

1 Module Details	<p>Module Name Sonar Transducers and Arrays</p> <p>Nominal duration It is expected that students with the appropriate entry knowledge and skills will successfully complete this module in 40 hours.</p> <p>Module code NUE171</p> <p>Discipline code 0703205</p>
2 Module purpose	This module will provide the student with knowledge of sonar transducers and arrays.
3 Prerequisites	NUE172 Sonar Systems Operating Principles
4 Relationship to competency standards	This module provides some of the knowledge and skills underpinning competencies in the following standards: National Electrotechnology Industry Standards, Unit NES206c Metals & Engineering Industry Standards, Units MEM 18.57A
5 Content	<ol style="list-style-type: none"> 1. Safety <ul style="list-style-type: none"> • Safety procedures <ul style="list-style-type: none"> • Entry <ul style="list-style-type: none"> • Sonar dome • Confined spaces • Ventilation requirements • Safety numbers • Clothing/Safety equipment • Equipment isolation • Radiation hazards • Safety symbols <ul style="list-style-type: none"> • High voltages • Radiation hazards • Safety signs <ul style="list-style-type: none"> • High voltages • Radiation hazards • Transducer components/ devices <ul style="list-style-type: none"> • Handling • Disposal 2. Transducer – Operation <ul style="list-style-type: none"> • Sonar devices <ul style="list-style-type: none"> • Transducer • Hydrophone • Element types <ul style="list-style-type: none"> • Electric <ul style="list-style-type: none"> • Piezo electric • Electrostrictive • Magnetic <ul style="list-style-type: none"> • Electrodynamic • Electromagnetic • Magnetostrictive • Element Properties

- Linearity
- Reversibility
- Polarisation
- Element shape
- Frequency response
- Advantages/ Disadvantages

3. Transducer Arrays

- Transducers
- Physical construction
 - Line array
 - Planar array
 - Cylindrical array
 - Conformal array
 - Spherical array
- Operating characteristics
 - Beam types
 - Narrow
 - Wide
 - Operational frequency
 - Space available
 - Ships
 - Submarines
 - Bearing accuracy and discrimination
 - Power output
 - Mediums
 - Salt water
 - Fresh water
 - Oils
 - Operational requirements
 - Bearing discrimination
- Advantages/ Disadvantages

4. Transducer – Hull Outfits

- Hull outfit types
 - Retractable
 - Sonar dome
 - Directing gear
 - Raise lower mechanism
 - Fixed
 - Hull mounting
 - Sonar dome
 - Dome, ship fairings
 - Venting and pressure balancing system
- Design constraints
 - Streamlining
 - Acoustic transparency
 - Watertight requirements
 - Strength requirements
 - High speed
 - Ship manoeuvrability
 - Retractable dome
 - Size
 - Number of transducers
 - Minimum maintenance fitting
 - Maintenance requirements
 - Vibration

- Advantages/ disadvantages
 - Fixed hull outfits
 - Retractable hull outfits
- 5. Principals of beamforming
 - Properties of beamforming
 - Requirement for narrow beams
 - Formation of narrow transmit beams
 - Constructive interference
 - Destructive interference
 - Pattern of transmission, amplitude against bearing
 - Source level
 - Element spacing
 - Larger transducer arrays
 - Vector sums
 - Formation of narrow received beams
 - Narrow beams – disadvantages
 - Side lobes
 - Sweep rate
 - Transducer configurations
 - Disadvantages – counteractions
 - Shading
 - Beam steering
 - Mechanical
 - Electrical
 - Beam switching
- 6. Transducer arrays – operation, measurement, and maintenance
 - Appropriate test equipment selection
 - Test equipment calibration
 - Measurement errors – effects
 - Test equipment operation
 - Transducers/arrays, description, measurement and calculations
 - Power output and physical size relationship
 - Propagation
 - Size
 - Shape
 - Material
 - Current and voltage distribution
 - Frequency
 - Impedance, checks/ matching
 - Checks
 - Matching
 - Phase relationship
 - Transducer elements
 - Installation and removal

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

Conditions of assessment	multiple choice, short answer and problem solving.
7 Learning Outcome Details	Learning and assessment will take place in a classroom environment.
Learning Outcome 1	Outline the risks to personnel from sonar transducers.
Assessment criteria	<p>1.1 Describe the safety procedures for sonar domes and sonar transducers with reference to:</p> <ul style="list-style-type: none"> • Entry to Sonar dome in confined spaces • Ventilation requirements for sonar domes • Safety numbers • Clothing and Safety equipment • Equipment isolation • Radiation hazards <p>1.2 Describe the safety signs and symbols associated with high voltages.</p> <p>1.3 Outline handling and disposal procedures for transducer components and devices.</p>
Learning Outcome 2	Describe the operation of transducers used in sonar equipment.
Assessment criteria	<p>2.1 Describe the operation of typical sonar devices:</p> <p>2.2 Describe typical electric and magnetic types of transducer elements.</p> <p>2.3 Describe typical transducer element properties.</p> <p>2.4 State the advantages and disadvantages of typical transducer elements.</p>
Learning Outcome 3	For a transducer array describe its construction and the principles of operation.
Assessment criteria	<p>3.1 Define the term “transducer array”</p> <p>3.2 Sketch the physical construction of the following arrays:</p> <ul style="list-style-type: none"> • Line array • Planer array • Cylindrical array • Conformal array • Spherical array <p>3.3 Describe the relationship between the arrays in 3.2 and the following parameters.</p> <ul style="list-style-type: none"> • Function <ul style="list-style-type: none"> • Narrow beam • Wide beam • Frequency of operation • Space available <ul style="list-style-type: none"> • Ships • Submarines

	<ul style="list-style-type: none"> • Bearing accuracy • Power output • Mediums <ul style="list-style-type: none"> • Salt water • Fresh water • Oils <p>3.4 Describe the operational requirements of the arrays in 3.2, with reference where applicable to:</p> <ul style="list-style-type: none"> • Bearing discrimination <p>3.5 List the advantages and disadvantages of the arrays in 3.2.</p>
Learning Outcome 4	Discuss sonar transducer hull outfits.
Assessment criteria	<p>4.1 Describe the two types of hull outfits.</p> <ul style="list-style-type: none"> • Retractable <ul style="list-style-type: none"> • Sonar dome • Directing gear • Raise, lower mechanism • Fixed <ul style="list-style-type: none"> • Hull mounting • Sonar dome • Dome, ship fairings • Venting and pressure balancing system <p>4.2 Describe the following design constraints of a hull outfit.</p> <ul style="list-style-type: none"> • Streamlining • Acoustically transparent dome • Water tight requirements • Strength requirements <ul style="list-style-type: none"> • High speed • Ship manoeuvrability • Retractable dome • Size <ul style="list-style-type: none"> • Number of transducers • Minimum maintenance fitting/ maintenance requirements • Vibration free <p>4.3 List advantages/disadvantages of fixed and retractable hull outfits.</p>
Learning Outcome 5	State the principals of beam forming.
Assessment criteria	<p>5.1 Using illustrations and calculations, describe the following properties of beamforming</p> <ul style="list-style-type: none"> • Requirement for narrow beams • Formation of narrow transmit beams <ul style="list-style-type: none"> • Constructive interference • Destructive interference • Pattern of transmission, amplitude against bearing • Source level • Element spacing

	<ul style="list-style-type: none"> • Large transducer arrays <ul style="list-style-type: none"> • Vector sums • Formation of narrow receive beams <p>5.2 Discuss the following disadvantages of narrow beams</p> <ul style="list-style-type: none"> • Side lobes • Sweep rate • Transducer configurations <p>5.3 Describe how to counteract the difficulties discussed in 5.2 with reference where applicable to:</p> <ul style="list-style-type: none"> • Shading • Beam steering <ul style="list-style-type: none"> • Mechanical • Electrical • Beam switching
<p>Learning Outcome 6</p>	<p>Install, operate, measure, and maintain transducers and transducer arrays.</p>
<p>Assessment criteria</p>	<p>6.1 Select appropriate test equipment from commercial test equipment catalogues to properly carry out measurements related to sonar devices and components</p> <p>6.2 Calibrate test equipment so as to obtain accurate readings</p> <p>6.3 Describe the effects of measurement errors that can occur when measuring the parameters associated with transducers and transducer arrays.</p> <p>6.4 Operate test equipment to make measurements of parameters associated with transducers and transducer arrays.</p> <p>6.5 Describe, measure and calculate (where applicable) the following aspects of transducers/arrays.</p> <ul style="list-style-type: none"> • Power output and physical size relationship • Propagation <ul style="list-style-type: none"> • Size • Shape • Material • Current and voltage distribution • Frequency • Impedance, cheeks/ matching • Phase relationship <p>6.6 Describe the procedures for installation/ removal of “ electric” and “magnetic type transducer elements.</p>
<p>8 Delivery of the module</p>	
<p>Delivery strategy</p>	<p>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</p>

	<p>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.</p>
Resource requirements	Resources should be sufficient for students to carry out practical exercises on an individual basis.
Occupational health and safety requirements	A safe and healthy environment will be provided for students and teachers as well as safety procedures with regard to teaching/learning activities.