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 20: Electrical, Electronic and 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

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Use appropriate mathematical techniques to solve a range of electrical and electronic problems</td><td rowspan="2">D1 Apply an accurate approach to problem-solving with clear justification of methods used with a high standard of explanation for each method.</td></tr>
<tr><td>P1 Produce basic solutions to electrical and electronic problems to a satisfactory standard, but with some misunderstandings.</td><td>M1 Provide reasoned solutions to problems, showing a logical approach and using a range of mathematical methods.</td></tr>
<tr><td colspan="2">LO2 Apply appropriate circuit theorems to solve problems in electrical networks</td><td rowspan="2">D2 Evaluate electrical theory by using a variety of mathematical and other methods to produce accurate solutions with clear justification of the methods used.</td></tr>
<tr><td>P2 Use electrical network theory to provide solutions to problems to a satisfactory standard, with some level of ambiguity and errors.</td><td>M2 Apply electrical network theory and provide accurate solutions to problems, showing a logical approach.</td></tr>
<tr><td colspan="2">LO3 Use appropriate laboratory and computer simulation techniques to investigate both analogue and digital circuits and interpret the results</td><td rowspan="2">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.</td></tr>
<tr><td>P3 Use appropriate laboratory and computer simulation techniques to explain the performance of digital logic circuits and analogue circuits.</td><td>M3 Explore analogue and digital logic circuits to show a structured approach to the solutions of problems using a variety of methods.</td></tr>
<tr><td colspan="2">LO4 Explain the characteristics of non-linear circuits to predict their behaviour under a variety of conditions</td><td rowspan="2">D4 Evaluate the application of theory, simulation and practical investigation of a number of circuits using non-linear circuits.</td></tr>
<tr><td>P4 Describe the characteristics of non-linear circuits and how their behaviour differs in practice with ‘ideal’ devices.</td><td>M4 Investigate a variety of non-linear circuits by calculating the effects of non-linear behaviour in a number of differing circuits.</td></tr>
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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.

Electronic

Patents, Standards and data:

http://www.bath.ac.uk/library/subjects/resources/patents-engineering.html

British Standards Online:

http://libproxy.bath.ac.uk/login?url=http://bsol.bsigroup.com

IEEE Standards:

http://libproxy.bath.ac.uk/login?url=http://ieeexplore.ieee.org/xpl/standards.jsp

Reference information & data:

http://libproxy.bath.ac.uk/login?url=http://app.knovel.com/web

Data, equations, examples & design methods/principles:
http://libproxy.bath.ac.uk/login?url=http://www.esdu.com/

Professional Body:

http://www.theiet.com/

Journals (Links)

http://www.theiet.org/resources/journals/index.cfm

http://www.ieee.org/publications_standards/publications/journmag/journals_magazines.html

http://www.newelectronics.co.uk/digital-magazine/

http://www.electronicsworld.co.uk/magazine

http://tie.ieee-ies.org/

http://www.epemag.com/

www.theiet.com

If the student becomes a member of the IET, they will gain access to a wealth of journals and webcasts covering the wide range of engineering, as well as the opportunity to network within the region they are based.

Links

This unit links to the following related units:

Unit 19: Electrical and Electronic Principles