Module Specification

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Module Code	ENG6B9
Module Title	Power Electronics and Electrical Machines
Level	6
Credit value	20
Faculty	FAST
HECoS Code	100192
Cost Code	GAME

Programmes in which module to be offered

Programme title	Is the module core or option for this programme
BEng (Hons) Electrical & Electronic Engineering	Option
MEng Electrical & Electronic Engineering	Option
BEng (Hons) Renewable & Sustainable Engineering	Option
MEng Renewable & Sustainable Engineering	Option
BEng (Hons) Industrial Engineering (Electrical and Automation)	Core

Pre-requisites

None

Breakdown of module hours

Learning and teaching hours	24 hrs
Placement tutor support	0 hrs
Supervised learning e.g. practical classes, workshops	16 hrs
Project supervision (level 6 projects and dissertation modules only)	0 hrs
Total active learning and teaching hours	40 hrs
Placement / work based learning	0 hrs
Guided independent study	160 hrs
Module duration (total hours)	200 hrs

For office use only	
Initial approval date	22nd Aug 2022
With effect from date	Sept 2022
Date and details of revision	
Version number	1

Module aims

- To provide students with an understanding of the operation of power electronic systems/devices and electrical machinery including the appropriate analytical techniques to undertake the design and evaluation of power electronics and electrical machines applications.

Module Learning Outcomes - at the end of this module, students will be able to:

1	Analyse operation of power electronic systems and devices in power conversion industrial applications.
2	Apply appropriate analysis techniques and evaluation methods to assess, select and optimise the electrical machines applications including its control.
3	Use the power electronic equipment and components to install, test and maintain power electronic convertors and electrical machines.
4	Apply appropriate calculation methods to analyse operational parameters electrical machines and power electronic applications.

Assessment

Indicative Assessment Tasks:
This section outlines the type of assessment task the student will be expected to complete as part of the module. More details will be made available in the relevant academic year module handbook.

Assessment 1 - The theoretical aspects of the module content will be assessed by means of an examination. This will be closed book exam and the students will be expected to recall formulae necessary for calculations. The exam will involve the application of appropriate formulae in order to determine solutions relating to conversion of electrical energy using power electronic systems and electrical machines including performance, efficiency and reliability aspects. Indicative exam time 2 hrs.

Assessment 2 – This assessment is a portfolio of practical laboratory investigations and problem-solving activities exploring all topics of power electronics and electrical machines. The laboratory investigations involve appropriate circuit design, use of instrumentation and data collection relating to an analysis of performance of power electronics systems and electrical machines. The portfolio should cover the broad concepts along with the depth of study relating to a particular power electronic circuit and electrical machine. Indicative word count 2000 words.

Assessment number	Learning Outcomes to be met	Type of assessment	Weighting (%)
1	1, 2	Examination	50%
2	3, 4	Portfolio	50%

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%.

Learning and Teaching Strategies

Lectures - presentation of theory, facts and concepts, relating to electrical power engineering in order to convey critical information. Interaction or active learning should be implemented to develop an understanding of principles and concepts and stimulate discussion.

Tutorials – Close interaction with students ensuring that the work presented during lectures has been understood, with specific help being given in order to overcome any learning problems, should they occur.

Laboratory works – Practical experiments performed in order to demonstrate electrical power engineering principles being applied.

The module is taught through a combination of lectures and workshops. An active and inclusive approach is used to engage learners in the topics and will involve individual, group work and flipped learning experiences aligned to the university's Active Learning Framework (ALF). The approach offers students a flexible and adaptive learning experience that can accommodate a range of options that includes both on campus learning and remote learning where appropriate.

The Moodle VLE and other on-line materials and resources will be available to support learning. ALF offers a balance between the classroom elements and digitally enabled activity incorporating flexible and accessible resources and flexible and accessible feedback to support learning.

Indicative 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

Electromagnetism and Electromechanical Energy Conversion: Magnetic field, Force on current currying wire, Magneto-motive force, Magnetic circuits, Assumptions to calculate magnetic circuit, Magnetic materials, Magnetisation curve and hysteresis, Hysteresis loss, Eddy current loss, Torque, Load, Rotational speed, Angular velocity, Mechanical power.

Transformers: Principles, Ideal transformer, Transformer ratio of turns, e.m.f. equation, Equivalent circuit, Referred parameters, Phasor diagram, Determination of transformer parameters, Copper and core losses, Power flow diagram, Efficiency, Voltage regulation.

DC Machines: Principles of operation, Construction, Induced e.m.f. equation, Magnetisation curve of dc machines, Types of dc generators, Power flow diagram, Efficiency, Voltage regulation, Performance and characteristics of Separately excited, Shunt and Series dc generators, Types of dc motors, Developed torque and power, Power flow diagram, Efficiency, Performance and characteristics of Permanent magnet, Separately excited, Shunt and Series dc motors.

Induction Motors: Construction and principle of operation of three phase induction motor, Wound rotor induction motor, Squirrel cage induction motor, Generation of a rotating magnetic field, Synchronous and asynchronous speeds, Slip, Rotor e.m.f., Equivalent circuit, Dynamic resistance, Approximation of equivalent circuit, Losses, Power flow diagram, Efficiency, Torque/slip characteristics, Determination of equivalent circuit parameters, No-load test, Blocked rotor test.

Indicative Bibliography:

Please note the essential reads and other indicative reading are subject to annual review and update

Essential Reads

T. Wildi, *Electrical Machines, Drives and Power Systems*, 6th Ed. Harlow: Pearson Education, 2014.

Other indicative reading

M. H. Rashid, *Power Electronics: Devices, Circuits, and Applications*, 4th Ed. Harlow: Pearson Education, 2018.

S. J. Chapman, *Electric Machinery Fundamental*s, 5th Ed. McGraw-Hill, 2011.

Employability skills – the Glyndŵr Graduate

Each module and programme is designed to cover core Glyndŵr Graduate Attributes with the aim that each Graduate will leave Glyndŵr having achieved key employability skills as part of their study. The following attributes will be covered within this module either through the content or as part of the assessment. The programme is designed to cover all attributes and each module may cover different areas.

Core Attributes
Engaged
Enterprising
Creative
Ethical

Key Attitudes
Commitment
Curiosity
Resilience
Confidence
Adaptability

Practical Skillsets
Digital Fluency
Organisation
Leadership and Team working
Critical Thinking
Emotional Intelligence
Communication