1. Module details

Module name

Modulation Principles

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

NUE704

Discipline code

0703501 Communications Engineering – General.

2. Module purpose

This module will provide students with a basic knowledge of AM and FM modulation.

3. Prerequisites

NE039 Communications Fundamentals.

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

Amplitude modulation concepts
basic amplitude modulation fundamentals review
phasor representation of carrier and sidebands
phase on modulation envelope
index and percentage modulation depth
power in carrier and sidebands
overmodulation and "splatter"

Sideband modulation techniques
terminology: double-sideband (DSB); single-sideband (SSB); vestigial-sideband (VSB)
frequency domain representation
double-sideband signal (DSB)
single-sideband signal (SSB)
demodulation requirements for DSB and SSB

Frequency and phase modulation
frequency modulation concepts review
time and frequency domain representation
amplitude and frequency distribution of sidebands
frequency modulation (FM) production
phase modulation (PM)production
equivalent FM and PM – audio processing
NBPM Armstrong method of producing (phasor description)

6. Assessment strategy

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

Explain amplitude modulation in terms of time and frequency domain.

Assessment criteria

1.1 Draw a time domain representation of an amplitude modulated radio frequency carrier showing the envelope outline for one full cycle of audio modulation.

1.2 From simple amplitude modulated circuit show how the modulation index and modulation percentage are derived from the ratio of peak modulation voltage and the dc supply.

1.3 Measure the depth of modulation using an oscilloscope representation of a modulated envelope and a trapezoid wave.

1.4 Display on a spectrum analyser the frequency domain components.

1.5 Show the instantaneous phase relationship between the carrier and sidebands at any point of the modulated envelope.

1.6 Given appropriate carrier voltages and resistive load impedance, calculate power in the carrier and in the individual side bands for any given depth of modulation.

1.7 Adjust the modulation gain of a transmitter for optimum depth of modulation without "splatter" for speech and music.

1.8 Show how "splatter" can be eliminated in both broadcast quality and communication quality transmitters.

Learning outcome 2	**Relate amplitude modulation fundamentals to the double-sideband and single-sideband modes of modulation.**
Assessment criteria	2.1 Relate the following terms to their symbolic time domain representation and their WARC 1979 emission classifications: - double-sideband full carrier (DSB-FC) - double-sideband reduced carrier (DSB-RC) - double-sideband suppressed carrier (DSB-SC) - single-sideband suppressed carrier (SSB-SC) - vestigial-sideband. 2.2 Explain the circuit operation of a balanced modulator for producing a DSB signal. 2.3 Draw waveforms for the output of a balanced modulator with a sine wave modulation. 2.4 Adjust balanced modulator for minimum carrier leakage and optimum RF and AF drive. 2.5 Draw a block diagram showing how a single-sideband signal can be produced using the filter method. 2.6 Define the term “shape factor” and explain its significance in the filter operation. 2.7 Adjust the carrier crystal frequencies for optimum audio quality in an SSB transmitter. 2.8 Measure the sideband filter frequency response of a typical SSB transmitter by plotting the peak RF output to peak amplitude microphone input. 2.9 Draw the block diagram of an SSB exciter using the phase-shift method of producing SSB. 2.10 State the requirements for demodulating DSB-SC and SSB-SC at the receiver.

Learning outcome 3	**Explain frequency modulation in terms of time and frequency domain.**
Assessment criteria	3.1 From a simple model such as a capacitor microphone modulated oscillator describe how the following terms affect the carrier: - deviation - modulating frequency - modulation index - deviation ratio.
	3.2 Show how the frequency-modulated carrier may be represented in the time and the frequency domain.
	3.3 Using a table of Bessel functions show how to find the amplitudes for significant sidebands and their frequencies.
	3.4 Calibrate the deviation of a frequency-modulated oscillator or FM transmitter using a communications receiver to set modulation index for the zero carrier amplitude.
	3.5 Show how direct FM can be accomplished with a varactor diode controlling the frequency of a variable frequency oscillator (VFO).
	3.6 Explain how phase modulation (PM) can be generated.
	3.7 Draw a graph showing how the deviation varies with audio frequency for a constant level audio test signal comparing FM and PM.
	3.8 Explain how automatic frequency control can correct frequency drift in a direct FM transmitter.
	3.9 Using the phasor explanation for DSBFC draw the block diagram for the Armstrong method of phase modulation showing how narrow band can be obtained.
	3.10 Explain why pre-emphasis and de-emphasis are used in frequency and phase modulated systems.

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:

- Spectrum analyser
- Analogue VDM
- RF probe
- Deviation meter
- AM stereo broadcast receiver
- FM stereo broadcast receiver
- Communications receiver
- AM stereo broadcast transmitter
- FM transmitter
- Field strength meter
- Absorption wavemeter
- Pip oscillator
- Cathode Ray Oscilloscope, 60MHz, dual beam
- Signal gen. FM/AM modulation std
- Function generator, 0 to 30 MHz with sine, square, triangular and pulse outputs
- Power supply, dual, 0 to +/- 30 V DC, 5A
- Multimeter, analog
- Multimeter, digital

Suggested Learning Resources:

Miller, Gary M. Modern Electronic Communication, 5th Edition, Prentice Hall, 1996.
ISBN 0-13-217879-6

Tomasi, Wayne Electronic Communications Systems: Fundamentals Through Advanced, 3rd Edition, Prentice Hall, 1998.
ISBN 0-13-751439-5

	Schweber, William. Electronic Communication Systems: A Complete Course, 2nd Edition, Prentice Hall, 1996. ISBN 0-13-301482-7 Young, Paul H. Electronic Communication Techniques, 4th Edition, Prentice Hall, 1994. ISBN 0-13-779984-5
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.