

**TRADE: MILLWRIGHT (ELECTROMECHANICIAN)**

<b>MODULE</b>	<b>CODE</b>	<b>OBJECTIVES</b>	<b>CRITERIA</b>
<b>INDUCTION</b>	ID1	Recall applicable sections of the Manpower Training (Act No 56, 1981), with special reference to discipline and legal responsibilities.	Pass a questionnaire with at least 80%.
	ID2	Recall terms and conditions of apprenticeship as Gazetted 26 July 1991.	Pass a questionnaire with at least 80%.
	ID3	Recall applicable grievance procedures.	Pass a questionnaire with at least 80%.
	ID4	Recall applicable disciplinary procedures.	Pass a questionnaire with at least 80%.
	ID5	Recall company rules and procedures.	Pass a questionnaire with at least 80%.
	ID6	Recall quality assurance procedures.	Correct according to company standards and procedures with a minimum of five (5) questions and 100% pass.
<b>SAFETY</b>	SF1	Recall relevant regulations of the following Acts: (where applicable) Occupational Health and Safety Act (Act No 85, 1993) - Minerals Act and Regulations (Act No 50, 1991).	Pass a questionnaire with at least 80%.
	SF2	Attend a standard industrial safety course accredited by the industry.	Obtain a recognised certificate.
	SF3	Recall safety in welding and gas cutting.	All safety aspects correct according to accredited procedures.
	SF4	Attend a first aid course.	Obtain a recognised certificate - 1st level.

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	SF5	Identify relevant colour markings and symbolic safety signs.	Correct use of SABS 0140 and SABS 1186 publications.
<b>HAND TOOLS</b>	HT1	Identify measuring, checking, forming, cutting, marking and fastening tools and tooling aids.	Correctly identify all the tools and state all their physical characteristics.
	HT2	Use measuring, checking, forming, cutting, marking and fastening tools and tooling aids.	<ol style="list-style-type: none"> <li><u>Measuring and marking tools</u> - 1,0mm accumulative dimensional tolerances and 2° on angular tolerance.</li> <li><u>Checking tools</u> - 0,5mm dimensional tolerance.</li> <li><u>Forming, cutting and marking tools</u> - correct application.</li> <li>All safety aspects adhered to.</li> </ol>
	HT3	Maintain measuring, checking, forming, cutting, marking and fastening tools and tooling aids.	Tools in a safe and functional working condition.
	HT4	Use hand tools applicable to the trade.	<ol style="list-style-type: none"> <li>All safety aspects adhered to.</li> <li>No tools or equipment are damaged.</li> <li>All tools and equipment are clean after use.</li> </ol>
<b>WORKSHOP TOOLS</b>	WT1	Use fixed and portable drilling machines.	<ol style="list-style-type: none"> <li>Correct speeds and feeds to be used.</li> <li>Holes to be within 0,5mm of centre.</li> <li>Correct cutting compounds to be used.</li> </ol>
	WT2	Use fixed and portable grinding machines including replacing, setting, truing and ringing of wheels.	All prescribed safety standards applied.
	WT3	Use a portable jig-saw.	<ol style="list-style-type: none"> <li>All safety aspects adhered to.</li> <li>No equipment is damaged.</li> <li>All tools and equipment are clean after use.</li> </ol>
	WT17	Operate pneumatic and electrical power tools.	<ol style="list-style-type: none"> <li>All safety aspects adhered to.</li> <li>No damage to components and equipment.</li> </ol>

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	WT20	Use hand operated presses.	<ol style="list-style-type: none"> <li>1. All safety aspects adhered to.</li> <li>2. No damage to components.</li> </ol>
	WT21	Mount grinding stone to pedestal grinder. Maximum size : 250mm diameter wheel RPM = 2 000	<ol style="list-style-type: none"> <li>1. Ring test 100% correct.</li> <li>2. No visible damage.</li> <li>3. Only blotting paper gaskets on each side.</li> <li>4. Speed of grinder must not exceed wheel speed.</li> <li>5. Tool rest as close as possible to stone.</li> <li>6. Tighten nut to hold wheel firmly.</li> </ol>
	WT22	Dress a grinding wheel.	Wheel must be concentric.
<b>MATERIALS</b>	MA3	Identify ferrous and non-ferrous metals.	Each type of material correctly identified.
	ME3	Identify the following conducting materials with respect to conductivity, current carrying capacity and temperature: copper, aluminium and nickel chrome resistance wire.	Correct according to SABS 0142.
	ME4	Identify and use the following insulating material with respect to resistivity, temperature and hygroscopic qualities: PVC, glass fibre, porcelain, resins, tapes, varnishes, epoxy compounds and PVC compounds.	Correct according to the relevant SABS codes and manufacturers' specifications.
	MA13	Recall characteristics of ferrous metals - mild steel and cast iron.	Minimum of 15 questions with at least 80% pass.
	MA14	Recall characteristics of non-ferrous metals - copper, brass, aluminium, white metal and stainless steel.	Minimum of 15 questions with at least 80% pass.
<b>DRAWINGS AND SKETCHES</b>	DSE1	Recall symbols and abbreviations used on electrical circuits for schematic and wiring diagrams, connection schedules, cable schedules, layouts and single-line drawings.	A test of minimum 25 questions to be set with an 80% pass mark in accordance to a recognised code of practice.

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	DSE2	Recall symbols and abbreviations as used on engineering drawings.	A test of minimum 25 questions to be set with an 80% pass mark against SABS 044, Part 2.
	DSE3	Recall symbols and abbreviations pertaining to electronic circuit diagrams.	100% correct according to ISO R286.
	DSE22	Interpret and wire electrical circuits to prescribed standards.	Wiring of electrical circuits to be 100% functionally correct.
	DSE5	Interpret engineering drawings.	Correct according to an acceptable code of practice.
	DSE6	Interpret electronic circuit diagrams.	Explanation of drawing to be 100% functionally correct.
	DSE7	Compile material lists from electrical, engineering and electronic drawings.	Correct according to the given drawing.
	DSE23	Make free hand sketches of existing circuits and installations.	Sketches to be legible and identifiable.
	DS9	Identify type of fits from engineering drawings.	100% Correct according to ISO R286.
	DS14	Recall symbols and abbreviations pertaining to hydraulic circuit diagrams.	<ol style="list-style-type: none"> <li>100% correct to ISO tables, DIN tables, IEC tables as applicable.</li> <li>Recognition of components and details 100% correct.</li> </ol>
	DS15	Recall symbols and abbreviations pertaining to pneumatic circuit diagrams.	<ol style="list-style-type: none"> <li>100% correct to ISO tables, DIN tables, IEC tables as applicable.</li> <li>Recognition of components and details 100% correct.</li> </ol>
	DS39	Interpret and draw hydraulic circuit diagrams.	Correct according to ISO 1219 tables.
	DS40	Interpret and draw pneumatic circuit diagrams.	Correct according to ISO 1219 tables.

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	DS18	Compile material lists from hydraulic and pneumatic drawings.	Correct according to ISO 1219 tables.
<b>MARKING OFF</b>	MO1	Mark off a project applicable to the trade.	<ol style="list-style-type: none"> <li>1. All angles to be within <math>\pm 30</math> minutes.</li> <li>2. All dimensions to be within <math>\pm 0,25</math>mm.</li> </ol>
	MO2	Mark off a bus-bar.	<ol style="list-style-type: none"> <li>1. All sizes to be within 0,5mm.</li> <li>2. All dimensions of hole centres within 0,1mm.</li> </ol>
	MT6	Mark off a seven-holed flange/coupling.	<ol style="list-style-type: none"> <li>1. No double lines.</li> <li>2. Punch hole centres 100% correct.</li> <li>3. All dimensions to be within 0,25mm.</li> <li>4. According to specific drawings.</li> </ol>
	MT7	Mark off a five-holed flange/coupling.	<ol style="list-style-type: none"> <li>1. No double lines.</li> <li>2. Punch hole centres 100% correct.</li> <li>3. All dimensions to be within 0,25mm.</li> <li>4. According to specific drawings.</li> </ol>
	MT8	Mark off a flange consisting of a centre hole.	<ol style="list-style-type: none"> <li>1. No double lines.</li> <li>2. Punch hole centres 100% correct.</li> <li>3. All dimensions to be within 0,25mm.</li> <li>4. According to specific drawings.</li> </ol>
	MT9	Mark off projects for manufacturing using all standard marking-off techniques and tools.	<ol style="list-style-type: none"> <li>1. No double lines.</li> <li>2. Punch hole centres 100% correct.</li> <li>3. All dimensions to be within 0,25mm.</li> <li>4. According to specific drawings.</li> </ol>
<b>HAND SKILLS</b>	HS1	Fabricate a project applicable to the trade.	<ol style="list-style-type: none"> <li>1. All dimensions to be within <math>\pm 0,25</math>mm.</li> <li>2. All angles to be within <math>\pm 0,25</math>mm.</li> <li>3. Surface texture N7.</li> </ol>
	HS2	Sharpen chisels.	Cutting angle is correct and no mushroom on the chisel head.

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	HS3	Sharpen drills.	Angles according to tables and application.
	HS4	Dress screwdrivers.	<ol style="list-style-type: none"> <li>1. All safety aspects adhered to.</li> <li>2. Screwdrivers to be functionally correct.</li> </ol>
	HS5	Sharpen punches.	<ol style="list-style-type: none"> <li>1. All safety aspects adhered to.</li> <li>2. Correct included angles according to application.</li> </ol>
	HS7	Sharpen marking-off tools.	Marking edge to make single scribing lines.
	HS8	Manufacture a project using the following techniques and material: filing, sawing, drilling, tapping, reaming. Material: mild steel.	<ol style="list-style-type: none"> <li>1. All sizes within 0,05mm.</li> <li>2. All surfaces flat and square.</li> <li>3. Surface texture down to N9 according to comparison scale.</li> </ol>
	HS9	Harden and temper a centre punch.	<ol style="list-style-type: none"> <li>1. Temperature and colour controlled according to specifications.</li> <li>2. Temper to be correct for application.</li> </ol>
<b>ARC WELDING</b>	A01	Identify and set up AC and/ or DC welding machines, equipment including starting up and shutting down procedures.	Correct according to manufacturer's handbook.
	A02	Differentiate between arc welding consumables.	Correct according to company welding practices.
	A03	Prepare material for arc welding.	Correct according to company welding procedures and practices with regard to weld joint preparation, voltage, amperages and welding consumables.
	A04	Tack and arc weld workpieces incidental to the trade using manual metal arc welding techniques.	<ol style="list-style-type: none"> <li>1. Correct according to company quality control procedures.</li> <li>2. All safety aspects adhered to.</li> </ol>
<b>GAS WELDING AND BRAZING</b>	GW10	Identify and set up oxygen-fuel gas equipment including light up, adjustment of gas pressure and shut down procedure.	<ol style="list-style-type: none"> <li>1. Correct according to manufacturer's handbook.</li> <li>2. All safety aspects adhered to.</li> <li>3. Selection of correct size nozzles in relation to material thickness.</li> </ol>

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	GW11	Differentiate between brazing and gas welding consumables.	Correct according to manufacturers' specifications.
	GW12	Prepare material for brazing and gas welding.	Correct according to company brazing and gas welding procedures with regard to joint preparation including brazing and gas welding consumables.
	GW13	Braze and gas weld workpieces incidental to the trade.	<ol style="list-style-type: none"> <li>1. Correct according to company quality control procedures.</li> <li>2. All safety aspects adhered to.</li> </ol>
<b>GAS CUTTING AND HEATING</b>	GC1	Identify and assemble gas cutting and heating equipment, including, light up and shut-down procedures.	Correct method and procedure according to safety standards.
	GC2	Select nozzles and gas pressures for cutting and heating different materials of various thicknesses.	100% Correct according to manufacturers charts.
	GC3	Hand cut and heat materials incidental to the trade.	Company quality standards on finish and with maximum 2mm deviation from line.
<b>BASIC LIFTING TECHNIQUES</b>	BG2	Recall overhead crane hand signals.	100% Correct according to recognised code of practice.
	BG3	Demonstrate overhead crane hand signals.	100% Correct according to recognised code of practice.
	BG4	Use the following equipment: <ul style="list-style-type: none"> <li>- chain block : 2 ton max</li> <li>- coffer block : 2 ton max</li> <li>- shackles : 2 ton max</li> <li>- chain slings : 2,5 ton max</li> <li>- wire rope slings : 20mm diameter.</li> </ul>	<ol style="list-style-type: none"> <li>1. Working load not to exceed equipment safe loading capacity.</li> <li>2. Correct method of slinging.</li> <li>3. No kinks in wire rope slings and chain slings.</li> <li>4. No damage to equipment.</li> </ol>

MODULE	CODE	OBJECTIVES	CRITERIA
<b>ELECTRICAL MEASURING EQUIPMENT (PANEL MOUNTED)</b>	MJ1	Select and connect the following panel mounted meters and interpret the readings: voltmeter, ammeter and energy meter (KWH).	<ol style="list-style-type: none"> <li>1. Meters selected and connected correctly.</li> <li>2. Gives correct reading on meter.</li> </ol>
<b>ELECTRICAL TESTING INSTRUMENTS (PORTABLE)</b>	ET1	Select and connect the following instruments for safety and fault finding as used for electrical systems up to 750 volts: voltage tester, multimeter, insulation tester, oscilloscope, earth leakage tester, phase rotation tester and signal generator.	<ol style="list-style-type: none"> <li>1. Correct test instrument selection for the application.</li> <li>2. 100% evaluation of test readings.</li> <li>3. All safety rules to be applied.</li> </ol>
<b>MEASURING EQUIPMENT</b>	MF1	Use a micrometer - outside - depth - inside.	<ol style="list-style-type: none"> <li>1. All sizes within 0,05mm.</li> <li>2. Standard holding technique to be maintained.</li> <li>3. Correct zeroing method applied.</li> </ol>
	MF2	Use a vernier - depth - inside - outside	All sizes within 0,1mm.
	MF3	Use a tape measure and steel rule.	All sizes within 0,5mm.
	MF4	Use a calliper - inside - outside	All sizes within 0,5mm.
	MF5	Use a machine level.	All sizes within 0,05mm per running meter.
	MF6	Use a vernier height gauge.	All sizes within 0,1mm.
	MF14	Use the following gauges: <ul style="list-style-type: none"> <li>- telescopic</li> <li>- thread</li> <li>- feeler</li> <li>- double dial test indicator</li> <li>- belt tensioner</li> </ul>	<ol style="list-style-type: none"> <li>1. All sizes for telescopic gauge to be within 0,05mm.</li> <li>2. All other measurements to be 100% correct.</li> </ol>

<b>MODULE</b>	<b>CODE</b>	<b>OBJECTIVES</b>	<b>CRITERIA</b>
<b>CABLES</b>	CA1	Make off and join multi and single core, stranded PVC armoured cable up to 16mm <sup>2</sup> 4 core. (1200 volt insulation.)	<ol style="list-style-type: none"> <li>1. Glands, ferrules and lugs used to be correct according to manufacturer's specification.</li> <li>2. Joint to be electrically and mechanically sound and according to manufacturers' specifications.</li> </ol>
	CA2	Identify ratings of cables by current, voltage and temperature.	Correct according to SABS 0142.
	CA3	Recall methods of storing cables.	Correct according to SABS 0142.
	CA4	Terminate PVC cables (up to 1200 volt insulation) for entry into a cable end box using mechanical and compression methods.	Correct according to SABS 0142.
<b>CONDUCTORS</b>	CO1	Recall the current carrying capacity of conductors according to length and cross-sectional area.	Correct according to SABS 0142.
	CO2	Join conductors by the following methods: <ul style="list-style-type: none"> <li>- crimping</li> <li>- soldering</li> </ul>	<ol style="list-style-type: none"> <li>1. Correct size ferrule to be used.</li> <li>2. Correct crimping tool to be used.</li> <li>3. Joint correct according to SABS 0142.</li> </ol>
	CO3	Insulate conductors.	Correct according to SABS 0142.
<b>ELECTRICAL EQUIPMENT</b>	EE1	Maintain the following equipment: control panels, distribution boards, contactors, relays, switch-gear, circuit breakers, timers, isolators, fuse holders, motor control gear, electrical machines, protective devices and lighting systems.	<ol style="list-style-type: none"> <li>1. All safety aspects adhered to.</li> <li>2. All other standards according to company maintenance manuals.</li> </ol>
<b>WIRING</b>	WI1	Design and wire the following with reference to the applicable drawings: panels, starters, motors, motor control gear, electrical distribution systems, protective systems, lighting systems including discharge and florescent lamps.	<ol style="list-style-type: none"> <li>1. Safety standards to be adhered to.</li> <li>2. All circuits function according to specifications.</li> <li>3. Wiring correct according to SABS 0142.</li> </ol>

MODULE	CODE	OBJECTIVES	CRITERIA
AC MACHINES	AC9	Design and wire control and main circuit to which the following single phase machine can be connected: (take into consideration protection and safety equipment that must be used) Capacitor Start Motor - forward and reverse Capacitor start, Capacitor run motor - forward and reverse.	<ol style="list-style-type: none"> <li>1. Phase rotations 100% correct.</li> <li>2. Correct according to SABS 0142.</li> </ol>
	AC10	Design and wire the following control and main circuit to which 3 phase squirrel cage induction motors can be connected. (Take into consideration protection and safety equipment that must be used) <ul style="list-style-type: none"> <li>- Direct on line forward and reverse</li> <li>- Automatic Star-Delta</li> <li>- Auto transformer</li> <li>- Constant torque motor (2 speed)</li> </ul>	<ol style="list-style-type: none"> <li>1. Phase rotations 100% correct.</li> <li>2. Correct according to SABS 0142.</li> </ol>
	AC11	Design and wire the following control and main circuit to which a 3 KHW three phase slip ring induction motor can be connected i.e. Hand controlled resistance starter or automatic current limiting starters. (Take into consideration protection and safety equipment that must be used)	<ol style="list-style-type: none"> <li>1. Phase rotations 100% correct.</li> <li>2. Correct according to SABS 0142.</li> </ol>
	AC17	Before commissioning test the following AC machines electrically and mechanically: <ul style="list-style-type: none"> <li>- Capacitor start motor</li> <li>- Capacitor start capacitor run motor</li> <li>- 3 Phase squirrel cage induction motor</li> <li>- 3 KHW 3 phase slip ring motor</li> <li>- Industrial alternator</li> <li>- Transformers</li> <li>- Auto-transformers.</li> </ul>	<ol style="list-style-type: none"> <li>1. Correct according to SABS 0142 test procedures.</li> <li>2. All connections electrically and mechanically sound.</li> </ol>

MODULE	CODE	OBJECTIVES	CRITERIA
	AC18	<p>After commissioning fault find the following AC machines:</p> <ul style="list-style-type: none"> <li>- Capacitor start motor</li> <li>- Capacitor start capacitor run motor</li> <li>- 3 Phase squirrel cage induction motor</li> <li>- 3 KHW 3 phase slip ring motor</li> <li>- Industrial alternator</li> <li>- Transformers</li> <li>- Auto-transformers.</li> </ul>	<ol style="list-style-type: none"> <li>1. All faults must be repaired permanently and to manufacturers' specifications.</li> <li>2. All faults must be repaired according to SABS 0142 specifications.</li> <li>3. The observation of fault symptoms on AC panels and the diagnosis thereof as a result of their purpose and composition.</li> </ol>
<b>DC MACHINES</b>	DC4	<p>Connect the following 3 KHW DC machines according to given diagram and starting panel (take into consideration protection and safety equipment that must be used)</p> <ul style="list-style-type: none"> <li>- DC Series motor</li> <li>- DC Shunt motor</li> <li>- DC Compound motor</li> <li>- DC Generators</li> </ul>	<ol style="list-style-type: none"> <li>1. Rotation 100% correct.</li> <li>2. Correct according to SABS 0142.</li> <li>3. All corrections electrically and mechanically sound.</li> </ol>
	DC5	<p>Before commissioning test the following DC machines electrically and mechanically</p> <ul style="list-style-type: none"> <li>- DC Series motor</li> <li>- DC Shunt motor</li> <li>- DC Compound motor</li> <li>- DC Generators</li> </ul>	<ol style="list-style-type: none"> <li>1. Correct according to SABS 0142 test procedures.</li> <li>2. All corrections electrically and mechanically sound.</li> </ol>
	DC6	<p>After commissioning fault find the following on DC machines: e.g. sparking, bar marking, grooving, copper dragging, brushgear and bearings.</p>	<ol style="list-style-type: none"> <li>1. All faults must be repaired permanently and to manufacturers' specifications.</li> <li>2. All faults must be repaired according to SABS 0142 specifications.</li> </ol>
<b>SOFT SOLDER</b>	SS1	<p>Prepare and solder the following:</p> <ul style="list-style-type: none"> <li>- Hard copper</li> <li>- Soft copper</li> </ul>	Joint to be electrically and mechanically sound.



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	FA8	Plugging panel with AC and DC control circuit and connect to a 3 KHW slip ring induction motor.	<ol style="list-style-type: none"> <li>1. All safety aspects must be adhered.</li> <li>2. Current testing instruments must be used.</li> <li>3. Specifications as per drawings must be adhered to.</li> <li>4. All mountings must be correct.</li> <li>5. All faults must be permanently safe and neatly repaired.</li> </ol>
	FA9	Hoist panel with low DC injection voltage, 220 volt DC control circuit and 380 volt 3 phase main circuit connected to 3 KHW slip ring induction motor.	<ol style="list-style-type: none"> <li>1. All safety aspects must be adhered.</li> <li>2. Current testing instruments must be used.</li> <li>3. Specifications as per drawings must be adhered to.</li> <li>4. All mountings must be correct.</li> <li>5. All faults must be permanently safe and neatly repaired.</li> </ol>
	FA10	<p>The following 220V DC Heavy current motor control equipment and the practical application of fault finding techniques:</p> <ul style="list-style-type: none"> <li>– Motor does not run</li> <li>– No speed control</li> <li>– No plugging control</li> <li>– The observation of fault symptoms on DC panels and the diagnosis thereof as a result of their purpose and composition</li> <li>– DC dynamic and plugging breaking panel</li> <li>– Travel DC plugging panel</li> </ul>	<ol style="list-style-type: none"> <li>1. All safety aspects must be adhered.</li> <li>2. Current testing instruments must be used.</li> <li>3. Specifications as per drawings must be adhered to.</li> <li>4. All mountings must be correct.</li> <li>5. All faults must be permanently safe and neatly repaired.</li> </ol>
<b>INSTALLATIONS</b>	IN1	<p>Mount, wire and connect the following:</p> <ul style="list-style-type: none"> <li>– switch boards</li> <li>– distribution boards</li> <li>– motor control gear</li> <li>– isolators</li> <li>– electrical equipment</li> </ul>	<ol style="list-style-type: none"> <li>1. Safety standards to be adhered to.</li> <li>2. All circuits function according to specifications.</li> <li>3. Wiring correct according to SABS 0142.</li> </ol>

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	IN2	Install wire-ways including the following: <ul style="list-style-type: none"> <li>- steel and plastic conduit</li> <li>- racks</li> <li>- trunking</li> <li>- flexible conduit</li> </ul>	Correct according to SABS 0142.
<b>ELECTRONICS</b>	EL1	Identify the following electronic components: <ul style="list-style-type: none"> <li>- Resistors - wire wound up to 10 watts</li> <li>- - carbon and metal oxides (1 watt)</li> <li>- Capacitors - electrolytic and ceramic</li> <li>- Diodes</li> <li>- Transistors</li> <li>- Thyristors</li> </ul>	100% correct to manufacturers' specifications.
	EL2	Construct, solder and fault find the following electronic circuits: <ul style="list-style-type: none"> <li>- Bi-stable multi-vibrator</li> <li>- A-stable multi-vibrator</li> <li>- Mono-stable multi-vibrator</li> <li>- Elementary SCR speed control.</li> </ul>	All circuits to operate functionally correct.
	EL3	Use a dual-trace oscilloscope up to 29 MHZ to identify: <ul style="list-style-type: none"> <li>- Wave forms (DC &amp; AC)</li> <li>- Average values</li> <li>- Peak values</li> <li>- Frequencies</li> <li>- RMS values</li> </ul>	1. 100% correct. 2. All readings to within 5% of true values.
	EL5	Programme and use P.L.C. systems.	According to company requirements and manufacturers' specifications.
<b>LUBRICATION</b>	LU1	Identify the following types of lubrication systems: force feed, splash-feed and gravity feed.	100% correct.

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	LU2	Identify the following types of lubricants: oil, grease, copper compound, thread cutting compounds.	100% correct.
	LU3	Diagnose faults in a force feed system.	<ol style="list-style-type: none"> <li>1. No dirt contamination in system.</li> <li>2. All blockages detected.</li> <li>3. All outlets to deliver set amount of grease.</li> <li>4. All in-line filters clean.</li> </ol>
	LU4	Pack bearings with grease.	<ol style="list-style-type: none"> <li>1. Quantity as per speed specification.</li> <li>2. Bearings packed prior to start.</li> </ol>
<b>KEYS AND LOCKING DEVICES</b>	KL1	Identify the following types of keys and locking devices: gib-head, parallel, taper, feather, woodruff, split-cotters, lock-plates, split pins, wire method and taper lock bush.	100% correct.
	KL2	Manufacture a gib-head, parallel, taper and feather key.	<ol style="list-style-type: none"> <li>1. No damage to components.</li> <li>2. Sizes according to shaft size.</li> <li>3. Taper of key according to components.</li> <li>4. Surface to bear 80%.</li> </ol>
	KL3	Fit a gib-head, parallel, taper and feather key.	Surface to bear 80%.
	KL4	Install the following locking devices: lock-nuts, dowels, lock-plates, split pins, and wire method.	All burrs, rough edges and ground smooth.
	KL5	Remove a gib-head, parallel, taper and feather key.	No damage to components.
	KL6	Identify nuts and bolts.	100% Correct.
	KL7	Tighten nuts and bolts.	<ol style="list-style-type: none"> <li>1. Torque to specified standard.</li> <li>2. No damage to threads and bolt heads.</li> </ol>

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<b>COUPLINGS</b>	CP1	Identify the following types of couplings: flexible, rigid, slip couplings and universal couplings (cardan shaft).	100% Correct.
	CP2	Mount and align the following couplings: <ul style="list-style-type: none"> <li>- flexible tyre coupling</li> <li>- rigid flanged coupling</li> <li>- bibby type coupling</li> <li>- internal gear coupling</li> </ul>	According to manufacturers' specifications.
	CP7	Diagnose faults on the following couplings: fenner flex, rigid, bibby and internal gear couplings.	All faults diagnosed.
<b>BEARINGS</b>	BE1	Identify plain metal bearing materials such as bronze, white metal and synthetic.	100% Correct.
	BE2	Identify solid, split and guide bearings.	100% Correct.
	BE6	Identify classes of bearings.	Identify 16 out of 20 given bearings correctly.
	BE7	Identify the following ball bearings: deep groove, angular contact, self-alignment and thrust.	100% Correct.
	BE8	Identify the following types of roller bearings: spherical, thrust, taper and cylindrical.	100% Correct.
	BE9	Fit a bearing to a shaft using a hand operated press, sleeve, oil bath or induction heater.	<ol style="list-style-type: none"> <li>1. No damage to components and equipment.</li> <li>2. Fits according to ISO R286 standard.</li> <li>3. Correct bearing load application.</li> <li>4. No shock loads applied to bearing.</li> <li>5. Maximum heating temperature 110° celsius.</li> <li>6. Correct speed application.</li> </ol>
	BE10	Remove a bearing from a shaft using a bearing puller or hand operated press.	No damage to components.

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	BE11	Fit a spherical roller bearing and adaptor sleeve to a shaft.	Clearance between outer race and roller within 0,05mm.
	BE12	Remove a spherical roller bearing from an adaptor sleeve and shaft.	No damage to bearing, adaptor sleeve or shaft.
	BE13	Fit and remove a thrust bearing on a shaft (single direction).	<ol style="list-style-type: none"> <li>1. No damage to components.</li> <li>2. Bearing axial loading mounted correct.</li> </ol>
	BE14	Fit a roller bearing on a shaft.	Maximum axial end float 0,04mm.
	BE15	Recall types of bearing failures and their causes.	Pass a questionnaire with at least 80%.
<b>PUMPS</b>	PU1	Identify the following types of pumps: <ul style="list-style-type: none"> <li>– centrifugal</li> <li>– reciprocating</li> <li>– gear</li> </ul>	100% correct.
	PU2	Define the terms positive and non-positive displacement.	Correct according to specific type of pump.
	PU3	Install gland bush packings.	<ol style="list-style-type: none"> <li>1. No damage to components.</li> <li>2. One water drop per 10 seconds for gland lubrication.</li> <li>3. Distance between gland and bush even measurement.</li> <li>4. No scorch marks on shaft due to heat.</li> </ol>
	PU4	Install a mechanical seal.	<ol style="list-style-type: none"> <li>1. No damage to seal or components.</li> <li>2. No dirt contamination in sealing faces.</li> <li>3. No damage to components.</li> <li>4. No leaks.</li> </ol>
	PU5	Prime centrifugal, reciprocating and gear pumps.	<ol style="list-style-type: none"> <li>1. All air must be bled out.</li> <li>2. Direction 100% correct.</li> </ol>

MODULE	CODE	OBJECTIVES	CRITERIA
	PU6	Diagnose faults on centrifugal, reciprocating and gear pumps.	<ol style="list-style-type: none"> <li>1. No cavitation allowed.</li> <li>2. Correct position of foot-valves.</li> <li>3. Direct proportional head increase to motor amperage.</li> </ol>
	PU7	Interpret given flow diagrams and systems.	100% correct.
<b>INSTALLATION OF MACHINERY</b>	IM3	Install, and level gearboxes, motors, machines and pumps.	<ol style="list-style-type: none"> <li>1. All safety aspects adhered to.</li> <li>2. No damage to equipment.</li> <li>3. Level within 0,05mm per 1 000 mm.</li> <li>4. Correct position of wedges and packings.</li> </ol>
<b>DRIVES</b>	DR1	Identify the following types of drives: belt, gear, fluid and chain.	100% Correct.
	DR2	Identify A, B and C class V-belts.	100% Correct.
	DR3	Install and align a single belt-drive.	<ol style="list-style-type: none"> <li>1. Tension set according to 1mm per 100mm span length per kilogram force.</li> <li>2. Aligned within 0,05mm.</li> </ol>
	DR4	Install and align match-set belt drives.	<ol style="list-style-type: none"> <li>1. Tension set according to 1mm per 100mm span length per kilogram force.</li> <li>2. Aligned within 0,05mm.</li> </ol>
	DR6	Install and align chain drives.	<ol style="list-style-type: none"> <li>1. Tension correct according to formulae.</li> <li>2. Alignment within 0,5mm.</li> </ol>
	DR7	Maintain belt drives.	<ol style="list-style-type: none"> <li>1. Groove according to standard V-belt gauge.</li> <li>2. No scorch marks on belts.</li> <li>3. No axial movement of pulleys</li> </ol>
	DR8	Maintain gear drives.	<ol style="list-style-type: none"> <li>1. No deformation of involute shape.</li> <li>2. No broken teeth.</li> <li>3. No axial movement.</li> <li>4. Correct tooth depth clearance.</li> </ol>

MODULE	CODE	OBJECTIVES	CRITERIA
	DR9	Maintain chain drives.	<ol style="list-style-type: none"> <li>1. No axial movement at sprockets.</li> <li>2. No deformation of sprocket teeth.</li> <li>3. Maximum chain stretch = 2 x pitches or 2% elongation.</li> </ol>
	DR10	Maintain a fluid drive.	<ol style="list-style-type: none"> <li>1. Filling angle according to set standard chart.</li> <li>2. No cracks on spiral plate.</li> <li>3. No oil leaks at seals.</li> <li>4. Misalignment within specifications</li> </ol>
<b>BRAKES AND CLUTCHES</b>	BC1	Identify the following industrial brake systems: <ul style="list-style-type: none"> <li>- disc</li> <li>- thruster</li> <li>- electro-magnetic</li> </ul>	100% Correct.
	BC2	Maintain disc brakes.	<ol style="list-style-type: none"> <li>1. Minimum brake pad thickness = 1mm.</li> <li>2. No scored marks on disc braking surface.</li> <li>3. No air in hydraulic system.</li> <li>4. No fluid leaks.</li> </ol>
	BC3	Maintain thruster brakes - calliper type.	<ol style="list-style-type: none"> <li>1. Minimum brake pad wear = 1mm above rivet head.</li> <li>2. No scored marks on brake drum surface.</li> <li>3. Equal brake shoe air gap according to specification.</li> <li>4. No fluid leaks on thruster.</li> </ol>
	BC4	Maintain electro-magnetic brakes.	<ol style="list-style-type: none"> <li>1. Air gap set according to specifications.</li> <li>2. No scored marks on brake drum.</li> <li>3. Minimum brake pad wear = 1mm above rivet heads.</li> </ol>
	BC5	Identify centrifugal and multi-disc clutch systems.	100% Correct.
	BC7	Maintain multi-disc clutch.	<ol style="list-style-type: none"> <li>1. Air gap set according to specifications.</li> <li>2. Position adjusting ring lock clips.</li> <li>3. Maximum wear indication marks must be visible.</li> </ol>

MODULE	CODE	OBJECTIVES	CRITERIA
<b>ASSEMBLES</b>	AS1	Dismantle a worm-wheel type reduction gearbox.	<ol style="list-style-type: none"> <li>1. No damage components.</li> <li>2. Matching covers must be marked.</li> </ol>
	AS2	Assemble a worm-wheel type gearbox.	<ol style="list-style-type: none"> <li>1. No damage to components.</li> <li>2. Alignment: 25% oil lead on worm-wheel bearing teeth.</li> <li>3. Worm-wheel end float according to specifications.</li> <li>4. Worm end float according to specifications.</li> </ol>
	AS3	Identify the following types of fits on shafts and hole basis - clearance, transition, interference.	All tolerances within ISO standard hole basis system.
	AS4	Fit a boss to a shaft with reference to clearance fit.	All tolerances within ISO standard hole basis system.
	AS5	Fit a boss to a shaft with reference to transition fit.	All tolerances within ISO standard hole basis system.
	AS6	Fit a boss to a shaft with reference to interference fit.	All tolerances within ISO standard hole basis system.
	AS8	Fit seals and packings to mechanical components. e.g. pumps, gearboxes, etc.	<ol style="list-style-type: none"> <li>1. No damage to components.</li> <li>2. Sealing direction 100% correct.</li> </ol>
	<b>HYDRAULICS</b>	HY1	Interpret symbols and abbreviations.
HY2		Interpret elementary hydraulic circuit diagrams.	100% Correct according to ISO 1219 table.
HY3		Identify the following hydraulic fluids: <ul style="list-style-type: none"> <li>- petroleum based</li> <li>- emulsion based</li> </ul>	100% Correct.
HY4		Install and maintain the following filters: <ul style="list-style-type: none"> <li>- suction</li> <li>- pressure</li> <li>- return</li> </ul>	<ol style="list-style-type: none"> <li>1. No fluid leaks.</li> <li>2. Restriction indicator in specified position.</li> <li>3. Micron rating within specifications.</li> <li>4. Flow direction 100% correct.</li> </ol>

MODULE	CODE	OBJECTIVES	CRITERIA
	HY5	Install and maintain hydraulic tubing and fittings.	<ol style="list-style-type: none"> <li>1. Pipe schedule according to pressure range.</li> <li>2. No flow restriction due to pipe formations.</li> <li>3. Colour code according to ISO 0140, Part 3.</li> <li>4. No fluid leaks at compression fittings.</li> </ol>
	HY6	Install and maintain flexible hydraulic hoses and fittings.	<ol style="list-style-type: none"> <li>1. No fluid leaks at fittings.</li> <li>2. No twist on bends in pipes.</li> <li>3. Minimum bend radius must be maintained - 4% of pipe length allowed for pressure change.</li> <li>4. No crises-crossing of pipes.</li> </ol>
	HY7	Identify the following hydraulic pumps: vane, gear and piston.	100% Correct.
	HY8	Install and maintain hydraulic pumps.	<ol style="list-style-type: none"> <li>1. No damage to components, equipment and seals.</li> <li>2. Inlet manifold connected correctly.</li> <li>3. Outlet manifold connected correctly.</li> <li>4. No fluid leaks.</li> <li>5. Correct fluid used.</li> <li>6. All bolts secured.</li> <li>7. Alignment according to specifications.</li> <li>8. No score marks on sealing surfaces.</li> <li>9. Pump functions according to specifications.</li> </ol>
	HY9	Service a reservoir.	<ol style="list-style-type: none"> <li>1. No damage to components, equipment and seals.</li> <li>2. No fluid leaks.</li> <li>3. Correct fluid used.</li> <li>4. All bolts secured.</li> <li>5. No score marks on sealing surfaces.</li> <li>6. Pump functions according to specifications.</li> </ol>
	HY10	Install and maintain directional control, pressure and flow control valves.	<ol style="list-style-type: none"> <li>1. No fluid leaks.</li> <li>2. Pressure relieved to fail safe.</li> <li>3. No damage to equipment.</li> <li>4. No dirt contamination in components.</li> </ol>

MODULE	CODE	OBJECTIVES	CRITERIA
	HY11	Install and maintain hydraulic cylinders.	<ol style="list-style-type: none"> <li>1. No dirt contamination in components and fluids.</li> <li>2. No fluid leaks.</li> <li>3. No damage to equipment.</li> <li>4. No score marks and ridges in barrels.</li> <li>5. Pressure relieved to fail safe.</li> </ol>
	HY12	Identify and install accumulators.	<ol style="list-style-type: none"> <li>1. No damage to equipment.</li> <li>2. No gas leaks.</li> <li>3. No fluid leaks.</li> <li>4. Ensure complete discharge prior to pre-charge.</li> <li>5. Adhere to regulations.</li> </ol>
	HY13	Diagnose faults in basic hydraulic systems.	<ol style="list-style-type: none"> <li>1. Adhere to fail safe procedure.</li> <li>2. No deviation from pre-set pressure.</li> <li>3. No loss in fluid flow.</li> <li>4. No cavitation at pump.</li> <li>5. All pressure valves set to pre-set pressure.</li> <li>6. No malfunction at directional control valves.</li> <li>7. All quick-release couplings coupled safely.</li> </ol>
<b>PNEUMATICS</b>	PN1	Interpret symbols and abbreviations.	100% Correct according to ISO 1219 standards.
	PN2	Interpret pneumatic circuit diagrams.	100% Correct according to ISO 1219 standards.
	PN3	Identify compressed air pipelines.	Colour according to SABS 0140, part 3.
	PN4	Install and maintain compressed air pipelines.	<ol style="list-style-type: none"> <li>1. Ring main gradient - 2° in direction of air flow.</li> <li>2. All outlets to exit at top of main pipe.</li> <li>3. No air leaks.</li> </ol>
	PN5	Install and maintain air service units.	<ol style="list-style-type: none"> <li>1. No air leaks.</li> <li>2. Inlet and outlet direction 100% correct.</li> <li>3. No cracks in collector bowls.</li> </ol>
	PN6	Install and maintain cylinders.	<ol style="list-style-type: none"> <li>1. No damage to components.</li> <li>2. No air leaks.</li> <li>3. No dirt contamination.</li> <li>4. No score marks and ridges in barrel.</li> </ol>

MODULE	CODE	OBJECTIVES	CRITERIA
	PN7	Install and maintain directional control, flow control and pressure valves.	<ol style="list-style-type: none"> <li>1. No air leaks.</li> <li>2. Pressure relieved to fail safe.</li> <li>3. No damage to equipment.</li> <li>4. No dirt contamination in components.</li> </ol>
	PN9	Testing of safety valves.	<ol style="list-style-type: none"> <li>1. No damage to components.</li> <li>2. Blow-off pressure set at 5% of working pressure.</li> </ol>
	PN10	Recall the service procedure for air receivers.	According to the applicable regulations of the Minerals Act and Regulations or the Occupational Health and Safety Act, whichever Act is applicable.
	PN12	Diagnose faults in pneumatic systems.	<ol style="list-style-type: none"> <li>1. Adhered to fail safe procedures.</li> <li>2. No loss in air flow.</li> <li>3. All valves set to pre-set pressure.</li> <li>4. All quick-release couplings coupled safely.</li> <li>5. Flow sequence 100% correct.</li> <li>6. No air leakages.</li> </ol>
<b>THEORETICAL TRAINING</b>		<p>A four subject pass is needed to obtain the N course. Mathematics and the relevant trade theory subject is compulsory. A further two relevant subjects must be chosen by the employer college and apprentice in order to obtain the four subjects required for the course.</p>	
	TT1	Mathematics N1 Relevant Trade Theory N1 Plus two relevant subjects N1	Obtain a four subject certificate.
	TT2	Mathematics N2 Relevant Trade Theory N2 Plus two relevant subjects N2	Obtain a four subject certificate.

<b>MODULE</b>	<b>CODE</b>	<b>OBJECTIVES</b>	<b>CRITERIA</b>
		Should the apprentice have a qualification higher than that prescribed in the schedule, it must be ensured that the subjects are relevant to the trade in question, before a trade test date will be allocated.	
<b>ON THE JOB EXPERIENCE AND INDEPENDENT WORK</b>	EX1	On the job experience and independent work should cover at least 80% of all practical modules to ensure as wide as possible field of experience and must take place under supervisory control.	All work done to be recorded with respect to performance levels.

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