MODULE SPECIFICATION PROFORMA

Module Code:	ENG775

Module Title:	Power Electronics, Drives and Energy Systems

Level:	7	**Credit Value:**	20

Cost Centre(s):		JACS3 **code**:	H630

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

Scheduled learning and teaching hours	40 hrs
Guided independent study	160 hrs
Placement	0 hrs
Module duration (total hours)	200 hrs

Programme(s) in which to be offered (not including exit awards)	Core	Option
MSc Engineering (Renewable & Sustainable Energy) MSc Engineering (Electrical and Electronic)	✓	☐

Pre-requisites
N/A

Office use only
Initial approval: 19/06/2018 Version no:1
With effect from: 01/09/2018
Date and details of revision: Version no:

Module Aims

1. Build upon analytical skills and knowledge gained in previous studies and thus to further develop students' abilities relating to design, analysis and evaluation of electrical power systems including generation, transmission and distribution.
2. Extend the students to develop electric drive control strategies and to consider the electric drive as a complex structure in which electrical machine, power electronics and control system interact with each other.

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	Analyse the operation of power semiconductor devices and their application in power electronics and electric drive systems;	KS3	
		KS6	
2	Model and investigate the electrical power systems using appropriate software;	KS4	
		KS5	
3	Use methods and procedures for electrical machines selection and their control system design	KS1	
		KS9	
4	Evaluate the performance of electrical power systems under overload and fault conditions	KS7	
		KS10	
5	Design the basic electrical power system according to quality, reliability, and economic requirements	KS2	
		KS8	

Transferable skills and other attributes

1. Communication
2. ICT Technologies
3. Time management and organisation
4. Interpersonal skills
5. Problem solving

6. Information handling including numeracy

Derogations
Credits shall be awarded by an assessment board for those Level 7 modules in which an overall mark of at least 50% has been achieved with a minimum mark of 40% in each assessment element.

Assessment:

Indicative Assessment Tasks:

Assessment One: A Three-hour examination at the end of the module.

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 mainly through lead lectures and student-driven investigative work. A significant amount of the content is to be achieved through individual study. The study time will be made up from formal lectures, small group of tutorials and to individual study but also with access to lab/computer facilities, for practical and analytical activities. Where appropriate, guest lectures and seminars with invited researchers and individualist will also be incorporated.

Syllabus outline:

Power Electronics Fundamentals: Principles of operation of power semiconductor devices; Power loss in power semiconductors; Cooling of power semiconductors and heat-sink design; Rectifies, convertors and invertors; Control and protection of power electronic devices; Pulse width modulation (PWM); Industrial applications e.g. switching mode power supplies, frequency invertors, etc.

Electrical Machines and Drives: Principles of operation and characteristics of ac and dc electrical machines; Power losses and efficiency; Mechanical requirements for electric drives; Static and dynamic performance; Rotary-to-linear motion; Gears; Types of mechanical loads; Thermal management and motor selection.

Motor Control: Principles of ac and dc motor control; Control of speed, torque and position; Field-oriented control; Current control; Flux estimators and observers; Direct torque control; Field-weakening operation; Sensorless control. Vector control of induction-motor drives; Mathematical description of vector control; Space vector pulse-width-modulated inverters

Electric Drive Systems: Integration of electrical motors and power electronics; Model-based analysis and design; Performance of open-loop and closed-loop systems; Dynamic analysis of ac and dc motor drives using Matlab/Simulink.

Three Phase Systems Fundamentals: Star and delta connected systems, Balanced and unbalanced three phase systems, Three phase transformers, Star and delta connection

of three phase transformer windings, Active, reactive and apparent powers, Power factor, Methods of power factor improvement, Per unit system of measurement.

Synchronous Generators: Construction, Operation, Per phase equivalent circuit, Phasor diagram, Excitation, Losses, Power flow diagram, Efficiency, Voltage regulation, External characteristics, Synchronous generator tests, Performance under different power factor conditions, Parallel operation, Operation on infinite busbars.

Transmission: Types of transmission lines, Impedance of transmission line, Equivalent circuit of transmission line, Losses, Maximum power flow, FACTS applications.

Distribution and Protection: Industrial supplies and installation. Protection of industrial plants, Circuit breakers, Fuses, Isolators and switches; Calculation of a balanced and unbalanced short circuit fault, power electronic application in distribution systems.

Economics of Electricity and Tariffs: Power plants, Economics of electricity supply, Cost of electricity, Structure of tariffs, Maximum demand, Load factor, Diversity factor.

Power System Control: Power flow control, Generator-voltage control, Turbine-governor control, Load-frequency control, Smart grids.

Sustainable Energy: Wind turbines, Solar panels, Fuel cells, Micro-generators, Micro-grids.

Indicative Bibliography:

Essential reading

Rashid, M. (2013) Power Electronics: Devices, Circuits, and Applications. 4th edn. Pearson.

Other indicative reading

Weedy, V.M. (2012) Electrical Power Systems, 5th edn., Hoboken: Wiley

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

Kirtley, J.L. (2011) Electric Power Principles: Sources, Conversion, Distribution and Use, Chichester: Wiley.

Mohan, N. (2014) Advanced Electric Drives: Analysis, Control, and Modeling Using MATLAB/Simulink. Wiley.