1. Module details

Module name

Modulation Techniques and Circuits

Module duration

It is expected that students with the appropriate entry knowledge and skills will successfully complete this module in 18 - 20 hours.

Module code

NUE705

Discipline code

0703215 Communication Engineering/Technologies.

2. Module purpose

This module will enable students to develop and understanding of common modulation techniques.

3. Prerequisites

NUE704 Modulation Principles.

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

Multiplexing

Time Division Multiplexing (TDM)

Frequency Division Multiplexing (FDM)

Specialised multiplexing

Quadrature Amplitude Modulation (QUAM)

Compatible Quadrature Amplitude Modulation (CQUAM)

Digital modulation

Pulse Code Modulation

Pulse Width Modulation

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

Describe multiplexing techniques in the temporal and frequency domains and operate simple multiplexing systems.

Assessment criteria

1.1 Explain the meaning of the multiplexing.

1.2 Show with a diagram the basic principle of Time Division Multiplexing (TDM).

1.3 Show how TDM techniques may be used to transmit several signals over a single carrier.

1.4 Explain the use of a sample-and-hold circuit at the TDM receiver, and describe both analog and digital sample-and-hold techniques.

1.5 Calculate the bandwidth requirements for a TDM signal.

1.6 Explain why synchronisation is important between the transmitter and the receiver in a TDM system.

1.7 Set up and operate a multi-channel TDM system providing several channels.

1.8 Show how Frequency Division Multiplexing (FDM) may be used to impress more than one channel of modulation onto a carrier.

1.9 Using appropriate symbols draw a time domain representation of a group of telephone channels where each side-band occupies four kilohertz of bandwidth.

1.10 Explain the need for a guard band between FDM channels.

1.11 Set up and operate a multi-channel FDM system providing several voice channels.

Learning outcome 2	**Describe specialised multiplexing techniques used in communications and broadcasting and set up AM stereo and FM stereo receivers.**	
Assessment criteria	2.1	Describe the process whereby two signals in quadrature modulate a single carrier.
	2.2	Describe the ability of Quadrature Amplitude Modulation (QUAM) to convey stereo sound signals over a single carrier with a bandwidth equal to that of a conventional amplitude modulated signal.
	2.3	Describe the need for broadcast AM stereo signals to be compatible with single-channel AM broadcasts.
	2.4	Describe Compatible Quadrature Amplitude Modulation (CQUAM) techniques.
	2.5	Describe the operation of a CQUAM receiver.
	2.6	Given an AM stereo receiver, data sheet(s) and suitable test equipment, determine and verify the manufacturer's performance characteristics in terms of stereo separation.
	2.7	Draw the block diagram of a FM stereo exciter and the base-band spectrum presented to the transmitter of FM stereo.
	2.8	Draw the block diagram of a FM stereo decoder and explain its operation with relation to the spectrum of the base-band.
	2.9	Given a FM stereo receiver, data sheet(s) and suitable test equipment, perform an alignment of a FM stereo receiver decoder module and identify relevant components from the block diagram.

Learning outcome 3	**Describe digital modulation techniques and set up digital communications systems.**	
Assessment criteria	3.1	Explain the sampling theorem, the frequency of the minimum sample rate for a given maximum signal frequency, filtering requirements, and aliasing.
	3.2	Describe the analog-to-digital and digital-to-analog techniques employed in Pulse Code Modulation (PCM).
	3.3	Describe how the number of PCM quantisation levels is related to the number of bits per sample.
	3.4	Describe PCM systems as capable of delivering absolute signal values as required in instrumentation systems.
	3.5	Explain the terms quantisation, quantisation error, quantisation noise, quantisation levels and quantisation intervals.
	3.6	Demonstrate how quantisation noise is related to the number of bits per sample using a test panel.
	3.7	Demonstrate the effect of aliasing using a test panel by removing the low pass filter.
	3.8	Confirm the reproducibility of Pulse Width Modulation (PWM) by storing and retrieving PCM-encoded data.
	3.9	Describe methods of compression and expansion to reduce the effects of quantisation noise.
	3.10	Explain the meaning of companding in relation to communications systems.
	3.11	Describe the analog-to-digital and digital-to-analog techniques employed in PWM.
	3.12	Explain PWM using waveform diagrams.
	3.13	Describe PWM systems as being dependent on demodulator calibration.
	3.14	Demonstrate PWM and demodulation using a test panel.
	3.15	Compare PCM and PWM systems in terms of preservation of absolute signal values and bandwidth.

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:

Suitable laboratory equipment: benches, lighting, adequate working space and ventilation, and seating.

Multiplexing systems: Simple FDM and TDM communication systems.

Analog Receiving equipment: AM stereo receivers, FM stereo receivers.

Digital modulation systems: Test panels or other equipment capable of PCM modulation and demodulation, test panels or other equipment capable of PWM modulation and demodulation.

Test equipment: AM stereo RF signal generators, FM stereo RF signal generators, digital signal generators, analog and digital multimeters, analog and digital signal generators, oscilloscopes, frequency meters, spectrum analysers, deviation meters, audio voltmeters.

Receiver equipment/service manuals or textbook descriptions of receiver equipment, including alignment and faultfinding procedures.

Texts and other references may include the following:

The Open University. T321 2. Technology: A Third Level Course “Telecommunications Systems", Unit 2 - Modulation. The Open University Press.

Kennedy. Electronic Communication Systems. McGraw-Hall.

Gary M. Miller. Modern Electronic Communication. Third Edition. Prentice-Hall.

Grob and Kiver. Applications of Electronics. Second Edition. McGraw-Hill.

Edward A. Wilson. Electronic Communications Technology.

	1989. Prentice-Hall. Robert L Shrader. Electronic Communication. Fifth Edition. McGraw-Hill. Motorola. CQUAM of AM stereo.
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.