Wrexham glyndŵr UNIVERSITY

MODULE SPECIFICATION PROFORMA

Module Title:	**Electrical Machines**	**Level**:	5	**Credit Value**:	20

Module code:	ENG564	**Is this a new module?** No	**Code of module being replaced**:	

Cost Centre:	GAEE	**JACS3 code**:	H360

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 and Electronic Engineering	☐	✓
BEng (Hons) Automation Engineering	✓	☐

Pre-requisites
None

Office use only
Initial approval February 17
APSC approval of modification Version 1
Have any derogations received Academic Board approval? Yes ✓ No ☐

Module Aims
1. To develop the theory and operation of electric machines and the properties of electric and magnetic materials used in their construction; to apply these ideas to the operation and application of rotating electric machines and transformers. 2. To develop the students' abilities to analyse techniques and performance of synchronous, induction and special machines by an in-depth knowledge of the principles of operation in order to exercise the ability to select a machine 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	Identify and explain the essential principles of operation and construction of a range of electrical machines	KS3	
		KS4	
2	Define the operating characteristics of rotating machines and transformers	KS4	
3	Analyse and select appropriate rotating machines and transformers for given applications	KS3	
4	Evaluate the various types of electrical machine used in industry and select the appropriate machine for optimum efficiency	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:

Assessment One: is by means of a portfolio of problem-solving activities and practical laboratory investigations exploring all topics of electric machinery. It covers outcomes 2 and 4.
Assessment Two: is by means of an examination covering outcomes 1 and 3. It is an unseen time-constrained examination with a fixed number of questions, typically five, where students are required to answer only three out of the five possible.

Assessment number	Learning Outcomes to be met	Type of assessment	Weighting (%)	Duration (if exam)	Word count (or equivalent if appropriate)
1	2,4	Portfolio	40		2000
2	1,3	Examination	60	2 Hours	

Learning and Teaching Strategies:

The module will be delivered through lectures, tutorials and practical exercises. The module will be presented to students through a specific structure of lectures and interactive tutorials. Leaning will be reinforced and extended by directed self-study via a set of problem-solving activities and practical laboratory investigations.

Syllabus outline:

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

DC Machines: Principles of operation, Construction, Induced e.m.f. equation, Magnetisation curve of dc machines, Commutation, Armature reaction.

DC Generators: Types of dc generators, Power flow diagram, Efficiency, Voltage regulation, Performance and characteristics of Separately excited, Shunt and Series dc generators.

DC Motors: 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.

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.

Three-Phase Synchronous Motors: Construction, Operation, Per phase equivalent circuit, Phasor diagram, Excitation, Losses, Power flow diagram, Efficiency, Characteristics, Performance under different power factor conditions.

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, Starting techniques and skin effect, NEMA type consideration, Principle of operation and performance of single phase induction motor. Three phase induction motor operating as a single phase induction motor.

Induction Generator: Principle of operation of induction generator, Self-exciting conditions, Double feed induction generator.

Special Motors: Construction, operation, performance and applications of Stepper motor, Brushless dc motor and Permanent magnet synchronous motor.

Bibliography:

Essential reading

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

Other indicative reading

Chapman, S. J. (2011) Electric Machinery Fundamentals, 5th Edn., New York: McGraw-Hill Higher Education.
Mohan, N. (2012) Electric Machines and Drives: A First Course, Hoboken: Wiley.