UNIVERSITY OF WARWICK

Proposal Form for New or Revised Modules (MA1 - version 7 - November 2016)

Approval information	
Approval Type	☐ New module ☒ Revised module ☐ Discontinue module
Date of Introduction/Change	October 2018
If new, does this module replace another? If so, enter module code and title:	
If revised/discontinued, please outline the rationale for the changes:	Over-assessed module - revised to reduce assessment. Ticked IET learning outcomes are unchanged.
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)	ES2C6
2. Module Title	Electromechanical System Design
3a. Lead department:	School of Engineering
3b. Teaching Split (if known)	Minimum 90% School of Engineering Maximum 10% WMG
4. Name of module leader	Dr Layi Alatise
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

Module Summary	
7. Principal Module Aims	The module aims to develop an understanding of electrical power generation, transmission, distribution and consumption and of how integrated engineering systems with energy conversion stages operate. It also aims to an understanding of the underpinning science behind energy conversion in electromechanical systems and instil the fundamental engineering principles and mathematical techniques of electromechanical power conversion. The module aims to show applications of instrumentation and measurement in integrated electromechanical engineering systems, apply the principles of engineering control and feedback and design an electromechanical system with motors, actuators, sensors, control, etc.
8. Principal Learning Outcomes	By the end of the module the student should be able to: • Apply the mathematical principles and formulations behind real, reactive, complex and apparent power. • Evaluate the design and efficiency of a power system with transformers and motors • Appreciate and understand the operation of motors for energy conversion in modern electro-mechanical systems • Use sensors, op-amps, actuators and feedback to implement control in modern electromechanical systems • Understand measurement and instrumentation in modern electro-mechanical systems. • Conceptualise, design and evaluate an electro-mechanical system
9. Timetabled Teaching Activities (summary)	Lectures 30 hrs, Seminars on industrial case studies 3 x 1 hr, Revision classes 2 x 1hr, design project briefing 1 hrs, 8 hours supervised project design lab, 8 hours self-directed project design lab **Total 52 hours**
10. Departmental Web-link	www2.warwick.ac.uk/fac/sci/eng/eso/modules/year2/es2c6/
11. Other essential notes	Advice and feedback hours for answering questions on the lecture material (theory and examples) and past examination questions. Students will be divided into sub-groups working within five separate Group Projects
12. Assessment methods (summary)	Design Project Group Report with peer assessment (40%) 2 hour Examination (60%)

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.

Minimum 90% School of Engineering. Maximum 10% WMG

14. Availability of module

Degree Code	Title	Study Year	C/OC/ A/B/C	Credits
H113	BEng Engineering	2	C	15
H114	MEng Engineering	2	C	15
H161	BEng Biomedical Systems Engineering	2	C	15
H163	MEng Biomedical Systems Engineering	2	C	15
H216	BEng Civil Engineering	2	C	15
H217	MEng Civil Engineering	2	C	15
H315	BEng Mechanical Engineering	2	C	15
H316	MEng Mechanical Engineering	2	C	15
H335	BEng Automotive Engineering	2	C	15
H336	MEng Automotive Engineering	2	C	15
H605	BEng Electrical and Electronic Engineering	2	C	15
H606	MEng Electrical and Electronic Engineering	2	C	15
H63W	BEng Electronic Engineering	2	C	15
H63X	MEng Electronic Engineering	2	C	15
HH35	BEng Systems Engineering	2	C	15
HH31	MEng Systems Engineering	2	C	15
HH75	BEng Manufacturing and Mechanical Engineering	2	C	15
HH76	MEng Manufacturing and Mechanical Engineering	2	C	15
HN11	BSc Engineering and Business Studies	2	C	15
HN15	BEng Engineering Business Management	2	C	15

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

1 (core module)

16. Pre- and Post-Requisite Modules

Module Content and Teaching		
17. Teaching and Learning Activities *(totals for module – please see guidance)*		
Module duration (weeks)	10 weeks	
Lectures	30 hours	
Seminars	3 x 1 hour (case studies and industrial lectures) 1 hour (Briefing for design project – relevant to all projects)	
Tutorials		
Project Supervision	8 hours (design implementation) for each project	
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.*	8 hours of self-directed design lab implementation 2x1 hour revision classes Guided Independent Learning 98 hrs	
18. Assessment Method (Standard)		
Type of assessment	**Length**	**% weighting**
Written Examinations	2 Hours	60
Practical Examinations		
Assessed essays/coursework	Design project group report including peer assessment	40
18a. Final chronological assessment *(please see guidance*)	**Examination**	

19. Methods for providing feedback on assessment.
• Support through advice and feedback hours. • Written feedback on marked design report. • Cohort-level feedback on final exam.

20. Outline Syllabus

Fundamentals of Electrical power

- AC power (real, reactive, complex and apparent power)
- Power factor correction and reactive power compensation in AC systems
- 3-Phase AC system (Star systems, delta systems, phase quantities, line quantities)
- Magnetic circuits and Systems (Fields, flux, Ampere's law, Reluctance, magnetic cores, permeability, Magnetomotive force, B-H curves, air-gaps etc)
- Transformers (equivalent circuit, leakage reactance, magnetizing inductance etc).
- Power Systems (line diagrams, transmission lines, transmission losses, radial and ring systems)
- Rotating magnetic fields (machine coils and derivation from 3-phase currents)
- Induction motors (Equivalent circuits, speed vs Torque characteristics, slip)
- DC Motors (Separately excited, shunt, series DC motors, Torque, speed and control)
- 3 phase inverters and rectifiers (Brief introduction)

Instrumentation and Measurements

- Sensors (speed sensors, current sensors, voltage sensors etc)
- Recap of operational amplifiers
- Op-amp circuits e.g. instrumentation amplifiers
- Basic control system with gain, error and feedback (open loop and closed loop)
- Block diagram and signal flow representation of control systems (system modelling and reduction techniques)
- PID controllers implemented by Op-amps
- Stability (transfer functions, Barkhausen criterion, Nyquist stability, Zeigler Nicholls)
- Data acquisition

Case studies

Indicative topics:

- Gyroscopically stabilised structures (using control theory and motors for earthquake resistance buildings)
- Electric Transportation (Automotive, Rail, MEA, ship-traction)
- Heating, Ventilation and air-conditioning systems (HVAC) for buildings

21. Illustrative Bibliography

Stephen J. Chapman, Electric Machinery Fundamentals, 5th edition, McGraw Hill, 2012.
Measurement and Instrumentation: Theory and Application, Second Edition, Alan S. Morris and Reza Langari, Academic Press, Elsevier, 2016
Introduction to Instrumentation and Measurements, Third Edition, Robert B. Northrop, 2014 , CRC Press

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.
N/A

Approval	
24. Module leader's signature	Dr Layi Alatise
25. Date of approval	20 March 2018
26. Name of Approving Committee (include minute reference if applicable)	School of Engineering and WMG Course and Module Approval Committee Minute 155-17/18
27. Chair of Committee's signature	Professor Gillian Cooke
28. Head of Department(s) Signature	Professor David Towers

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	**Design Project Group Report including peer assessment 40%**	**2 hours**
A3. Will this module be examined together with any other module (sectioned paper)? If so, please give details below.		
N		
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)?	**January**	
A6. Is reading time required?	☐ Yes	☒ No
A7. Please specify any special exam timetable arrangements.		
A8. Stationery requirements		
No. of Answer books?	**2**	
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)**
Apply the mathematical principles and formulations behind real, reactive, complex and apparent power.	Lectures	Examination
Evaluate the design and efficiency of a power system with transformers and motors	Lectures	Examination
Appreciate and understand the operation of motors for energy conversion in modern electro-mechanical systems	Lectures, design project	Design project report and examination
Use sensors, op-amps, actuators and feedback to implement control in modern electromechanical systems	Lectures, design project	Design Project Report and examination
Understand measurement and instrumentation in modern electro-mechanical systems.	Lectures, design project	Design project report and examination
Conceptualise, design and evaluate an electro-mechanical system	Lectures, design project	Design project report