Unit 52: Further Electrical, Electronic and Digital Principles

Unit code	**L/615/1520**
Unit level	**5**
Credit value	**15**

Introduction

Almost every aspect of our lives relies on electrical powered, electronically controlled machines and devices, many of them digital in format. To properly understand how to make the most efficient use of these devices in a safe and economical way, it is vital to have a thorough knowledge of the underlying principles on which they rely.

This unit builds on the preliminary techniques and skills introduced in *Unit 19: Electrical, Electronic and* Unit 20: *Digital Principles*.

The emphasis in this unit will be in developing a structured approach to the analysis of AC single-phase and three-phase powered circuitry. This will help students to arrive at the solution in the most efficient way, with the greatest probability of it being correct. In addition, students will be introduced to the expanding use of computers, using specialised software to solve electrical, electronic and digital circuits. This will allow students to develop the necessary confidence and competence in the four key areas of mathematical techniques, circuit analysis, circuit simulation and laboratory practice.

Successful completion of this unit will enable students to cope with increasingly complex problems and prepare them for the challenge of Level 6 academic programmes.

Learning Outcomes

By the end of this unit students will be able to:

1. Use appropriate mathematical techniques to solve a range of electrical and electronic problems.
2. Apply appropriate circuit theorems to solve problems in electrical networks.
3. Use appropriate laboratory and computer simulation techniques to investigate both analogue and digital circuits and interpret the results.
4. Explain the characteristics of non-linear circuits to predict their behaviour under a variety of conditions.

Essential Content

LO1 **Use appropriate mathematical techniques to solve a range of electrical and electronic problems**

Formal steady state circuit analysis:

Determinants, mesh analysis and nodal analysis (and their comparison)

Analysis using ideal sources, superposition theorem

AC circuit analysis:

Complex notation, polar and Cartesian coordinates, RLC circuits

Advanced use of phasor diagrams

Power: instantaneous power, power factor, apparent power, the power triangle

LO2 **Apply appropriate circuit theorems to solve problems in electrical networks**

Three-phase theory:

Application of trigonometric methods to solution of phasor diagrams

Application of complex numbers to represent quantities in AC circuits

Single-phase representation

Solution of balanced three-phase circuits

Complex notation applied to three-phase, unbalanced loads, unconnected neutral point

Power, reactive power and power factor correction for three-phase systems

LO3 **Use appropriate laboratory and computer simulation techniques to investigate both analogue and digital circuits and interpret the results**

ECAD:

Use of computer modelling and simulation techniques to analyse and solve electronic, electrical and digital circuits, such as filters and amplifiers using operational amplifiers and discrete devices; digital logic circuit elements; and simple combination and sequential circuits

LO4 **Explain the characteristics of non-linear circuits to predict their behaviour under a variety of conditions**

Non-linear circuits:

Characteristics of linear and non-linear circuits, mathematical modelling of a number of semiconductor devices, including diodes, bipolar and Field Effect Transistors and how this can be used to predict their 'real' behaviour in practice

Mathematically modelling the behaviour of semiconductor diodes, bipolar transistors and Field Effect Transistors

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Use appropriate mathematical techniques to solve a range of electrical and electronic problems		**D1** Apply an accurate approach to problem solving with clear justification of methods used with a high standard of explanation for each method
P1 Produce basic solutions to electrical and electronic problems to a satisfactory standard, but with some misunderstandings	**M1** Provide reasoned solutions to problems, showing a logical approach and using a range of mathematical methods	
LO2 Apply appropriate circuit theorems to solve problems in electrical networks		**D2** Evaluate electrical theory by using a variety of mathematical and other methods to produce accurate solutions with clear justification of the methods used
P2 Use electrical network theory to provide solutions to problems to a satisfactory standard, with some level of ambiguity and errors	**M2** Apply electrical network theory and provide accurate solutions to problems, showing a logical approach	
LO3 Use appropriate laboratory and computer simulation techniques to investigate both analogue and digital circuits and interpret the results		**D3** Present a clear evaluation of the operation of current analogue and digital logic circuits by comparing their predicted behaviour with the simulated, theoretical and practical results
P3 Use appropriate laboratory and computer simulation techniques to explain the performance of digital logic circuits and analogue circuits	**M3** Explore analogue and digital logic circuits to show a structured approach to the solutions of problems using a variety of methods	

Pass	Merit	Distinction
LO4 Explain the characteristics of non-linear circuits to predict their behaviour under a variety of conditions		**D4** Evaluate the application of theory, simulation and practical investigation of a number of circuits using nonlinear circuits
P4 Describe the characteristics of non-linear circuits and how their behaviour differs in practice with 'ideal' devices	**M4** Investigate a variety of non-linear circuits by calculating the effects of non-linear behaviour in a number of differing circuits	

Recommended Resources

Textbooks

BIRD, J. (2013) *Electrical Circuit Theory and Technology*. Routledge.

HUGHES, E. et al. (2012) *Electrical and Electronic Technology*. Pearson.

REHG, J.A. and SARTORI, G.J. (2005) *Industrial Electronics*. Prentice-Hall.

WILAMOWSKI, B.M. and IRWIN, J.D. (2011) *The Industrial Electronic Handbook: Fundamentals of Industrial Electronics*. CRC Press.

Websites

http://www.bath.ac.uk/	University of Bath Patents (General Reference)
http://www.bsigroup.com	British Standards Institution Standards (General Reference)
https://www.ieee.org	Institute of Electrical and Electronics Engineers Standards (General Reference)
https://app.knovel.com/	Knovel (Research)
https://www.esdu.com	Engineering Science Data Unit (General Reference)
http://www.theiet.org/	Institute of Engineering and Technology (General Reference)
http://www.theiet.org/	Institute of Engineering and Technology (Journal)
http://www.newelectronics.co.uk/	New Electronics Digital Magazine (Journal)

http://www.electronicsworld.co.uk/	Electronics World Magazine (Journal)
http://tie.ieee-ies.org/	Industrial Economics Society (Journal)
http://www.epemag.com/	Everyday Practical Electronics Magazine (Journal)

Links

This unit links to the following related units:

Unit 19: Electrical and Electronic Principles

Unit 20: Digital Principles