

# ES97K-15 Computational Intelligence in Biomedical Engineering

**20/21**

**Department**

School of Engineering

**Level**

Taught Postgraduate Level

**Module leader**

Christopher James

**Credit value**

15

**Module duration**

10 weeks

**Assessment**

40% coursework, 60% exam

**Study location**

University of Warwick main campus, Coventry

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## Description

### Introductory description

ES97K-15 Computational Intelligence in Biomedical Engineering

[Module web page](#)

### 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.

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.

### Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

- Introduction
  - o Fundamentals
  - o Basic Signal Processing Techniques
  - o The need for Computational Intelligence (CI) in BME
- Artificial Neural Networks (ANNs)
  - o Basics
  - o Architectures
  - o Optimization and Learning
  - o Popular ANN architectures and learning algorithms
- Support Vector Machines (SVM)
  - o Classifiers and Classification
  - o Support Vector Classifiers
  - o Support Vector Regression
  - o Training SVMs
- Hidden Markov Models (HMMs)
  - o The Markov Chain
  - o The Hidden State
  - o Types of HMMs
- Fuzzy Sets and Fuzzy Logic
  - o Fuzzy Sets
  - o Fuzzy Membership Functions
  - o Fuzzy Operations
  - o Applications of Fuzzy Systems
- Applications of CI to BME case studies:
  - o Cardiology – ECG feature extraction, disease diagnosis
  - o Neurophysiology – disease detection and diagnosis, EMG & neuromuscular disease
  - o Biomechanics and Gait Analysis – recognition of pathological/ageing and falls-risk, aligned to gait

## Learning outcomes

By the end of the module, students should 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.
- participate in a multidisciplinary working group for the systematic design and development of an innovative solution to a practical problem.
- evaluate the effectiveness of techniques applied to biomedical signals/ data against specific benchmarks.

## Indicative reading list

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 Schaffer, 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)

## Subject specific skills

TBC

## Transferable skills

TBC

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## Study

### Study time

Type	Required
Lectures	20 sessions of 1 hour (13%)
Practical classes	4 sessions of 2 hours (5%)
Other activity	2 hours (1%)
Private study	120 hours (80%)
Total	150 hours

### Private study description

Guided Independent Learning 120 hours

### Other activity description

2x1 hour example/revision classes

## Costs

No further costs have been identified for this module.

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## Assessment

You must pass all assessment components to pass the module.

### Assessment group D1

	Weighting	Study time
Coursework Assignment Assignment 4000 words	40%	
Written Examination Written Examination 2 hours	60%	

### Feedback on assessment

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

[Past exam papers for ES97K](#)

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## Availability

### Courses

This module is Optional for:

- UESA-H107 MEng Engineering
  - Year 4 of H107 Engineering MEng
  - Year 4 of H10E Engineering with Appropriate Technology MEng
  - Year 4 of H10J Engineering with Automotive Engineering MEng
  - Year 4 of H10C Engineering with Business Management MEng
  - Year 4 of H10G Engineering with Communications MEng
  - Year 4 of H10H Engineering with Computer Engineering MEng
  - Year 4 of H10M Engineering with Fluid Dynamics MEng
  - Year 4 of H10F Engineering with Instrumentation MEng
  - Year 4 of H10K Engineering with Robotics MEng
  - Year 4 of H10D Engineering with Sustainability MEng
  - Year 4 of H10L Engineering with Systems Engineering MEng
- UESA-H109 MEng Engineering with Intercalated Year
  - Year 5 of H109 Engineering with Intercalated Year MEng
  - Year 5 of H10Q Engineering with Intercalated Year with Appropriate Technology MEng
  - Year 5 of H10U Engineering with Intercalated Year with Automotive Engineering MEng

- Year 5 of H10N Engineering with Intercolated Year with Business Management MEng
- Year 5 of H10S Engineering with Intercolated Year with Communications MEng
- Year 5 of H10T Engineering with Intercolated Year with Computer Engineering MEng
- Year 5 of H10X Engineering with Intercolated Year with Fluid Dynamics MEng
- Year 5 of H10R Engineering with Intercolated Year with Instrumentation MEng
- Year 5 of H10V Engineering with Intercolated Year with Robotics MEng
- Year 5 of H10P Engineering with Intercolated Year with Sustainability MEng
- Year 5 of H10W Engineering with Intercolated Year with Systems Engineering MEng
- UESA-H110 MEng Engineering with Year in Research
  - Year 5 of H110 Engineering with Year in Research MEng
  - Year 5 of H11C Engineering with Year in Research with Appropriate Technology MEng
  - Year 5 of H11G Engineering with Year in Research with Automotive Engineering MEng
  - Year 5 of H11A Engineering with Year in Research with Business Management MEng
  - Year 5 of H11E Engineering with Year in Research with Communications MEng
  - Year 5 of H11F Engineering with Year in Research with Computer Engineering MEng
  - Year 5 of H11K Engineering with Year in Research with Fluid Dynamics MEng
  - Year 5 of H11D Engineering with Year in Research with Instrumentation MEng
  - Year 5 of H11H Engineering with Year in Research with Robotics MEng
  - Year 5 of H11B Engineering with Year in Research with Sustainability MEng
  - Year 5 of H11J Engineering with Year in Research with Systems Engineering MEng
- UESA-HH63 MEng Systems Engineering
  - Year 4 of HH63 Systems Engineering (MEng)
  - Year 4 of H63E Systems Engineering with Automotive Engineering
  - Year 4 of H63A Systems Engineering with Business Management
  - Year 4 of H63C Systems Engineering with Computer Engineering
  - Year 4 of H63D Systems Engineering with Instrumentation
  - Year 4 of H63F Systems Engineering with Robotics
  - Year 4 of H63B Systems Engineering with Sustainability
- UESA-HH64 MEng Systems Engineering with Intercolated Year
  - Year 6 of HH64 Systems Engineering with Intercolated Year
  - Year 6 of H63S Systems Engineering with Intercolated Year with Automotive Engineering
  - Year 6 of H63N Systems Engineering with Intercolated Year with Business Management
  - Year 6 of H63Q Systems Engineering with Intercolated Year with Computer Engineering
  - Year 6 of H63R Systems Engineering with Intercolated Year with Instrumentation
  - Year 6 of H63T Systems Engineering with Intercolated Year with Robotics
  - Year 6 of H63P Systems Engineering with Intercolated Year with Sustainability
- UESA-HH65 MEng Systems Engineering with Year in Research
  - Year 5 of HH65 Systems Engineering with Year in Research
  - Year 5 of H63L Systems Engineering with Year in Research with Automotive Engineering
  - Year 5 of H63G Systems Engineering with Year in Research with Business Management
  - Year 5 of H63J Systems Engineering with Year in Research with Computer

## Engineering

- Year 5 of H63K Systems Engineering with Year in Research with Instrumentation
- Year 5 of H63M Systems Engineering with Year in Research with Robotics
- Year 5 of H63H Systems Engineering with Year in Research with Sustainability
- Year 1 of TESA-H800 Postgraduate Taught Biomedical Engineering