Unit 215 The analysis and design of electrical fields and circuits

Unit summary
This unit is about two fundamental topics in electrical engineering, fields and circuits.

Aims
The unit aims to develop understanding of fields and circuits and to use this understanding to solve problems in electrical engineering.

Prerequisites
None.

Learning outcomes
There are **two** outcomes to this unit. The candidate will be able to:

- Solve problems involving field theory
- Solve problems involving circuit theory

Guided learning hours
It is recommended that 300 hours should be allocated for this unit. 120 of those hours are actual taught hours. This may be on a full time or part time basis.

Key Skills
This unit contributes towards the Key Skills in the following areas:

N4.1
Develop a strategy for using application of number skills over an extended period of time.

N4.2
Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving:

- deductive and inferential reasoning;
- algebraic manipulation.

N4.3
Evaluate your overall strategy and present the outcomes from your work, including use of charts, diagrams and graphs to illustrate complex data.

Occupational Standards
This unit has been mapped to the following National Occupational Standards:

1.1.1 Identify the requirements of clients for engineering products or processes
1.1.2 Produce specifications for engineering products or processes
2.1.1 Determine the production requirements of engineering products and processes
3.1.1 Determine the installation requirements for engineering products or processes
3.1.2 Specify installation methods and procedures to achieve installation requirements
3.2.2 Solve installation problems with engineering solutions
3.3.1 Monitor the installation process
3.3.2 Evaluate the installation process
3.4.1 Commission engineering products or processes
4.1.1 Determine the operational requirements of engineering products or processes
4.1.2 Specify operational methods and procedures to achieve operational requirements
4.1.3 Schedule operational activities to implement the operational methods and procedures
4.3.1 Monitor operational processes
4.3.2 Evaluate operational processes
5.1.1 Determine the maintenance requirements of engineering products or procedures
5.1.2 Specify maintenance methods and procedures to achieve maintenance requirements
6.1.1 Analyse the risks arising from engineering products and processes
6.1.2 Specify methods and procedures to reduce risks
6.2.1 Assure the quality of engineering products or processes
8.1.1 Maintain and develop own engineering expertise

Unit 215 The analysis and design of electrical fields and circuits

Outcome 1 Solve problems involving field theory

Knowledge requirements
The candidate knows how to:

1 use Laplace's equation to determine potential distribution in two dimensions for simple geometric shapes of conducting boundaries

2 apply image methods to the above

3 use Gauss's theorem for electrical flux density calculations for

- a isotropic dielectric media
- b composite dielectric media

4 calculate D and E

5 calculate capacitance of configurations with two or more conductors

- a parallel plate capacitor
- b concentric cylinders
- c parallel wires
- d wire and parallel plate

6 determine dielectric polarisation and energy density

7 produce and measure magnetic fields

8 assess the properties and characteristics of magnetic materials

9 assess magnetic losses with alternating excitation

10 determine magnetic potential and magnetomotive force

- a Biot-Savart and Ampere laws for calculating B and H in fields produced by conductor and coil configurations
- b calculations for coil arrangements to produce magnetic fields between poles faces
- c flux leakage
- d fringing

11 determine electromagnetic induction by calculation of self-inductance and mutual induction for simple configurations

- a co-axial cable
- b transmission line

12 determine mechanical force and torque relations for conductor shapes in magnetic and electrical fields

13 assess electromagnetic skin effect

Unit 215 The analysis and design of electrical fields and circuits

Outcome 2 Solve problems involving circuit theory

Knowledge requirements
The candidate knows how to:

1 assess time-domain response

2 analyse lumped-parameter networks excitations

- a impulse
- b step
- c ramp
- d sine wave
- e others

3 determine steady-state and transient responses

4 evaluate the response from poles and zeroes

5 apply superposition theorem and convolution

6 use locus diagrams

7 use Fourier series and Fourier transforms power spectra and spectral analysis of simple waveforms

8 systematic formulate network equations in linear dc and ac circuits

- a nodal
- b mesh

9 manipulate two port parameters in two-port networks

10 apply the above to filter circuits and networks

- a transformers
- b T-networks
- c Π - networks
- d ladder networks

11 analyse the relationships of the above

Unit 215 The analysis and design of electrical fields and circuits

Recommended reading list

Core texts	Author(s)	Publisher	ISBN
An Introduction to Circuit Analysis: A Systems Approach	Scott	McGraw Hill	0070561273
Analysis of Linear Circuits	Paul	McGraw Hill	007909340X
Fundamentals of Engineering Electromagnetics	Cheng	Addison Wesley	0201566117
Fundamentals of Electromagnetics with Engineering Applications	Wentworth	John Wiley	0471661325