## 1. Module details

**Module name**

# Introduction to Resonance, Filters and Oscillators

**Module duration**

It is expected that students with the appropriate entry knowledge and skills will successfully complete this module in 36 - 40 hours.

**Module code**

NUE158

**Discipline code**

0703201

## 2. Module purpose

This module will provide students with the underpinning knowledge and skills to use circuits incorporating resonance, filters and oscillators.

## 3. Prerequisites

NUE056 Applied Electricity 4.

## 4. Relationship to competency standards

This module provides part of the underpinning knowledge and skills in the 'Evidence Guide' of specific units of competency in the National Electrotechnology Training Package and provides similar support, where mapped, to equivalent units in the National Metals and Engineering Competency Standards. For details refer to the module to unit maps, available from NUEITAB.

## 5. Content

**Repetitive complex waveforms**
definition of the following terms: complex repetitive wave; harmonic; fundamental frequency; waveform analysis using Fourier's Theorem

**Introduction to resonance**
series and parallel resonance: phasor diagrams showing the relationship between voltages and current in RLC circuits: above, below and at resonance; impedance: above, below and at resonance; voltage magnification effect; Q factor; cut-off frequencies; bandwidth; damped oscillation; selectivity
practical applications and disadvantages of resonance

**Introduction to filters**
purpose
frequency response characteristics of the passive filters: low pass; high pass; band pass; band stop
circuit symbols
terminology: pass band; cut-off frequency; order of filter; roll off; attenuation; pass and attenuation; bandwidth; phase shift
typical applications
schematic diagrams of single and double section passive filters: low pass; high pass; band pass; band stop

**Introduction to feedback**
open and closed loop models
reasons for applying feedback to an electronic circuit
differences between positive and negative feedback
effects of negative feedback on the amplifier characteristics

**Introduction to oscillators**
purpose
block diagram
requirements for oscillation
Sine Wave oscillator
RC Phase Shift oscillator
Colpitts oscillator
applications

## 6. Assessment strategy

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| **Assessment methods** | Assessment should be progressive reflecting a holistic approach to ensure the module purpose is met. To assist in ensuring validity, reliability and fairness assessment instruments should include practical exercises, assignments and written tests consisting of a number of item types, such as multiple choice, short answer and problem solving. |
| **Conditions of assessment** | Learning and assessment will take place in an environment that is conducive to a learner's development. |

## 7. Learning outcome details

**Learning outcome 1** — **Use the principles of Fourier's Theorem to determine which harmonics will be present in a complex repetitive waveform.**

**Assessment criteria**

1.1 Define the following terms:
- complex repetitive wave
- harmonic
- fundamental frequency.

1.2 State Fourier's Theorem as it applies to a complex repetitive waveform.

1.3 Identify even and odd repetitive functions and state whether sine terms or cosine terms are present in the Fourier series.

1.4 Identify half wave symmetry and determine whether even or odd harmonics are present for a given waveform.

1.5 Experimentally verify the fourier series of a square wave.

**Learning outcome 2** — **Describe the characteristics of RLC resonant circuits.**

**Assessment criteria**

2.1 Define the conditions necessary for resonance in series and parallel LCR circuits.

2.2 Calculate and verify by measurement the resonant frequency of series and parallel (high Q) resonant circuits.

2.3 State the effect on current and voltage of frequency variations in a resonant circuit.

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| | 2.4 Explain the meanings of the following terms as applied to resonant circuits:<br>- bandwidth<br>- voltage magnification effect<br>- Q factor<br>- damped oscillation. |
| | 2.5 Calculate and verify by measurement the cut-off frequencies, bandwidth and Q for series and parallel resonant circuits. |
| | 2.6 Explain the term selectivity and sketch the amplitude and phase response of a parallel resonant circuit driven from a current source (for high, medium and low values of Q). |
| | 2.7 Describe the practical applications and disadvantages of resonance. |
| **Learning outcome 3** | **List the basic types and state the applications of filters in electronic systems.** |
| **Assessment criteria** | 3.1 State the purpose of a filter in electronic application. |
| | 3.2 Describe and sketch the frequency response characteristics of the following passive filters:<br>- low pass<br>- high pass<br>- band pass<br>- band stop. |
| | 3.3 Sketch the circuit symbol for the above filters. |
| | 3.4 Define the following terms:<br>- pass band<br>- cut-off frequency<br>- order of filter<br>- roll off<br>- attenuation<br>- pass and attenuation<br>- bandwidth<br>- phase shift. |

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| | 3.5 State the typical applications of the following filters:<br>- low pass<br>- high pass<br>- band pass<br>- band stop. |
| | 3.6 Sketch the schematic diagrams of the following single and double section passive filters:<br>- low pass<br>- high pass<br>- band pass<br>- band stop. |
| **Learning outcome 4** | **Determine the effect of negative and positive feedback on amplifier characteristics.** |
| **Assessment criteria** | 4.1 State the reasons for applying feedback to an electronic circuit. |
| | 4.2 Describe the differences between positive and negative feedback. |
| | 4.3 Describe the effects of negative feedback on the following characteristics of an amplifier:<br>- gain<br>- input impedance<br>- output impedance<br>- bandwidth<br>- noise and distortion. |
| | 4.4 Estimate and confirm by measurement the terminal characteristics of a voltage amplifier when negative feedback is applied. |

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| **Learning outcome 5** | **State the purpose for and explain the operation of oscillators in electronic systems.** | |
| **Assessment criteria** | 5.1 | State the general purpose of oscillators. |
| | 5.2 | Draw a block diagram of an oscillator and state the function of each block. |
| | 5.3 | Describe the requirements for sustained oscillation. |
| | 5.4 | Identify the difference between a Sine Wave oscillator and other types. |
| | 5.5 | Sketch the circuit of a Phase Shift oscillator and explain its operation. |
| | 5.6 | State and apply the equation for calculating the oscillating frequency of a phase shift oscillator. |
| | 5.7 | Describe the operation of a Colpitts oscillator showing its feedback path and class of operation. |
| | 5.8 | State and apply the equation for calculating the oscillating frequency of a Colpitts oscillator. |
| | 5.9 | Confirm calculations of oscillator operation by observation and measurement. |
| | 5.10 | Describe the conditions that cause instability in amplifier circuits. |
| | 5.11 | Identify and state the applications for different types of oscillator circuits. |

## 8. Delivery of the module

**Delivery strategy**

Delivery strategies must be suitable for learning both theoretical and practical aspects described in the module purpose. It is considered that the most effective method to achieve this is by integration of theory and practice where students learn by experimentation, research and reports. It is recommended that learning and assessment be facilitated in a holistic manner that may require learning outcome sequence other than that indicated in the module.

**Resource requirements**

*Resources should be sufficient for students to carry out learning activities on an individual basis. This will require the following:*

- dual trace cathode ray oscilloscopes (20MHz)
- dual rail variable power supplies 0-30VDC
- function generators 0 – 2Mhz
- analogue and digital multimeters
- digital frequency and period counter
- combination dip oscillator and absorption wavemeter
- test panels for representative oscillators
- suitable components: resistors, capacitors, inductors, or panels containing these components

*Suggested Learning Resources:*

Davis, Garry Understanding DC Power Supplies and Oscillators, Prentice Hall, 1996.
ISBN 0-72-481274-4

Edwards, Rodney, C. and Meyer, Douglas, F. Electronics. A Basic Course, McGraw Hill, 1994.
ISBN 0-07-470029-4

Boylsted, Robert L. and Nashelsky, Louis Electronic Devices and Circuit Theory, 6th Edition, Prentice Hall, 1996
ISBN 0-13-375734-X

Floyd, Thomas, L. Electronic Devices, 4th Edition, Merrill.
ISBN 0-13-362963-5

**Occupational health and safety requirements**

A safe and healthy environment will be provided for students and teachers as well as the particular safety procedures followed as part of the learning / teaching activity and content.