Wrexham glyndŵr UNIVERSITY

MODULE SPECIFICATION

Module Title:	**Power Electronics and Electric Drives**	**Level**:	6	**Credit Value**:	20

Module code:	ENG645	**Is this a new module?** No	**Code of module being replaced**:	N/A

Cost Centre:	GAEE	**JACS3 code**:	H650

Trimester(s) in which to be offered:	1 & 2	**With effect from:**	September 17

School:	Applied Science, Computing & Engineering	**Module Leader:**	Yuriy Vagapov

Scheduled learning and teaching hours	60 hrs
Guided independent study	140 hrs
Placement	0 hrs
Module duration (total hours)	200 hrs

Programme(s) in which to be offered	Core	Option
BEng (Hons) Electrical & Electronic Engineering	☐	✓
BEng (Hons) Automation Engineering	✓	☐
BEng (Hons) Industrial Engineering	☐	✓

Pre-requisites
None

Office use only
Initial approval February 17
APSC approval of modification Version 2
Have any derogations received Academic Board approval? Yes ✓ No ☐

Module Aims
1. To develop the understanding of power electronic devices into the control or provision of power supplies and in controlling electrical machinery and thus to design and prove electronics-based circuits for the control of electrical machines and power supplies; 2. To develop the students' abilities to analyse techniques and performance of ac and dc electric drives by an in-depth knowledge of the principles of operation in order to exercise the ability to select an appropriate system for a given task.

Intended Learning Outcomes

Key skills for employability

KS1	Written, oral and media communication skills
KS2	Leadership, team working and networking skills
KS3	Opportunity, creativity and problem solving skills
KS4	Information technology skills and digital literacy
KS5	Information management skills
KS6	Research skills
KS7	Intercultural and sustainability skills
KS8	Career management skills
KS9	Learning to learn (managing personal and professional development, self-management)
KS10	Numeracy

At the end of this module, students will be able to		Key Skills	
1	Comprehensively understand the principles and operation of the electronic devices available for power applications	KS3	KS4
2	Critically analyse and evaluate the effects of power electronics equipment on electrical supplies and loads	KS4	
3	Apply appropriate techniques in the design of different types of converters	KS3	
4	Analyse the operating characteristics of the dc and ac electric drives with interaction to mechanical loads	KS3	
5	Evaluate the various types of electric drives used in industry and select the appropriate system for optimum performance	KS3	KS4

Transferable/key skills and other attributes

1. System analysis and design;
2. Apply design
3. Apply Technology

Derogations

A derogation from regulations has been approved for this programme which means that whilst the pass mark is 40% overall, each element of assessment (where there is more than one assessment) requires a minimum mark of 30%.

Assessment:

All learning outcomes will be assessed by means of a 3-hour written examination. It is an unseen time-constrained examination with a fixed number of questions, typically six, where students are required to answer only four out of the six possible.

Assessment number	Learning Outcomes to be met	Type of assessment	Weighting (%)	Duration (if exam)	Word count (or equivalent if appropriate)
1	1,2,3,4,5	Examination	100	3 Hours	

Learning and Teaching Strategies:

The module will be delivered through lectures, tutorials and student-driven investigative work. A significant amount of the content is to be achieved through individual study. Approximately one third of the timetabled time will be devoted to formal lectures. The remainder of the time will be allocated to tutorials and to individual study but also with some programmed access to lab/computer facilities, for practical investigation and analysis activities.

Syllabus outline:

Power Semiconductor Devices: Operation, characteristics, ratings, applications of diodes, thyristors, MOSFETs, IGBTs. Darlington-pair configuration, transistor as a switch. Analysis and calculation of power losses in power semiconductors. Selection of devices for particular tasks.

Thermal Consideration: Cooling systems and heat sinks. Thermal resistances. Thermal equivalent circuits. Heat transfer coefficient. Analysis and calculation of heat sink parameters.

AC–DC Converters - Rectifiers: Principle of operation of controlled rectifiers. Thyristor firing methods. Phase control firing circuits. Natural and forced commutation circuits. Single-phase and three-phase bridge rectifiers operating under different load conditions. Harmonics and power factor improvement.

DC–DC Converters: Principle of operation and characteristics of step-down, step-up, inverting converters. Duty ratio and voltage control.

DC–AC Converters - Inverters: Principle of operation and characteristics of single-phase and three-phase inverters. Pulse width modulation. Voltage control and harmonics.

Power Electronic Applications: Switching mode power supplies, Uninterruptible power sources. Power factor correctors. Static voltage regulators.

Introduction to Electric Drives: Mechanical system requirement for electric drives, Torque, speed and inertia in electric drive systems, Steady state and dynamic conditions, Coupling mechanisms, Rotary to linear motion, Gears, Optimum gear ratio, Types of load, Four quadrant operation.

Industrial Motor Control: Control devices, Induction motor control applications: Across-the-line starter, Reversing the direction of rotation, Primary resistance starting, Star-delta starting.

DC Electric Drives: Methods of speed control of dc motors, Speed control by controlled rectifiers, Dynamic model of dc motor, Block diagram and transfer function of dc motor, Dynamic behaviour of dc motor, Torque, speed and position sensors and feedbacks, Closed loop torque, speed and position control, Resistance starting, Dynamic braking.

AC Electric Drives: Methods of speed control of ac motors, Variable frequency converter and cycloconverter, Speed control of squirrel cage induction motor by static voltage regulator, Speed control of wound rotor induction motor with recovering slip power.

Motor Selection: Power range, Load requirements, Thermal consideration, duty cycle and rating, Enclosures and cooling, Dimension standards, Energy saving applications.

Bibliography:

Essential reading

Hughes, A. (2013) Electric Motors and Drives: Fundamentals, Types and Applications, 4th Edn., Oxford: Newnes.

Other indicative reading

Rashid, M. H. (2012) Power Electronics: Devices, Circuits, and Applications, 4th Edn., Harlow: Pearson Education.

Wildi, T. (2014) Electrical Machines, Drives and Power Systems, 6th Edn., Harlow: Pearson Education.