1	**Module Details**	
	Module Name	**Introduction to Antennas**
	Nominal duration	It is expected that students with the appropriate entry knowledge and skills will successfully complete this module in 72 to 80hours.
	Module code	NUE099/100
	Discipline code	0703501 Communications Engineering – General
2	**Module purpose**	This module will provide students with the underpinning knowledge and skills to select and locate an appropriate antenna for a radio signal.
3	**Prerequisites**	Electrical Concepts and Applications (NUE058) Electrical Wiring and Equipment (NE172.1)
4	**Relationship to competency standards**	This module provides some of the knowledge and skills underpinning competency in the following standards: National Electrotechnology Industry Standards, Units: NES202, NES401, NES105, NES209. Metals and Engineering Industry Standards, Units: 12.2A, 10.2A, 10.3A
5	**Content**	1. Electromagnetic propagation fundamentals • safety hazards associated with electromagnetic radiation • definition of electromagnetic wave • classification of radio bands • wavelength and frequency • polarisation • environmental effects of wave propagation - reflection - refraction - diffraction • ground- and space-wave propagation • effects of the ionosphere on sky-wave propagation - critical frequency - skipping - skip zone - fading - tropospheric ducking and scatter 2. Antenna concepts • definition of antenna • antenna size

- antenna gain and directivity
- front-to-back ratio
- definition of:
  - radiation resistance
  - loss resistance
  - antenna efficiency

3. Dipole antennas – half wave, full wave and folded dipole
   - length
   - frequency range
   - radiation pattern
   - current and voltage distribution
   - feedpoint

4. Vertical antennas

   - ground reflections
   - antenna types
     - radiations patterns
     - current and voltage distribution
     - applications
   - loading coil
   - top loading
   - VHF and UHF vertical antennas

5. Arrays

   - operation and performance of various array types
     - broadside
     - collinear
     - driven collinear array
     - Yagi-Uda array

6. UHF and microwave antennas – satellite and terrestrial

   - circular polarisation
   - helical antennas
   - parabolic dishes – horn feed and Cassegrain

7. Antenna selection and location

   - safety procedures when working on antennas
   - antenna selection
   - manufacturers' data
   - antenna location and orientation
   - use of field strength meter

8. Introduction to transmission lines

   - purpose
   - transmission line types and their applications
   - balanced and unbalanced lines

identification
- dielectric
- power handling
- attenuation

- velocity factor
- characteristics impedance

9. Antenna matching

- resistance-reactance model
- matching antennas
- loading components
- baluns
- quarter wave transformer
- stub matching
- types of interference to RF signals including:
  - multiple path reception
  - power line interference
- reduction and rejection of interference

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 a Classroom/laboratory environment and in a real or simulated automotive environment.

7 Learning Outcome Details

Learning Outcome 1

Explain the principles of electromagnetic propagation from a transmitter to a receiver.

Assessment criteria

1.1 Describe the safety hazards associated with electromagnetic radiation, and the precautions that should be taken.
1.2 Classify the radio spectrum into bands and state the corresponding frequency ranges.
1.3 Calculate the frequency of an electromagnetic wave in free space given its wavelength, and vice versa.
1.4 Define and measure electric field strength and state its unit.
1.5 Describe the term polarisation
1.6 Outline the environmental effects on wave propagation including reflection, refraction and diffraction.
1.7 Describe ground- and space-wave propagation.

	1.8 Describe ionospheric layers and their effects on sky-wave propagation. 1.9 Define the following terms: - critical frequency - skipping - skip zone - fading - tropospheric ducking and scatter
Learning Outcome 2	Describe the operation of an antenna and explain the main parameters that specify its performance.
Assessment criteria	2.1 Define the term antenna. 2.2 State the general relationship between antenna size and wavelength at the frequency of operation. 2.3 Show how the polarisation of a signal is defined in terms of E field. 2.4 Explain the following terms: - antenna gain - directivity - front-to-back ratio. 2.5 Define the following terms: - radiation resistance - loss resistance - antenna efficiency.
Learning Outcome 3	Outline the operation and performance of various dipole types, compare their characteristics and describe their applications.
Assessment criteria	3.1 Describe the safety hazards associated with high voltages found on dipole antennas. 3.2 Calculate the nominal physical length of half wave, full wave and folded dipoles. 3.3 Sketch the 3D and E and H plane radiation patterns of half wave, full wave and folded dipoles. 3.4 Draw the current and voltage distribution on half wave, full wave and folded dipoles. 3.5 Compare the electrical and mechanical characteristics of half wave, full wave and folded dipoles. 3.6 Sketch the general construction of half wave, full wave and folded dipoles, showing the method of feed, mounting details, and nominal size. 3.7 Measure and plot the radiation pattern of a half wave dipole, and determine its beamwidth.
Learning Outcome 4	Outline the operation and performance of vertical antenna types, compare their characteristics and describe their applications.
Assessment criteria	4.1 Describe the effect that ground has on an antenna.

	4.2 Compare the vertical (E plane) radiation patterns of ¼, ½, ¼ and 1 wavelength high vertical antennas. 4.3 Outline the current and voltage distribution on ¼, ½, ¾ and 1 wavelength high vertical antennas. 4.5 Describe the applications of vertical antennas, and compare performance with dipoles and other types.
Learning Outcome 5	Describe the operation and performance of various antenna arrays.
Assessment criteria	5.1 Define and classify array types. 5.2 Briefly describe the construction, operation and properties of the following array types: - broadside - collinear - driven collinear array - Yagi-Uda array 5.3 Sketch the general arrangements of **broadside** (including **collinear**) **array dipoles**, showing the method of feeding each dipole, spacing, current distribution and radiation patterns. 5.4 Sketch the general arrangements of a **driven collinear array**, showing the method of feeding each dipole, current distribution and radiation patterns 5.5 Sketch the general arrangements of a **Yagi-Uda array,** showing the method of feeding each dipole, typical element lengths, spacings and radiation patterns. 5.6 Measure the radiation pattern and gain of a Yagi-Uda array.
Learning Outcome 6	Describe the principles involved when using antennas at higher frequencies (UHF and microwave applications).
Assessment criteria	6.1 State the requirements for antennas for satellite use. 6.2 Explain how the circular polarisation can be produced. 6.2 Show how the polarisation of an antenna may be reversed. 6.3 Describe the feed methods for a parabolic dish. 6.4 Describe a helical antenna for use with circular polarisation.
Learning Outcome 7	Select and locate various antenna types.
Assessment criteria	7.1 Select the correct antenna for use with different frequency bands using manufacturers' data. 7.2 Determine the optimum location and orientation of an antenna using a field strength meter.

Learning Outcome 8	Briefly describe the characteristics of common transmission lines.
Assessment criteria	8.1 State the basic function of a transmission line. 8.2 Identify balanced and unbalanced transmission lines and specify their differences with respect to: - dielectric - power handling - attenuations 8.3 Measure the velocity factor of a line using time domain reflectometry. 8.4 Measure the characteristic impedance of a line using time domain reflectometry.
Learning Outcome 9	Describe the principles involved in matching an antenna and a transmission line.
Assessment criteria	9.1 List the safety procedure to be followed when working with antennas. 9.2 Given the length of an antenna in proportions of quarter wavelengths draw the mathematical model for Marconi and Hertz antennas. 9.3 Show how inductive and capacitive loading can tune an antenna. 9.4 Measure the reactive and resistive components of an antenna using RF bridge. 9.5 List the applications of RF balun. 9.6 Briefly describe the use of a quarter-wavelength matching transformer. 9.7 Tune an antenna using matching unit. 9.8 Recognise, then eliminate or minimise the types of interference picked up or introduced by an antenna or distribution system.

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 way to achieve this is by the integration of theory and practice where students learn by experimentation and through research and laboratory reports. It is recommended that learning and assessment be facilitated in a holistic manner, which may require a learning outcome sequence other than that indicated in the module.
Resource requirements	A range of experimental circuit components and measuring equipment and practical equipment. Resources should be sufficient for students to carry out experiments on an individual basis.

	Useful references include: Young, Paul H. Electronic Communication Techniques, Merrill, 1994. ISBN 0-13-779984-5 Smith, Martin S. Introduction to Antennas, Macmillan Education C., 19888 ISBN 0-38-791323-8 Miller, Gary M. Modern Electronic Communication, Prentice Hall, 1993. ISBN 0-13-301482-7 Hills Antenna Installation and TV Systems Manual compiled by RFW Castle
Occupational health and safety requirements	A safe and healthy environment will be provided for students and teachers as well as safety procedures followed with regard to teaching/learning activities.