analysis: A Case-Study Approach. IEEE press 2001
2. Eugene N. Bruce, Biomedical Signal Processing and Signal Modeling, John Wiley & Sons, 2000
3. 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
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

Resources

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

Practical Sessions require access to the Computer Laboratory in order to perform processing and analysis of biomedical signals.

Approval

24. Module leader's signature	Dr Igor Khovanov
25. Date of approval	Teaching Policy Committee Chair's Action 30 August 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**
50	**15 Worksheet based on Laboratory Classes (coursework)** **35 Individual data analysis Assignment. Functioning Code with Report; max 5000 words**	**2hr**
A3. Will this module be examined together with any other module (sectioned paper)? If so, please give details below.		
No		
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

Examination Information		
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 a systematic knowledge of the complex physical and physiological principles that underpin biomedical signals.	Formal lectures and laboratories	Examination/coursework
Demonstrate an advanced understanding of the principals of digital signal processing.	Formal lectures, laboratories	Examination/coursework
Systematically apply advanced methods to extract relevant information from biomedical signal measurements.	Formal lectures, laboratories	Examination/assignment
Critically assess the appropriateness of biomedical signal processing techniques for various problems in the field.	Formal lectures, laboratories, assignment	Examination/assignment
Evaluate the effectiveness of techniques applied to biomedical signals against specific benchmarks.	Formal lectures, laboratories, assignment	Assignment