1. Module details

Module name

Basic Receivers

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

NUE151

Discipline code

0703501 Communications Engineering – General.

2. Module purpose

This module will provide students with knowledge of typical radio receiver operation.

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

Receiver block diagrams
image reception problems with single conversion
principle of dual conversion technique
block diagram of Double Sided Band Full Carrier (DSBFC) dual conversion receiver
FM dual conversion receiver
Single Sided Band Suppressed Carrier (SSBSC) receiver

Radio frequency (RF) amplifiers
purpose of RF amplifiers
Bipolar Junction Transistors (BJT's) as RF amplifiers
Field Effect Transistors (FET's) as RF amplifiers
input and output coupling

Mixer stages
mixer stage requirements
mixing techniques
noise figure and conversion gain
local oscillator injection
calculation of first order mixer output frequencies

Intermediate frequency amplifiers
choice of intermediate frequency
input and output coupling
filters

limiter requirements with FM
limiter operation concepts
limiter performance

Demodulation
AM demodulation
FM demodulation

Automatic gain control (AGC) systems
need for AGC
AGC in FM receivers
AGC for DSBSC receivers

Phase locked loops (PLLs)
PLL basics
loop frequency response and bandwidth
frequency synthesis basic

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

Sketch the block diagram of dual conversion superheterodyne receivers suitable for the reception of Amplitude Modulation Double Side Band (AMDSB), Frequency Modulation (FM) and Single Side Band Suppressed Carrier (SSBSC) demodulators.

Assessment criteria

1.1 State the advantage of dual conversion as compared to single conversion superheterodyne receivers.

1.2 Calculate the image frequency of typical single and dual conversion superheterodyne receivers.

1.3 Sketch the block diagram, showing typical frequencies, of a dual conversion receiver suitable for the reception of DSBFC signals.

	1.4	Sketch the block diagram, showing typical frequencies, of a dual conversion receiver suitable for the reception of FM signals.
	1.5	List the advantages and disadvantages of SSBSC systems as compared to DSBFC systems.
	1.6	State the requirements for demodulation of SSBSC signals.
	1.7	Sketch the block diagram, showing typical frequencies, of a receiver suitable for the reception of SSBSC signals.
	1.8	Measure the image rejection performance of a single and a dual conversion superheterodyne receiver.
	1.9	Compare the image rejection performance of a single and a dual conversion superheterodyne receiver and calculate the difference in performance in decibels.
Learning outcome 2	**Explain the performance criteria for good RF amplifier performance.**	
Assessment criteria	2.1	List the purposes of the RF amplifier.
	2.2	Compare the performance of a BJT in an RF amplifier operating in the: - common emitter configuration - common base configuration.
	2.3	Compare the performance of FETs to BJTs as RF amplifiers.
	2.4	State and list the input and output coupling requirements of an RF amplifier.
	2.5	Define the terms cross-modulation and inter-modulation as applied to receiver RF amplifiers.
	2.6	Describe the techniques to minimise RF receiver amplifier cross-modulation and inter-modulation.

Learning outcome 3	**Define the various mixing techniques and performance criteria for receiver mixer stages.**	
Assessment criteria	3.1	Define the requirements of a mixer stage.
	3.2	Sketch the basic schematic diagram of the various mixing techniques.
	3.3	Define noise figure and conversion gain of a mixer stage.
	3.4	Explain the operation and signal injection method of the mixer stage given the schematic diagram of a commercial receiver.
Learning outcome 4	**Explain the alignment of receiver IF stages and state the importance of bandwidth and selectivity upon the performance of the aligned receiver.**	
Assessment criteria	4.1	Compare the performance of receivers equipped with low frequency and high frequency intermediate frequency amplifiers.
	4.2	Explain why some IF amplifiers require neutralisation and sketch the basic schematic diagram of neutralised IF stage.
	4.3	Sketch the basic schematic diagram of the various techniques of input and output coupling to IF amplifiers.
	4.4	Compare the bandwidth requirements of DSBFC, SSBSC and FM receivers.
	4.5	Sketch the response of a typical filter used in IF amplifiers showing all relevant frequencies and amplitudes.
	4.6	Explain the need for limiters with FM receivers.
	4.7	Sketch the schematic diagram of a simplified limiter stage.
	4.8	Measure and graph the response of an IF amplifier after aligning the amplifier as per the instructions detailed in the receiver's service manual.

Learning outcome 5	**Compare the differences between the demodulation requirements of DSBFC, FM and SSBSC demodulators.**	
Assessment criteria	5.1	Sketch the schematic diagram and explain the operation of a DSBFC demodulator.
	5.2	List the advantages and disadvantage of the following types of FM demodulators: - Foster Seeley detector - ratio detector - quadrature detector - PLL detector.
	5.3	Explain the need for carrier reinsertion in SSBSC demodulators.
	5.4	Sketch the schematic diagram of a basic SSBSC demodulator and explain the circuit operation.
	5.5	Explain the need for “clarifier” or “Receiver Incremental Tuning (RIT)” controls in SSBSC receivers.
	5.6	Measure and graph the discriminator “S” curve showing all relevant frequencies and amplitudes given a commercial FM receiver, appropriate test equipment and the receiver’s service manual.
Learning outcome 6	**Explain the AGC requirements for DSBFC, SSBSC and FM receivers.**	
Assessment criteria	6.1	Describe the need for AGC in DSBFC and SSBSC receivers.
	6.2	Explain the need for AGC in DSBFC and SSBSC receiver as compared to FM receivers.
	6.3	Compare the AGC characteristics for DSBFC receivers and SSBSC receivers.
	6.4	Measure and graph the performance of the AGC system in maintaining a relatively constant audio output level for varying RF input levels.

Learning outcome 7	**Sketch the block diagram of a frequency synthesis system using a PLL suitable for use in a multi-channel communications receiver.**
Assessment criteria	7.1 Explain the three operating conditions of a basic phase locked loop. 7.2 Explain the relationship between Voltage Controlled Oscillator (VCO) frequency response and bandwidth. 7.3 Compare the differences between direct and indirect frequency synthesis. 7.4 Sketch the block diagram and describe the operation of a phase locked loop frequency synthesizer providing multi-channel receiver facilities. 7.5 Measure the VCO frequency and PLL reference frequency of a commercial multi-channel receiver for various channels given appropriate test equipment and the receiver's service manual.

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:

- Frequency counter, 1MHz-250MHz
- Oscilloscope, 60MHz, dual beam
- Spectrum analyser, 50-870MHz, kit
- Spectrum analyser, 1-100MHz, probe
- AM/SSB receiver or transceiver
- FM receiver or transceiver
- Workshop manuals, set
- RF signal generator (AM and FM)
- SINAD meter
- Power supply for receiver/transceiver
- Service manual for receiver/transceiver
- 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.