Unit T2: Power Electronics and Drives

Unit code:	D/503/7222
QCF level:	6
Credit value:	15

The aim of this unit is to develop learners' understanding of the characteristics of semiconductor switching components, their application and implementation, so that they can apply this understanding to the specification of electronic drive systems.

Unit abstract

Electronic power conversion systems and drives allow for advanced control of electrical machines, and more efficient use of power. Electronic converters also allow for advanced power conditioning.

This unit covers the characteristics of power electronic system components and their use in drives for the control of a range of electrical machines. The unit also explores the related field of power conversion, addressing switch mode power supplies and DC to DC converters. Through this unit learners will develop the skills needed to specify electronic drives and power converters.

Learning outcomes

On successful completion of this unit a learner will:

1 understand semiconductor devices in power electronic systems

2 understand the operation of electronic power converter circuits

3 understand application and implementation issues of power electronic systems

4 be able to specify electronic drive systems.

Unit content

1 Understand semiconductor devices in power electronic systems

Semiconductor devices: operation; characteristics and performance range of common semiconductor switching devices (MOSFETs, bipolar junction transistors, insulated gate bipolar transistors [IGBT], thyristors)

Semiconductor device applications: eg choppers, full and half H bridges, phase and burst Alternating Current (AC) power control, rectifiers

2 Understand the operation of electronic power converter circuits

Characteristics of electronic power converters: input requirements; outputs; physical size and weight; cost, performance

Operation: average and Root Mean Square (RMS) values; rectifiers; pulse width modulation; pulse frequency modulation; harmonic content

Circuits: circuit topologies; inverter systems; switch mode power supplies; Buck and Boost Direct Current – Direct Current (DC-DC) power converters; dynamic behaviour

3 Understand application and implementation issues of power electronic systems

Applications: benefits of the use of power electronics; common applications, eg uninterruptable power supplies, traction drives in electrical vehicles; application imposed constraints, eg physical size, acceptable efficiency, input power sources

Implementation issues: power losses; temperature control and thermal management; protection of electronic system and application hardware; electromagnetic compatibility (EMC) issues; interference suppression

4 Be able to specify electronic drive systems

Electric motors: physical characteristics and operation of AC and DC motors (induction and synchronous motors, shunt and series dc motors, permanent magnet motors, stepper and brushless DC/electronically commutated motors); motor characteristics (operating performance, characteristic curves); common applications

Drive design: control of motor performance (speed, torque, position); motor operation (soft start); efficiency; power factor correction

Control parameters: relation of voltage; current and frequency to the characteristic curves of the various motor types; full and half wave control of stepper motors

Implementation of control: generation of waveforms to achieve control of motor parameters, eg Pulse Width Modulation (PWM) to control voltage, PWM frequency and harmonic control; sensing requirements, eg speed, temperature, current, torque, position; measurement methods, eg hall sensors, optical encoders, back EMF

Learning outcomes and assessment criteria

Learning outcomes On successful completion of this unit a learner will:	**Assessment criteria for pass** The learner can:
LO1 Understand semiconductor devices in power electronic systems	1.1 Critically appraise the operation of semiconductor switching devices 1.2 Justify the selection of semiconductor devices used in power electronic circuits 1.3 Critically evaluate applications of semiconductor switching devices
LO2 Understand the operation of electronic power converter circuits	2.1 Critically appraise the characteristics of electronic power converters 2.2 Describe the operation of DC-DC power converters and inverters 2.3 Justify converter circuit design to meet a specified requirement
LO3 Understand application and implementation issues of power electronic systems	3.1 Explain the functionality of power electronic applications 3.2 Critically appraise implementation issues for power electronic systems
LO4 Be able to specify electronic drive systems	4.1 Select thorough critical evaluation appropriate motor types for specified applications 4.2 Critically evaluate the design of electronic drives 4.3 Justify selection of control implementation techniques

Guidance

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

The learning outcomes associated with this unit are closely linked with:

Level 4	Level 5	Level 6
Unit 68: Applications of Power Electronics		

The content of this unit has been designed and mapped against the Engineering Council's current Learning Outcomes for IEng Accreditation. The completion of the learning outcomes for this unit will contribute knowledge, understanding and skills towards the evidence requirements for IEng Registration.

See *Annexe B* for summary of mapping information for IEng Accreditation.

Essential requirements

Access to appropriate laboratory equipment to perform investigations such as AC and DC motors and suitable measurement equipment is essential.

Delivery

Contact time of approximately 45 hours will be required for this unit. The unit favours the use of formal lecture session to introduce important concepts and to aid in the analysis of characteristics etc, with significant laboratory session support to provide context and practical experience. Case studies and inquiry-based learning around specified problems would enhance the learning experience.

Assessment

A mixture of assessment types is appropriate for this unit. There should be some practically-based assessment where learners are required to demonstrate synthesis of new solutions.

Resources

Books

Hart D – *Power Electronics* (McGraw-Hill, 2010) ISBN 978-0071289306

Hughes A – *Electric Motors and Drives: Fundamentals, Types and Applications* (Newnes, 2005) ISBN 978-0750647182

Petruzella F – *Electric Motors and Control Systems* (McGraw Hill, 2009) ISBN 978-0071220330

Wildi T – *Electrical Machines, Drives and Power Systems*, 6th Edition (Pearson, 2005) ISBN 978-0131969186