



## 2023/24 ANNUAL TEACHING PLANS: ELECTRICAL TECHNOLOGY (POWER SYSTEMS): GRADE 11 (TERM 1)

TERM 1	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10	WEEK 11	
CAPS TOPICS	OHS	Tools and measuring instruments	DC machines	DC machines	DC machines	DC machines	Single phase AC generation	Single phase AC generation	Single phase AC generation	PAT consolidation, revision and assessment	PAT consolidation, revision and assessment	
TOPICS, CONCEPTS, SKILLS AND VALUES	<p><b>OHS</b></p> <p>Basic introduction to regulations</p> <ul style="list-style-type: none"><li>- What are regulations?</li><li>- How to use regulations?</li><li>- Impact of regulations on the workshop</li><li>- Introduction and purpose of the regulations</li></ul> <p>General Machinery Regulation 1988</p> <ul style="list-style-type: none"><li>- Supervision of machinery</li><li>- Safeguarding of machinery</li><li>- Operation of machinery</li><li>- Working on moving or electrically alive machinery</li><li>- Devices to start and stop machinery</li><li>- Reporting of incidents in connection with machinery</li></ul> <p>Electrical Machinery Regulations 1988</p> <ul style="list-style-type: none"><li>- Safety equipment</li><li>- Electrical control gear</li><li>- Switchboards</li><li>- Portable electric tools</li><li>- Earthing</li><li>- Conductors</li></ul> <p>Safety</p> <ul style="list-style-type: none"><li>- What is ergonomics? (Workplace conditions, comfort – everything has a place and everything is in its place)</li></ul> <p><b>Personal safety</b></p> <ul style="list-style-type: none"><li>- Protective gear for machinery</li><li>- Personal protection equipment</li><li>- Eye protection</li><li>- Coveralls, overalls</li><li>- Hearing protection</li></ul> <p><b>Practical:</b> Use personal protection equipment (during practical sessions)</p> <p>He or she obtains quotations for PAT projects and submit to SMT</p> <p>Principal approves procurement of PAT projects resources</p> <p>Teacher ensures that PAT project is procured</p>	<p><b>Testing equipment</b></p> <p>Line tester, clamp meter &amp; power factor meter</p> <ul style="list-style-type: none"><li>- External parts and their functions</li><li>- Application</li><li>- Care, maintenance</li></ul> <p>Function generator and oscilloscope</p> <ul style="list-style-type: none"><li>- External parts and their functions</li><li>- Application</li><li>- Care and maintenance</li></ul> <p>Calculations on the oscilloscope</p> <ul style="list-style-type: none"><li>- Time</li><li>- Frequency</li><li>- Phase difference</li><li>- Maximum value</li></ul>	<p>Introduction to DC machines</p> <ul style="list-style-type: none"><li>- Difference between generators and motors</li><li>- Revision of the DC motor working principle in grade 10</li><li>- Construction of DC machine</li><li>- Armature</li><li>- Commutation</li><li>- Brushes</li><li>- Yoke</li><li>- Name plate</li><li>- Field windings</li><li>- Lap</li><li>- Wave</li></ul> <p>Purpose of components, parts of the DC machine</p> <ul style="list-style-type: none"><li>- Armature</li><li>- commutation</li><li>- Brushes</li><li>- Yoke</li><li>- Name plate</li><li>- Field windings</li><li>- Pole pairs</li><li>- Inter poles</li></ul>	<p><b>Practical:</b> Identify the parts of the motor</p> <p>Principle of operation of the DC machine</p> <ul style="list-style-type: none"><li>- Armature reaction</li><li>- Reducing armature reaction</li></ul>	<p>Principle of operation of the DC machine</p> <ul style="list-style-type: none"><li>- Commutation</li><li>- Improving of commutation</li></ul> <p><b>Practical:</b> Perform insulation resistance test and continuity test on motor windings</p> <p>Types of DC machine series, shunt and compound machines</p> <p>Application of each type</p> <p>Relationship between speed and torque</p> <p>Characteristics curves (effect of changes in load on speed and torque)</p>	<p>The Stepper Motor</p> <p>Field poles</p> <ul style="list-style-type: none"><li>- Basic working principles</li><li>- Servo motors</li><li>- Basic working principles</li><li>- Characteristic s curves (effect of changes in load on speed and torque)</li><li>- Speed control done through electronics – pulse width modulation (concept only)</li></ul> <p>PAT: Teacher ensures that there is secure storage for PAT projects, hands out and takes in PAT projects and includes practical sessions for learners to complete PAT project every week</p> <p>Learners commence with completion of the PAT project</p> <p>HOD checks on teacher to ensure that practical workshop sessions take place on a weekly basis</p>	<p><b>Introducing single phase AC generation</b></p> <ul style="list-style-type: none"><li>- Difference between DC and AC</li><li>- Motivation for using AC rather than DC</li><li>- Generation of a single phase supply by rotating a conductor loop through a two-pole magnetic field</li></ul> <p><b>Laws of electricity</b></p> <ul style="list-style-type: none"><li>- Faraday's Law</li><li>- Fleming's Right Hand Generator Rule</li><li>- Fleming's Left Hand Motor Rule (revision)</li></ul> <p>Function generator and oscilloscope external parts and their functions</p> <ul style="list-style-type: none"><li>- Principle of operation</li><li>- Application</li><li>- Care</li><li>- Maintenance</li></ul> <p><b>Demonstration:</b></p> <p>Rotate magnetic field through a coil and display on oscilloscope</p>	<p>The Sinusoidal Waveform</p> <p>Instantaneous value (calculations)</p> <p><math>\omega = 2\pi f</math> (radians)</p> <p><math>\theta = \omega t</math> (degrees)</p> <p><math>i = I_{\text{max}} \times \sin \theta</math> (A)</p> <p><math>v = V_{\text{max}} \times \sin \theta</math> (V)</p> <p>Maximum value Calculations)</p> <p><math>V_{\text{max}} = V_{\text{RMS}} \times 1.414</math> (V )</p> <p>RMS value rule (no mid-ordinate) Calculations</p> <p><math>V_{\text{RMS}} = V_{\text{max}} \times</math></p> <p>Average value over half cycle 0.707 (V) calculations</p> <p><math>V_{\text{ave}} =</math></p> <p><math>V_{\text{max}} \times 0.637</math> (V)</p>	<p>Calculation of: Instantaneous value</p> <ul style="list-style-type: none"><li>▪ <math>v = V_m \sin \theta</math> (Volts)</li><li>▪ maximum value <math>V_m = 2\pi \beta A n N</math> (V)</li><li>▪ <math>E = \beta l v</math> (V)</li><li>▪ RMS value <math>V_{\text{RMS}} = V_m \times 0.707</math> (V)</li><li>▪ Average value over half cycle (mid-ordinate rule to show where average value comes from)</li></ul> <p><math>V_{\text{ave}} = V_m \times 0.637</math> (V)</p> <p><b>Practical:</b> Measure mains voltage using a multimeter</p> <p><b>Practical:</b> Measure mains current using a clamp meter</p>	<p>Completion of simulation 1</p> <p>PAT project, circuit diagrams and component list</p>	<p>Completion of simulation 1</p> <p>PAT project, circuit diagrams and component list</p>	
REQUISITE PRE-KNOWLEDGE	Introduction of the OHS Act, electrical machinery regulations			Electromagnetism and working principle of DC motor			Introduction to magnetism and basic power sources					
RESOURCES (OTHER THAN TEXTBOOK) TO ENHANCE LEARNING	OHS Act, safety signs in workshop, first aid training manuals			YouTube video clips and related IT resources								
				Old question papers								

TERM 1		WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10	WEEK 11
ASSESSMENT	INFORMAL ASSESSMENT: REMEDIATION	Classwork, case studies, worksheets, homework, class tests (theory and practical work)										
	SBA & PAT (FORMAL)	<b>PAT simulation 1 completed</b> Safe work practices are types of administrative controls that include procedures for safe and proper work used to reduce the duration, frequency, or intensity of exposure to a hazard. The section on tools and equipment must be infused when doing all PAT simulations.									Assignment	

## 2023/24 ANNUAL TEACHING PLANS: ELECTRICAL TECHNOLOGY (POWER SYSTEMS): GRADE 11 (TERM 2)

TERM 2		WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10	WEEK 11
CAPS TOPICS		Single phase transformers	Single phase transformers	Single phase transformers	Single phase transformers	RLC	RLC	RLC	RLC	Simulation 2	PAT consolidation, revision and assessment	PAT consolidation, revision and assessment
TOPICS, CONCEPTS, SKILLS AND VALUES		<b>Introduction to transformers</b> <ul style="list-style-type: none"><li>- Magnetic Induction</li><li>- Lenz's Law</li><li>- Magneto magnetic force</li><li>- Self and mutual inductance</li><li>- Function and operation of transformers</li></ul>	<ul style="list-style-type: none"><li>- Losses in transformers (no calculations)</li><li>- Advantages and disadvantages</li><li>- Construction and symbols of the transformer and core types</li><li>- Application of an ideal transformer</li></ul>	<b>Calculations related to transformers</b> <ul style="list-style-type: none"><li>• Power calculations<ul style="list-style-type: none"><li>Full load<ul style="list-style-type: none"><li><math>P = VI \cos \theta</math> (VA ratings)</li><li><math>S = VI</math> (VA)</li></ul></li></ul></li><li>• Primary and secondary voltage, current 0%</li></ul>	<ul style="list-style-type: none"><li>• Ratio calculations<ul style="list-style-type: none"><li><math>\frac{V_{input}}{V_{output}} = \frac{N_{input}}{N_{output}} = \frac{I_{output}}{I_{input}}</math></li></ul></li><li>• Efficiency<ul style="list-style-type: none"><li><math>\eta = \frac{P_{output}}{P_{input}} \times 10</math></li></ul></li></ul>	<b>Effects of alternating current on resistor, inductors and capacitors (RLC)</b> Components in series only All applicable calculations relevant to the theory to be completed Emphasis will be on circuits containing ONE resistor, ONE capacitor and ONE inductor Wave representation	Phasor diagram Inductance reactance <ul style="list-style-type: none"><li>• <math>X_L = 2\pi fL</math></li></ul> Capacitance reactance <ul style="list-style-type: none"><li>• <math>X_C = \frac{1}{2\pi fC}</math></li></ul> Effects of frequency on X <sub>L</sub> and X <sub>C</sub> .  <b>Demonstration:</b>  Show phase difference between RL and RC	Impedance <ul style="list-style-type: none"><li>• <math>Z = \sqrt{R^2 + (X_L - X_C)^2}</math> (Ω)</li><li>• Scalar: representation of the impedance triangle</li><li>• Power<ul style="list-style-type: none"><li><math>P = V \times I \cos \theta</math> (Watt)</li></ul></li></ul> <b>Start PAT simulation 2</b>	Power factor <ul style="list-style-type: none"><li>• <math>\cos \theta = \frac{R}{Z}</math></li><li>• <math>\cos \theta = \frac{V_R}{V_Z}</math></li></ul> Phase angle <ul style="list-style-type: none"><li>• <math>\theta = \cos^{-1} \frac{R}{Z}</math> (Deg)</li><li>• <math>\theta = \cos^{-1} \frac{V_R}{V_Z}</math> (Deg)</li></ul> <b>PAT simulation 2 continues</b>	Natural oscillation Effects of frequency changes on the impedance and the current flow Resonance with its characteristics Completion of simulation 2 PAT project design part 2: Circuit description tool list and learner's own PCB design	Consolidation of term 2 work PAT project design part 2: Circuit description tool list and learner's own PCB design	Consolidation of term 2 work PAT project design part 2: Circuit description tool list and learner's own PCB design
REQUISITE PRE-KNOWLEDGE		Basic electronic components and principles of magnetism				Basic electronic components and principles of magnetism						
RESOURCES (OTHER THAN TEXTBOOK) TO ENHANCE LEARNING		YouTube video clips and related IT resources Old question papers				YouTube video clips and related IT resources Old question papers				RLC “spook box” simulation	Old question papers	Old question papers
ASSESSMENT	INFORMAL ASSESSMENT: REMEDIATION	Classwork, case studies, worksheets, homework, class tests (theory and practical work)										
	SBA & PAT (FORMAL)	<b>PAT simulation 2 completed</b> Safe work practices are types of administrative controls that include procedures for safe and proper work used to reduce the duration, frequency, or intensity of exposure to a hazard. The section on tools and equipment must be infused when doing all PAT simulations.								Controlled test		

## 2023/24 ANNUAL TEACHING PLANS: ELECTRICAL TECHNOLOGY (POWER SYSTEMS): GRADE 11 (TERM 3)

TERM 3		WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10	WEEK 11
CAPS TOPICS		Control devices	Control devices	Control devices	Control devices	Control devices	Control devices	Single phase motors	Single phase motors	Single phase motors s	PAT consolidation, revision and assessment	PAT consolidation, revision and assessment
TOPICS, CONCEPTS, SKILLS AND VALUES		<b>Introduction to control and protection of AC machines</b> <ul style="list-style-type: none"> <li>Principle of operation of protection theory session)</li> <li>➤ Overcurrent and undervoltage protection</li> <li>➤ Re-settable overcurrent protection (motor protection)</li> <li>➤ The zero-volt coil, no volt coil (operator protection)</li> </ul>	<b>The direct on-line (DoL) starter, contactor</b> <ul style="list-style-type: none"> <li>Identification, operation and purpose of: <ul style="list-style-type: none"> <li>➤ The contactor</li> <li>➤ Start button</li> <li>➤ Stop button</li> <li>➤ Overload protection</li> <li>➤ On delay timer, off delay timer</li> </ul> </li> <li>Setting overcurrent protection <ul style="list-style-type: none"> <li>○ <math>I_{overcurrent\ protect} = I_{max} \times 125\% (Ampere)</math></li> </ul> </li> <li>Wiring diagram of the DoL</li> </ul> <p>Testing and commissioning</p>	Practical: Connecting a DoL starter to a light Switch on and off PAT: PC board manufacturing	<b>Introduction to the programmable logic control device (PLC)</b> <ul style="list-style-type: none"> <li>History of the PLC</li> <li>What is hardware?</li> <li>What is software?</li> <li>Hard wiring vs soft wiring</li> <li>The programmed scan cycle of a PLC (input, process, output)</li> <li>Safety and PLC devices</li> </ul>	<b>PLC software – introduction on the computer</b> <ul style="list-style-type: none"> <li>The purpose of using software to program the PLC</li> <li>Navigating the graphic user interface of the programming software used (how to use software)</li> <li>Using ladder logic to write a program for a PLC</li> <li>What is a rung?</li> <li>Ladder logic symbols</li> <li>Inputs</li> <li>Outputs</li> <li>Inverting inputs and outputs</li> <li>AND, OR, NOT function</li> <li>Latching concepts in ladder logic</li> <li>Retaining contact</li> <li>Interlocking</li> </ul>	<b>The interface cable practical:</b> <ul style="list-style-type: none"> <li>Loading the program from the computer to the PLC</li> <li>Loading an existing program from the PLC to the computer</li> </ul> <b>Practical:</b> Program a PLC as a DoL starter and load it to a PLC	<b>Single phase induction motors</b> <ul style="list-style-type: none"> <li>The universal motor</li> <li>Construction of the AC motor</li> <li>Comparison between AC and DC motors</li> <li>Producing a rotating magnetic field in single phase motors</li> <li>Considerations when selecting a motor to suit a load</li> <li>How changes in load affects the speed of a motor</li> <li>Operation of split phase motors (methods of splitting single phase supply)</li> </ul>	<b>Capacitor start motor</b> (Note: This is a practical component – all aspects will be attended to as part of the practical work in the workshop in conjunction with the theory) <ul style="list-style-type: none"> <li>Function of components</li> <li>Diagram (interpret the circuit diagram and wire the starter and motor on a panel)</li> <li>Reversal of direction of rotation (add practical session on reversal of direction)</li> </ul>	<b>Capacitor start motor</b> <b>Practical:</b> <ul style="list-style-type: none"> <li>Testing a motor</li> <li>Visual inspection test</li> <li>Insulation</li> <li>Continuity of windings</li> <li>Test earth continuity</li> <li>Mechanical test</li> <li>Practical application &amp; use: Connection of a CSM</li> <li>Wire DoL to motor</li> <li>Start and stop motor</li> </ul> <b>Practical:</b> <ul style="list-style-type: none"> <li>Complete test on CS motor</li> <li>Wire CS motor with DoL starter.</li> <li>Start, stop and reverse the motor</li> </ul>	Completion of simulation 3 PAT project phase 2 Build an enclosure and installing circuit into enclosures	Completion of simulation 3 PAT project phase 2 Build an enclosure and installing circuit into enclosures
ASSESSMENT	INFORMAL ASSESSMENT: REMEDIATION	Classwork, case studies, worksheets, homework, class tests (theory and practical work)										
	SBA & PAT (FORMAL)	<b>Term test</b> <b>PAT simulation 3 completed</b> Safe work practices are types of administrative controls that include procedures for safe and proper work used to reduce the duration, frequency, or intensity of exposure to a hazard. The section on tools and equipment must be infused when doing all PAT simulations.										

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TERM 4		WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10
CAPS TOPICS		Power supplies	Power supplies	Power supplies	Power supplies	Power supplies	PAT consolidation & revision	PAT consolidation & revision	Examination	Examination	Examination
TOPICS, CONCEPTS, SKILLS AND VALUES		<b>DC power supplies</b> <ul style="list-style-type: none"><li>- What is a power supply unit (PSU)?</li><li>- Block diagram of a linear power supply</li><li>- The role that different semiconductor components play in a PSU</li></ul> <b>Semiconductors</b> <ul style="list-style-type: none"><li>➤ The PN diode</li><li>➤ Construction</li></ul>	<b>DC power supplies</b>  Principle of operation electron flow vs conventional flow P&N material <ul style="list-style-type: none"><li>• Forward biasing</li><li>• Reverse biasing</li><li>• Characteristics curve &amp; symbol of the diode</li></ul>	<b>Rectification (half wave and full wave)</b> <ul style="list-style-type: none"><li>• Waveforms</li><li>• Circuit construction (practical)</li><li>• Representation of waves on oscilloscope</li><li>• Principle of filtering and waveforms</li></ul>	<ul style="list-style-type: none"><li>• Block diagram</li><li>• Circuit construction of the C and LC filter (practical)</li><li>• Representation of waves on oscilloscope</li><li>• Ripple factor – percentage only</li></ul>	<b>DC power supplies practical:</b> Construct a half wave rectifier and display the waveform on the oscilloscope  <b>Practical:</b> Construct a full wave rectifier and display the waveform on the oscilloscope	Revision: Term 1 and Term 2  PAT: Finalisation of PAT portfolio and PAT project for moderation	Revision: Term 3 and term 4 PAT: Finalisation of PAT portfolio and PAT project for moderation			
REQUISITE PRE-KNOWLEDGE		Introduction to basic electronic components, basic operation									
RESOURCES (OTHER THAN TEXTBOOK) TO ENHANCE LEARNING		YouTube video clips, related IT resources and simulations Old question papers									
ASSESSMENT	INFORMAL ASSESSMENT: REMEDIATION										
	SBA (FORMAL)	Final examination									