ELECTRICAL INSTRUMENTATION

UNIT CODE: ENG/CU/ET/CR/04/6/A

Relationship to Occupational Standards
This unit addresses the unit of competency: Apply Electrical Instrumentation

Duration of Unit: 200 hours

Unit Description
This unit covers competencies required to apply electrical instrumentation. Competencies include; demonstrating understanding of measurements, applying analogue instruments, applying electromechanical instruments, applying digital instruments, measuring of electrical and physical quantities, applying waveform analyzing instruments, applying sensors, transducers and calibrating instruments

Summary of Learning Outcomes

1. Demonstrate understanding of measurements
2. Apply analogue instruments
3. Apply electromechanical instruments
4. Apply digital instruments
5. Measure electrical and physical quantities
6. Apply waveform analysing instruments
7. Apply sensors and transducers
8. Calibrate instruments

Learning Outcomes, Content and Suggested Assessment Methods:

Learning Outcome	Content	Suggested Assessment Methods

1. Demonstrate understanding of measurements	• Meaning of terms
	• Units of measurements
	• SI units and symbols
	  ◦ Mechanical units
	  ◦ Electrical units
	  ◦ Temperature scales
	• Industrial measurements and variables
	• Conversions
		• Written tests
		• Oral questioning
		• Practical tests
		• Observation

Learning Outcome	Content	Suggested Assessment Methods

	• Dimensions
	• Measurement errors
	  • Gross errors
	  • Systemic errors
	  • Absolute errors
	  • Relative errors
	• Accuracy
	• Precision
	• Resolution
	• Sensitivity
	• Significant figures
	• Functions of instruments
	  • Indicating instruments
	  • Recording instruments
	  • Controlling instruments	

2. Apply analogue instruments	• Meaning of terms
	• Analogue Instruments
	  • Voltmeter
	  • Transistor voltmeter circuit
	  • Voltmeter range changing
	  • Difference amplifier voltmeter
	  • Op amp amplifier Voltmeter
	  • Voltage to current converter
	  • Ohmeter
	  • Series ohmmeter circuit
	  • Shunt ohmmeter circuit
	  • Linear ohmmeter
	• Ammeter
		• Observation
		• Oral questioning
		• Practical tests
		• Written tests

Learning Outcome	Content	Suggested Assessment Methods

	• Ammeter circuit
	• Analogue electronic multimeter
	• Multimeter probes
	  • High voltage probes
	  • High current probes
	  • Radio Frequency Probes
	• Calculation of errors
	
	• Statistical methods of analyzing errors
	  • Arithmetic mean value
	  • Deviation
	  • Standard deviation	

3. Apply electromechanical instruments	• Meaning of terms
	• Permanent magnet moving coil and moving iron instruments
	  • Deflection instrument fundamentals
	  • PMC construction
	  • Torque equation and scale
	  • Deflecting torque
	  • Controlling torque
	  • Damping torque
	• Galvanometer
	  • Function
	  • DC and AC galvanometer
	  • Sensitivity
	  • Use of a galvanometer as null meter of null detector
	  • Types of galvanometers
	  • Ballistic galvanometer
		• Observation
		• Oral questioning
		• Practical tests
		• Written tests

Learning Outcome	Content	Suggested Assessment Methods

	• Vibration galvanometer
	• DC and AC Ammeters and Voltmeters
	  • Ammeter circuit
	  • Shunt resistance
	  • Swamping resistance
	  • Ammeter scale
	  • Multirange ammeters
	  • Rectifier ammeter
	  • Voltmeter circuit
	  • Swamping resistance
	  • Multirange voltmeter
	  • Rectifier voltmeter
	  • Classifications
	  • Moving iron type
	  • Attraction type
	  • Repulsion type
	  • Moving coil type
	  • DC permanent magnet type
	  • Electrodynamic (dynamometer) type
	  • Hot wire type
	  • AC induction type
	  • Split type
	  • Shaded pole
	  • Electrostatic type voltmeter
	• Wattmeter
	  • Types of wattmeter
	  • Dynamometer type
	  • AC Induction type
	  • DC Electrostatic type
	• Energy meters	

Learning Outcome	Content	Suggested Assessment Methods

4. Apply digital instruments	• Meaning of terms
	• Logic gates circuits e.g.
	  • AND gates
	  • OR gates
	  • NAND gates
	• Flipflops circuits
	• Digital displays e.g.
	  • Light emitting diode displays
	  • Liquid crystal displays
	• Digital counting e.g.
	  • Scale-of-16 bit counter
	  • Decade counter
	  • Scale-of-2000 bit counter
	  • Digital frequency division
	  • Seven-segment display
	• Digital voltmeter
	• Digital multimeter
	• Digital Cathode ray oscilloscope
	• Analogue-to-digital converters
	  • Methods of analogue to digital conversion
	• Digital-to-analogue converters
	  • Methods of digital to analogue conversion
	• Calculations involving accuracy and resolution in digital instruments
		• Observation
		• Oral questioning
		• Practical tests
		• Written tests

5. Measure electrical and physical quantities	• Meaning of terms
	• Methods resistance measurements
	  • Voltmeter and ammeter methods
	  • Substitution method
	  • Wheatstone bridge
	• Low resistance measurement
	  • Kelvin bridge
		• Observation
		• Oral questioning
		• Practical tests
		• Written tests

Learning Outcome	Content	Suggested Assessment Methods
	• Four terminal resistors • Low resistance linear Ohmmeter • Micro-ohmmeter • High resistance measurements • Voltmeter and ammeter methods • Guard wire and guard ring • Wheatstone bridge measurement of high resistance • Hand-cranked megohmmeter • Measurement of inductance and capacitance • RC and RL equivalent circuits • Inductor and capacitor equivalent circuit • Q factor of an inductor • D factor of a capacitor • AC bridge theory • Circuit and balance equations • Capacitance bridges • Inductance bridges • Multifunction impedance bridge • Analogue and digital R-C-L meter • Measurement of physical quantities e.g. • Temperature • Humidity • Noise	

Learning Outcome	Content	Suggested Assessment Methods

6. Apply waveform analyzing instruments	• Meaning of terms
	• Cathode ray tube
	  • Parts of a cathode ray tube
	• Cathode ray oscilloscope
	  • Operation of a CRO
	  • Classifications of CROs
	  • Triggered sweep type
	  • Recurrent sweep type
	• Dual trace, dual beam, sampling, digital readout CROs
	• Oscilloscope controls
	• Application of CROs
	• Logic analyzers
	• Spectrum analyzers
		• Observation
		• Oral questioning
		• Practical tests
		• Written tests

7. Apply sensors and transducers	• Meaning of terms
	  • Sensors
	  • Transducers
	• Types of sensors and transducers e.g.
	  • Resistance type
	  • Inductance type
	  • Capacitance type
	• Classification of transducers
	  • Active transducers
	  • Passive transducers
	• Signal processing
	  • Analogue signal processing
	  • Continuous time signal processing
	  • Discrete time signal processing
	  • Digital signal processing
	  • Nonlinear signal processing
	  • Statistical signal processing
	• Applications of signal processing
	• Data presentation displays
		• Observation
		• Oral questioning
		• Practical tests
		• Written tests

Learning Outcome	Content	Suggested Assessment Methods
	• LED displays • LCD displays	

8. Calibrate instruments	• Meaning of calibration
	• Comparison methods
	  • DC voltmeter calibration
	  • DC ammeter calibration
	  • Ohmmeter calibration
	  • Wattmeter calibration
	• Digital multimeters as standard instruments
	• Calibration instruments
	  • Precision voltage source
	  • Voltage calibrator
	• Potentiometers
	  • Basic potentiometers
	  • Potentiometers with switched resistors
	  • Potentiometer calibration methods
	• DC ammeter calibration
	• DC voltage calibration
		• Observation
		• Oral questioning
		• Practical tests
		• Written tests

Suggested Methods of Instruction

- Projects
- Demonstration by trainer
- Practice by the trainee
- Field trips
- On-job training
- Discussions

Recommended Resources

Tools and equipment

- Ammeters
- Voltmeters
- Ammeters
- Wattmeters
- Oscilloscope
- Electrician knives
- Calibrating instruments
- PPE – hand gloves, dust coats, dust masks, helmets, ear muffs, industrial boots

Materials and supplies

- Stationery
- Cables
- Computers
- Drawing instruments
- Cables

Reference materials

- IEE regulations
- Occupational safety and health act (OSHA)
- Work injury benefits act (WIBA)
- Manufacturers' catalogues
- British standards
- KEBS standards