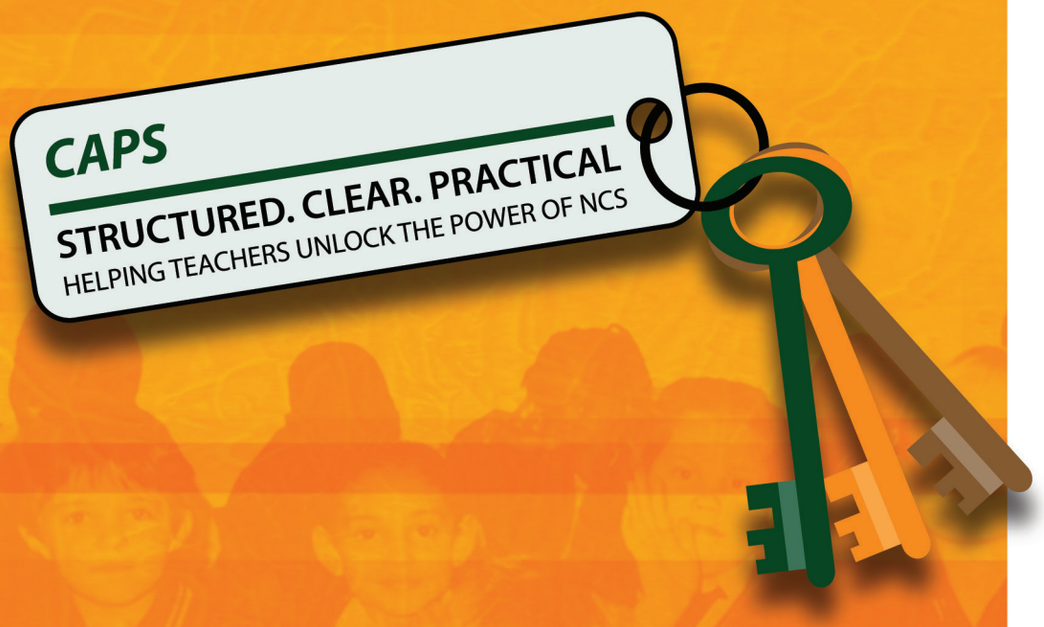
ELECTRICAL TECHNOLOGY

National Curriculum Statement (NCS)

Curriculum Assessment Policy Statement



GRADES 10 – 12

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CURRICULUM AND ASSESSMENT POLICY STATEMENT (CAPS)

GRADES 10 – 12

ELECTRICAL TECHNOLOGY

FOREWORD BY THE MINISTER

Our national curriculum is the culmination of our efforts over a period of seventeen years to transform the curriculum bequeathed to us by apartheid. From the start of democracy we have built our curriculum on the values that inspired our Constitution (Act 108 of 1996). The Preamble to the Constitution states that the aims of the Constitution are to:

- heal the divisions of the past and establish a society based on democratic values, social justice and fundamental human rights;
- improve the quality of life of all citizens and free the potential of each person;
- lay the foundations for a democratic and open society in which government is based on the will of the people and every citizen is equally protected by law; and
- build a united and democratic South Africa able to take its rightful place as a sovereign state in the family of nations.

Education and the curriculum have an important role to play in realising these aims.

In 1997 we introduced outcomes-based education to overcome the curricular divisions of the past, but the experience of implementation prompted a review in 2000. This led to the first curriculum revision: the *Revised National Curriculum Statement Grades R-9* and the *National Curriculum Statement Grades 10-12* (2002).

Ongoing implementation challenges resulted in another review in 2009 and we revised the *Revised National Curriculum Statement* (2002) to produce this document.

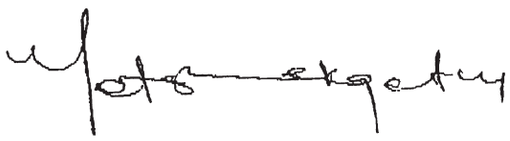
From 2012 the two 2002 curricula, for *Grades R-9* and *Grades 10-12* respectively, are combined in a single document and will simply be known as the *National Curriculum Statement Grades R-12.* The *National Curriculum Statement for Grades R-12* builds on the previous curriculum but also updates it and aims to provide clearer specification of what is to be taught and learnt on a term-by-term basis.

The *National Curriculum Statement Grades R-12* accordingly replaces the Subject Statements, Learning Programme Guidelines and Subject Assessment Guidelines with the

(a) Curriculum and Assessment Policy Statements (CAPS) for all approved subjects listed in this document;

(b) *National policy pertaining to the programme and promotion requirements of the National Curriculum Statement Grades R – 12*; and

(c) *National Protocol for Assessment Grades R – 12.*



MRS ANGIE MOTSHEKGA, MP

MINISTER OF BASIC EDUCATION

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SECTION 1

NATIONAL CURRICULUM AND ASSESSMENT POLICY STATEMENT FOR ELECTRICAL TECHNOLOGY

1.1 Background

The National Curriculum Statement Grades R – 12 (NCS) stipulates policy on curriculum and assessment in the schooling sector.

To improve its implementation, the National Curriculum Statement was amended, with the amendments coming into effect in January 2011. A single comprehensive Curriculum and Assessment Policy document was developed for each subject to replace the old Subject Statements, Learning Programme Guidelines and Subject Assessment Guidelines in Grades R – 12.

The amended National Curriculum Statement Grades R – 12: Curriculum and Assessment Policy (January 2011) replaces the National Curriculum Statement Grades R - 9 (2002) and the National Curriculum Statement Grades 10 – 12 (2004).

1.2 Overview

(a) The *National Curriculum Statement Grades R – 12 (January 2011)* represents a policy statement for learning and teaching in South African schools and comprises the following:

(i) Curriculum and Assessment Policy documents for each approved school subject as listed in the policy document *National Senior Certificate: A qualification at Level 4 on the National Qualifications Framework (NQF)*; and

(ii) The policy document *National Senior Certificate: A qualification at Level 4 on the National Qualifications Framework (NQF).*

(b) The *National Curriculum Statement Grades R – 12 (January 2011)* should be read in conjunction with the following documents:

(i) *An addendum to the policy document, the National Senior Certificate: A qualification at Level 4 on the National Qualifications Framework (NQF), regarding the National Protocol for Assessment Grade R – 12*, published in the *Government Gazette, No. 29467* of 11 December 2006; and

(ii) *An addendum to the policy document, the National Senior Certificate: A qualification at Level 4 on the National Qualifications Framework (NQF), regarding learners with special needs,* published in the *Government Gazette, No.29466* of 11 December 2006.

(c) The Subject Statements, Learning Programme Guidelines and Subject Assessment Guidelines for Grades R – 9 and Grades 10 – 12 are repealed and replaced by the *Curriculum and Assessment Policy documents for Grades R – 12 (January 2011)*.

(d) The sections on the Curriculum and Assessment Policy as outlined in Sections 2, 3 and 4 of this document constitute the norms and standards of the *National Curriculum Statement Grades R – 12* and therefore, in terms of *section 6A* of the *South African Schools Act, 1996 (Act No. 84 of 1996,)* form the basis for the Minister of Basic Education to determine minimum outcomes and standards, as well as the processes and procedures for the assessment of learner achievement to be applicable to public and independent schools.

1.3 General aims of the South African Curriculum

(a) The *National Curriculum Statement Grades R – 12* gives expression to what is regarded to be knowledge, skills and values worth learning. It will ensure that learners acquire and apply knowledge and skills in ways that are meaningful to their own lives. In this regard, the curriculum promotes the idea of grounding knowledge in local contexts, while being sensitive to global imperatives.

(b) The National Curriculum Statement Grades R – 12 serves the purposes of:

- Equipping learners, irrespective of their socio-economic background, race, gender, physical ability or intellectual ability, with the knowledge, skills and values necessary for self-fulfilment, and meaningful participation in society as citizens of a free country;
- Providing access to higher education;
- Facilitating the transition of learners from education institutions to the workplace; and
- Providing employers with a sufficient profile of a learner's competences.

(c) The National Curriculum Statement Grades R – 12 is based on the following principles:

- Social transformation; ensuring that the educational imbalances of the past are redressed, and that equal educational opportunities are provided for all sections of our population;
- Active and critical learning; encouraging an active and critical approach to learning, rather than rote and uncritical learning of given truths;
- High knowledge and high skills; the minimum standards of knowledge and skills to be achieved at each grade are specified and sets high, achievable standards in all subjects;
- Progression; content and context of each grade shows progression from simple to complex;
- Human rights, inclusivity, environmental and social justice; infusing the principles and practices of social and environmental justice and human rights as defined in the Constitution of the Republic of South Africa. The National Curriculum Statement Grades 10 – 12 (General) is sensitive to issues of diversity such as poverty, inequality, race, gender, language, age, disability and other factors;
- Valuing indigenous knowledge systems; acknowledging the rich history and heritage of this country as important contributors to nurturing the values contained in the Constitution; and
- Credibility, quality and efficiency; providing an education that is comparable in quality, breadth and depth to those of other countries.

(d) The National Curriculum Statement Grades R – 12 aims to produce learners that are able to:

- Identify and solve problems and make decisions using critical and creative thinking;
- Work effectively as individuals and with others as members of a team;
- Organise and manage themselves and their activities responsibly and effectively;
- Collect, analyse, organise and critically evaluate information;
- Communicate effectively using visual, symbolic and / or language skills in various modes;
- Use science and technology effectively and critically showing responsibility towards the environment and the health of others; and
- Demonstrate an understanding of the world as a set of related systems by recognising that problem solving contexts do not exist in isolation.

(e) Inclusivity should become a central part of the organisation, planning and teaching at each school. This can only happen if all teachers have a sound understanding of how to recognise and address barriers to learning, and how to plan for diversity.

1.4 Time Allocation

1.4.1 Foundation Phase

The instructional time for subjects in the Foundation Phase is as indicated in the table below:

Subject	Time allocation per week (hours)
Home Language	6
First Additional Language	4 (5)
Mathematics	7
Life Skills	6
Beginning Knowledge	1 (2)
Arts and Craft	2
Physical Education	2
Health Education	1

Instructional time for Grades R, 1 and 2 is 23 hours. For Grade 3, First Additional Language is allocated 5 hours and Beginning Knowledge is allocated 2 hours, as indicated by the hours in brackets in the table above.

1.4.2 Intermediate Phase

The table below shows the subjects and instructional times in the Intermediate Phase.

Subject	Time allocation per week (hours)
Home Language	6
First Additional Language	5
Mathematics	6
Science and Technology	3.5
Social Sciences	3
Life Skills	4
Creative Arts	1.5
Physical Education	1.5
Religion Studies	1

1.4.3 Senior Phase

The instructional time in the Senior Phase is as follows:

Subject	Time allocation per week (hours)
Home Language	5
First Additional Language	4
Mathematics	4.5
Natural Sciences	3
Social Sciences	3
Technology	2
Economic Management Sciences	2
Life Orientation	2
Arts and Culture	2

1.4.4 Grades 10 – 12

(a) The instructional time in Grades 10 – 12 is as follows:

Subject	Time allocation per week (hours)
Home Language	4.5
First Additional Language	4.5
Mathematics / Technical Mathematics	4.5
Life Orientation	2
(Three Electives)	12 (3x4h)

The allocated time per week may be utilised only for the minimum required NCS subjects as specified above, and may not be used for any additional subjects added to the list of minimum subjects. Should a learner wish to take additional subjects, additional time must be allocated for the offering of these subjects.

SECTION 2

Electrical Technology

2.1 What is Electrical Technology?

Electrical Technology focuses on the understanding and application of electrical and electronic principles. The subject focuses on three main areas of specialisation, namely:

- Electrical (Power Systems)
- Electronics
- Digital Electronics

In the following section, the respective areas of specialisation are described and placed within the intended context.

2.1.1 Electrical (Power Systems)

Electrical systems refer to applications of electricity where heavy current from mains supply is used in a number of applications. In Grade 10, the learner is introduced to direct current (DC) and domestic installations. The circuitry as it is found in a typical South African home, in accordance with the requirements of the SANS 10142, forms a major part of the learner's curriculum.

In Grade 11 the learner is introduced to light industrial single phase applications where motors and transformers are used. Programmable Logic Controllers (PLC) is introduced in Grade 11, and is continued in Grade 12.

The main focus of the Grade 12 year in Electrical Technology contextualises the generation, distribution and application of three phase power in motors and transformers as well as control using PLC. By the completion of Electrical specialisation in Electrical Technology, a learner will have knowledge of electrical heavy current in single and three phases from the supplier to the consumer, with domestic, light and heavy industrial motor and control.

A learner in Electrical Technology may opt to become an electrician and work in the manufacturing industry with specific focus on maintenance and repair of electrical installations and machinery. Further studies for such a learner will typically be along the lines of an FET college in conjunction with an internship at a local industry. Further studies could be pursued through a university for learners with the required subject combinations.

2.1.2 Electronics

Electronics as a specialisation in Electrical Technology introduces the learner to analogue electronics utilising mainly light current applications. In Grade 10 the learner will be introduced to the principles of electricity and current flow.

In Grade 11 the learner further explores discrete electronics through the examination of semiconductor devices and their various applications. The learner is introduced to instrumentation and how to use it to make measurements and subsequent conclusions based on observation.

Towards Grade 12 the learner is introduced to integrated circuits and how simple circuits are combined to form more complex circuitry for the purpose of establishing communication and control. A learner with Electrical Technology specialising in Electronics will be able to source solutions to problems using electronic applications and innovations made to existing circuits. The learner will be able to construct, test and commission electronic circuits.

Such a learner will typically opt for a career as a technician in light current, instrumentation, communication and even the entertainment industry. To become an artisan a learner will opt for studies at an FET college, in conjunction to following an internship at a related industry. Further studies for a learner with the required subject combinations will enable him / her to progress towards becoming an electronic technician / technologist / engineer through a university.

2.1.3 Digital Electronics

A learner taking Digital Electronics will have a strong interest in computers, programmable ICs, Boolean algebra, microcontrollers, system control, processors and programming. In Grade 10 a learner in Digital Electronics is introduced to the principles of electricity and electronics, similar to an Electronics learner.

In Grade 11 the focus shifts more towards digital electronics and Boolean algebra. The learner is also introduced to communication systems as this forms a corner stone of digital systems. At the same time the learner is introduced to a few aspects of motors and control using pulse width modulation, which opens up the world of robotics and interfacing the digital world with the real world, such as mechatronics.

In Grade 12 a learner is orientated towards integrated electronic devices that are "intelligent". In this instance the learner is taught how to program integrated circuits as a problem solving method to satisfy a need. The learner will be able to engage with basic robotics and mechatronics, setting a basis from which the learner can pursue a career in industrial electronics and control.

The digital electronics learner will typically pursue an engineering career with studies at a university directly following school, again with the required subject combinations for university access. Careers open to a learner include digital engineering, manufacturing systems design, information technology programming and even the film industry through robotics and special effects in computer graphics and interfacing. Further studies for a learner with the required subject combinations will enable him / her to progress towards becoming an electronic technician / technologist / engineer through a university.

2.2 Specific Aims

Electrical technology as a whole aims to equip the learner with a firm foundation in electrical, electronic and digital principles.

Through the integrated completion of theoretical work, practical assessment tasks (PAT) and simulations, the following skills are developed:

- safe work practices
- good housekeeping
- first aid practices
- reading and interpreting circuit diagrams from symbols to application
- sourcing components
- constructing circuits
- installation, testing and troubleshooting of circuits
- taking measurements
- workshop practice

Knowledge of subject principles combined with applied skills equips the electrical technology learner with a unique set of skills, placing her / him apart from other learners and in a category much desired by industry, tertiary institutions and entrepreneurs.

The aim is to develop the skills levels of learners from Grades 10 – 12 to such an extent that they are able to enter a career pathway as soon as possible.

2.3 Requirements to offer Electrical Technology

Schools wishing to offer Electrical Technology as a subject to learners should consider the following requirements that should be met in order to successfully implement the subject into the school curriculum.

Electrical Technology as a subject allows for three fields of specialisation. Typically a school wishing to offer more than one field of specialisation will have to comply with the following prerequisites:

- Can teachers offer all the chosen areas of specialisation?
- Does the workshop cater for the areas of specialisation?
- Is it possible to cater for different groups within school time-tabling?
- Schools offering more than one field of specialisation are not allowed to mix groups.

2.3.1 Subject offering by learners taking Electrical Technology

Learners taking Electrical Technology will be required to make a selection from the following choices:

Choice 1	Choice 2
Mathematics	Technical Mathematics
Science	Technical Science
Electrical Technology	Electrical Technology
Engineering Graphics & Design	Engineering Graphics & Design

Additionally, a learner may opt to take an eighth and ninth subject with these packages. Subjects that could be considered by learners as additional subjects that have a strong linkage with Electrical Technology are:

- Computer Applications Technology
- Information Technology
- Mechanical Technology

Before this option is exercised at a school the following prerequisites / requirements are brought to the attention of the school management team:

- availability of resources at the school
- availability of a teacher to offer the subject outside normal contact time
- adherence to all assessment requirements in terms of SBA and PAT
- a learner must take the subject from Grade 10 through to 12 and not only in Grade 12

2.3.2 Human Resources

Electrical Technology requires a trained subject specialist. It is preferred that the teacher offering electrical technology is an artisan / technician / technical teacher in an electrical / electronic / digital related area. Industry related experience and workshop management skills are essential and a tertiary qualification in technical teaching is needed.

Electrical Technology teachers are required to:

- Teach the subject content with confidence and flair
- Interact with learners in a relaxed but firm manner
- Manage the workshop resourcing, budget & safety
- Manage the teaching environment
- Conduct stock taking and inventory
- Plan for practical work
- Plan for theory lessons
- Conduct weekly practical sessions
- Maintain and service the workshop as a whole
- Maintain and service the tools and instruments
- Ensure learner safety
- Produce working PAT projects in cooperation with learners
- Carry out School Based Assessment (SBA)
- Implement innovative methods to keep the subject interesting
- Are self-motivated to keep her / him abreast of the latest technological developments
- Regularly attend skills workshops

2.3.3 Equipped Workshop

Electrical Technology cannot be implemented in a school without a well-equipped workshop.

Electricity supply to the workshop is crucial and a three phase, four-wire supply is needed.

Lighting and ventilation is of extreme importance and a workshop should ideally have multiple exits with doors that open outward. Windowpanes should be fitted and broken panes should be replaced.

Tools and equipment should have sufficient storage and a well-developed storage management system with an up to date inventory. Shelves should be clearly marked and storage areas defined.

Floors should have the needed demarcated markings and all areas should be clearly defined using green, yellow and black paint, in line with industry standards. No carpets or nylon flooring is allowed. Rubber mats should be installed in areas where learners will work with installations that will be energized.

Walls should contain subject related posters and a designated area where learner projects can be exhibited should be clearly visible.

Good housekeeping principles require that all workshops be cleaned regularly. A suitable waste removal system should be in place to accommodate refuse, off-cut materials as well as chemical waste. The Occupational Health and Safety (OHS) Act 85 of 1993 must be complied with at all times.

Instruments, measuring equipment and training equipment should have dust covers to keep it clean.

A workshop assistant for the Electrical Technology workshop is required to service the workshop. The purpose of this assistant is to perform preventative maintenance, maintenance, upgrading, service and repair of devices in cooperation with the subject teacher.

The workshop assistant is also required to assist in the safe preparation and completion of practical sessions with regards to issuing equipment and tools, keeping register of all equipment and performing regular inventory stock taking.

An assistant in an Electrical Technology workshop will be technically trained in heavy current / electronics / digital electronics, depending on the focus of the specialisation at the school. The assistant will also have a sound working knowledge of the OHS Act and workshop related safety.

Tables, workbenches and machinery on stands should be permanently affixed to the floor, with isolation switches for the mains supply. All machines should have working machine guards.

Electrical motors should ideally be painted bright orange. Specification plates should be clearly legible.

The workshop must have a lockable mains distribution board. The workshop must be fitted with an emergency cut-off switch/es which is / are easily accessible at all times. The red, mushroom type, emergency switch should preferably be lockable to prevent accidental re-connection with mains in the case of it being activated.

No learner is permitted to work on a live installation without supervision. Installations are only to be energized upon completion of work, after testing.

Only the teacher is permitted to energise mains supply to training and testing installations, after satisfactorily determining that the installation / test / simulation is safe to be energized.

2.3.4 Sustainable Support

Electrical Technology is a subject that requires sustained support. The Electrical Technology workshop requires regular resourcing for the purpose of completion of practical work as well as maintenance. Resourcing could be sub-divided into the following categories:

- Safety Equipment
- Tools and Equipment
- Consumable Materials
- PAT Resources
- Teaching and Learning Support Material
- Preventative Maintenance
- Maintenance

School management teams (SMT) at schools offering Electrical Technology should take note of the implications that the Electrical Technology workshop has on the budget of the school.

Whilst it is common practice to provide a working budget to a workshop, it is imperative to note that the budget should be structured to not only cater for the completion of PAT by the learners, but should also allow for the teacher to replenish tools and equipment and acquire consumable materials for experiments, demonstrations and simulations.

Apart from the PAT resources that are needed, the teacher must also be allowed to supplement teaching and learning support material in the form of posters, models, examples, videos, periodicals and more.

Preventative maintenance of training equipment on a regular basis, as well as provisioning for the inevitable failure of equipment, should not be disregarded, and the SMT of a school should have in place a plan to regularly phase out and replace obsolete equipment and tools.

2.4 Career Opportunities

Electrical Technology unlocks a world of potential to any learner taking the subject. Due to the nature of electrical technology, it is easy and relatively cheap to set up and operate an electrical / electronic / digital workshop at home for the purpose of starting a business or to practice a hobby for personal gain.

Learners that opt for careers not related to the subject will have sufficient knowledge and skills at the end of Grade 12 to continue experimenting for the purpose of self-tuition and the practice of electrical technique.

Learners taking Electrical Technology will opt for one of the following study opportunities:

- Apprenticeship to become an artisan
- Study at a college in the NC (V) in a vocational career pathway
- Enter Higher education at a University of Technology or University
- Enter the world of work as an entrepreneur or working with an entrepreneur
- Enter higher education to study technical education in order to become a technical teacher

Possible career and life experience opportunities that exist for learners with a foundation in Electrical Technology include, amongst others, the following:

Electrical fitter

- Electrical or electronic engineer
- Electrical draughtsperson
- Electrical or electronic technician
- Electrical or electronic technologist
- Digital / Software Engineer
- Academic in the field of Electrical Technology
- Electronic mechanic
- Auto-electrician
- Electrician
- Radio Technician
- Cell Phone Technician
- Communication Technician
- PLC Programming Expert
- Electronics Programming Engineer
- Computer Technician
- Robotics Engineer
- Mechatronics Technician
- Installation Electrician

- Radio Amateur
- Electronic hobbyist
- Radio Control Enthusiast
- Production Manager
- Sound and Light Engineer

SECTION 3

Content Outline

Listed below are the topics per grade with a short explanation of the focus. Note that some topics are continued from Grades 10 to 12, increasing in complexity from year to year, whilst other topics either form the basis for further study or develop from previous topics.

Electrical		
Grade 10 Topics	**Grade 11 Topics**	**Grade 12 Topics**
Occupational Health and Safety Responsibilities, Workshop Rules & Procedures	**Occupational Health and Safety** Introducing the OHS Act, Machinery Regulations and Electrical Machinery Regulations	**Occupational Health and Safety** The consequences of the OHS Act, risk assessment, human rights in the workplace, work ethics and emergencies
Tools and measuring instruments Tools and how to use them	**Tools and measuring instruments** Measuring instruments and how to use them	**RLC** The effect of AC on Series and parallel RLC Circuits
Basic Principles of Electricity Introduction of electricity as the core of the subject	**DC Machines** Introducing of DC machines, their construction and operating principles	**Three Phase AC Generation** Power in three phase systems, measurement and calculations
Power Sources Basic power sources such as the battery and how they operate	**Single Phase AC Generation** How electricity is generated	**Three Phase Transformers** Principles of operation, calculations and application
Electronic Components Basic electronic components and how they operate	**Single-phase Transformers** Induction, the operation of transformers and types of transformers	**Three Phase Motors & Starters** Principle of operation, testing and commissioning and starters
Domestic Installations House wiring from the supplier to the power outlets and domestic appliances	**RLC** The effect of AC on Series RLC Circuit	**Programmable Logic Controllers (PLC)** Motor Control using the PLC and Variable Speed Drives
Principles of Magnetism Principles of Magnetism and the relevant laws	**Control Devices** Motor Control and Programmable Logic Control	
	Single Phase Motors The Universal Motor, spit phase motor and their application	
	Power Supplies DC Power supplies, Semiconductors, the Zener Diode, rectification and regulating voltage using a transistor	

Electronics		
Grade 10 Topics	**Grade 11 Topics**	**Grade 12 Topics**
Occupational Health and Safety Responsibilities, Workshop Rules & Procedures	**Occupational Health and Safety** Introducing the OHS Act, Machinery Regulations and Electrical Machinery Regulations	**Occupational Health and Safety** The implications of the OHS Act, risk assessment, human rights in the workplace, work ethics and emergencies
Tools and measuring instruments Tools and how to use them	**Tools and measuring instruments** Measuring instruments and how to use them	**RLC** The effect of AC on Series and Parallel RLC Circuits
Basic Principles of Electricity Introduction of electricity as the core of the subject	**Waveforms** Introduction of waveforms, pulse technique and wave shaping as an approach to electronics	**Semiconductor Devices** Introduction to the FET, UJT, Darlington, 741 Op-Amp and 555 Timer
Power Sources Basic power sources such as the battery and how they operate	**RLC** The effect of AC on Series RLC Circuit	**Switching Circuits** Electronic Switching Circuits using the 555 Timer and 741 Op-Amp
Electronic Components Basic electronic components and how they operate	**Semiconductor Devices** Introduction of components and solid state devices	**Amplifiers** Principle of operation and application of discrete component amplifiers and oscillators
Logics Boolean Logic and basic Logic gates with their application	**Power Supplies** Principle of operation of linear power supplies, series and shunt using regulation	
Communication Systems Basic communication principles, antenna systems and modulation	**Amplifiers** Principle of operation and application of transistor amplifiers	
Principles of Magnetism Principles of magnetism and the relevant laws	**Sensors and Transducers** Sensors and transducers as the interface between real world conditions and electronic circuitry	
	Communication Systems Tuned Circuits, Transmitters and Receivers and their basic principles of operation	

Digital		
Grade 10 Topics	**Grade 11 Topics**	**Grade 12 Topics**
Occupational Health and Safety Responsibilities, Workshop Rules & Procedures	**Occupational Health and Safety** Introducing the OHS Act, Machinery Regulations and Electrical Machinery Regulations	**Occupational Health and Safety** The consequences of the OHS Act, risk assessment, human rights in the workplace, work ethics and emergencies
Tools and measuring instruments Tools and how to use them	**Tools and measuring instruments** Measuring instruments and how to use them	**Semiconductor Devices** Introduction of Integrated Circuits The 741 Op-amp The 555 Timer
Basic Principles of Electricity Introduction of electricity as the core of the subject	**Waveforms** Introduction of waveforms, pulse technique and wave shaping as an approach to electronics	**Switching Circuits** Electronic Switching Circuits using the 555 Timer and 741 Op-Amp
Power Sources Basic power sources such as the battery and how they operate	**RLC** The effect of AC on Series RLC Circuit	**Digital and Sequential Devices** Decoders and encoders, principles of combinational circuits without memory, principles of memory elements, counters and registers
Electronic Components Basic electronic components and how they operate	**Semiconductor Devices** Introduction of components and solid state devices	**Microcontrollers** History of Microcontrollers, Hardware, Software and PICAXE using Logicator as an approach to programming PICS
Logics Boolean Logic and basic Logic gates with their applications	**Logics** Boolean Logic, Karnaugh Maps, Logic Probes, RTL, TTL and Logic ICs	
Communication Systems Basic communication principles, antenna systems and modulation	**Power Supplies** 	
Principles of Magnetism Principles of magnetism and the relevant laws	**Sensors and Transducers** Sensors and transducers as the interface between real world conditions and electronic circuitry	
	Communication Systems Tuned Circuits, Transmitters and Receivers and their basic principles of operation	

3.1 Content Outline per Term: Electrical

3.1.1 Electrical: Grade 10

Electrical Grade 10: Term 1		
WEEK	**Topic**	**CONTENT**
1	**Occupational Health and Safety**	**Responsibilities** • What are your rights in the workshop? • What are your responsibilities in the workshop? **General Workshop Rules** • Housekeeping (Health hazards, safety hazards, workshop layout, workshop management) **Workshop Safety** • Unsafe acts • Unsafe conditions • Walkways (Colour codes), store areas, other designated areas • Information and safety signs • Signs in the workshop ➢ Information signs ➢ Safety signs ➢ Prohibition signs ➢ Fire Safety signs ➢ Regulatory signs **Note:** Clean the workshop on a weekly basis **Emergency Procedures** • Placement of the Master Switch • Critical versus non-critical emergencies • Medical emergencies • Electrical shock / Electrocution procedures • Evacuation procedures • Principles of fire fighting **Practical:** Perform an evacuation exercise for the workshop

Electrical Grade 10: Term 1		
WEEK	**Topic**	**CONTENT**
2	**Occupational Health and Safety**	**Basic First Aid** • What is HIV/AIDS and infectious disease? • How are diseases transferred? • What to do when someone is bleeding • What to do when someone has been burnt • What to do in case of electrical shock • How to administer CPR **Practical:** Perform a first aid exercise (Choose a topic from basic first aid) **Chemical Safety** (Printed Circuit Board manufacturing) • Personal protection equipment • Handling chemicals (Mixing of chemicals, disposing of chemicals, corrosive chemicals) • Where to work with chemicals (Ventilation, lighting, designated area) • Chemical processes in making PCBs (Preparing PCBs, developing the circuitry, etching the board, protecting the board) • Environmental considerations
3	**Tools and measuring instruments**	**Identification of the parts, functions of parts, care, maintenance, correct and safe use of the following tools:** • Screwdrivers (Flat and Phillips) • Files (Flat, Square, Round, Triangular and Half round) • Side Cutter • Long Nose pliers • Combination pliers • Wire Stripper • Utility Knife • Soldering Iron • Solder Sucker • Electric Hand Drill / Drill Press / PCB Drill (Dremel) • Hack Saw (Junior Hack Saw) • Breadboard • Fish Tape / Draw Wire • Bending Spring
4		**Practical Skills and Techniques** (These skills will be practiced in this week and honed throughout the year) • Safe and correct use of tools (Choose at least 4 specific tools on which skills will be practiced) • Introductory soldering / de-soldering skills • Introductory Printed Circuit Board manufacturing skills
5		**Safe Use and Care of Instruments** (These skills will be practiced in this week and honed throughout the year) • Continuity Tester • Analog Multimeter (Focus on demonstrations) • Digital Multimeter • Megger / Insulation Tester • The Oscilloscope (Teacher to set up instrument) **Practical:** Conduct simple continuity tests using the multimeter

Electrical Grade 10: Term 1		
WEEK	**Topic**	**CONTENT**
6	**Basic Principles of Electricity**	**Atomic Theory** • Theory of current flow (Electron flow vs. conventional current flow) • Resistive characteristics of different materials • Conductors, semiconductors, insulators • What is a conductor / semiconductor / insulator? (2-3 examples of each and their characteristics. No further theory needed) • A wire is a conductor, but not all conductors are made of wire (Electrical shock and safety) • Types of materials used as conductors: copper, aluminium, gold, silver, steel and nickel chrome wire • Specific resistance (no calculations) • Negative and positive temperature coefficient (no calculations)
7		**The Resistor** • What is a resistor? • Composition of a resistor • Types of resistors • Tolerance (Indicated value vs. measured value) (2% and 5%) • Colour code of resistors (4 band and 5 band resistors) • Power vs. size (1/8W, 1/4W, 1/2W, 2W and 5W) • Measuring the value of resistors • Calculating the value of resistors • Potentiometer (Construction, functional operation, symbols) • Rheostat (Difference between a Potentiometer and Rheostat (Construction, functional operation, symbols)
8		**Ohms Law** • Ohm's law: • Verify Ohm's Law with calculations • Pay attention to prefixes and unit conversions **Series circuit as voltage divider** • Kirchhoff's Voltage Divider: ○ $V_T = V_1 + V_2 \ldots + V_n \ (V)$ • Resistors in series ○ $R_T = R_1 + R_2 \ldots + R_n \ (\Omega)$ **Parallel circuit as a current divider** • Kirchhoff's Current Divider (combination circuits with calculations): ○ $I_T = I_1 + I_2 \ldots + I_n \ (A)$ • Resistors in parallel ○ $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} \ldots + \frac{1}{R_n} \ (\Omega)$

Electrical Grade 10: Term 1		
WEEK	**Topic**	**CONTENT**
9		**Series / Parallel Circuits** • Calculations on combination circuits containing: • 1 x Series and 2 x Parallel • 2 x Series and 2 x Parallel • 3 x Series and 3 x Parallel **Practical:** Measure voltage and current in a Series / Parallel Circuit • 1 x Series and 2 x Parallel • 2 x Series and 2 x Parallel • 3 x Series and 3 x Parallel
10		**Power** • Definition of Power • Power calculations: ○ $P_T = VI\ (W)$ ○ $P_T = I^2R\ (W)$ ○ $P_T = \frac{V^2}{R}\ (W)$ **Practical:** Apply power calculations to Series / Parallel Circuits **PAT Simulations 1 & 2 completed**

Electrical Grade 10: Term 2		
WEEK	**Topic**	**CONTENT**
1	**Power Sources**	**Energy** • What is energy? • Primary source of energy (The Sun) • Sources of energy (Wind, Sun, Coal, Nuclear, Geothermal, Hydro) • Storing energy (ways in which energy can be conserved / stored) **The Electrical Cell** • The Voltaic Cell • Operation of the Voltaic Cell • Diagram of the cell • Advantages / disadvantages **Primary Cells vs. Secondary Cells** • Lead Acid Battery • Principal of operation • Basic construction • Advantages / disadvantages • Applications • Safety considerations • Lithium Ion (Li-Ion) or Lithium Polymer (Li-Po) Battery • Principal of operation • Basic construction • Advantages / disadvantages • Applications • Safety considerations

Electrical Grade 10: Term 2		
WEEK	**Topic**	**CONTENT**
2		**Alternative Energy** • Solar / Photovoltaic Cell ➢ Symbol ➢ Basic principal of operation ➢ Basic construction / composition ➢ Advantages / disadvantages ➢ Functional application • Solar Cell vs Solar Panel • Generating electricity from the Sun • Reasons for using regulators • Reasons for using batteries with solar panels • Block diagram of a solar electricity generation system for domestic use **Potential Difference (PD)** • Understanding the concept of PD ○ $V = \frac{E}{Q}\ (Volt)$ **Electromotive Force (EMF)** • Understanding the concept of EMF • Difference between EMF and PD ○ $V_{EMF} = V_{PD} + V_r\ (Volt)$ **Internal Resistance** • What is Internal Resistance? • Advantages / disadvantages of Internal Resistance • Internal Resistance calculations ○ $\mathrm{E_{EMF}} = \mathrm{IR} + \mathrm{Ir}\ (\mathrm{Volt})$ ○ $\mathrm{R_{Total}} = \mathrm{R} + \mathrm{r}\ (\Omega)$
3		**Capacity and Power (VA) Rating** • Understanding the concept of Voltage Drop and Current Drain due to overload • Determine how long a battery will be able to deliver current to a load • Calculations: Ampere Hour ○ $Battery\ Capacity = I_{Charge} \times T_{Charge}(AH)$ **Practical:** Calculate internal resistance of a Cell / Battery in series with a resistor **Connecting Cells in Series** • Voltage and current rating ○ $V_T = V_1 + V_2 + \cdots V_n(V)$ ○ $I_T = I_1 = I_2 = \cdots I_n(A)$ **Practical:** Connect cells in series to form a battery. Measure voltage and current **Connecting Cells in Parallel** • Voltage and current rating ○ $V_T = V_1 = V_2 = \cdots V_n(V)$ ○ $I_T = I_1 + I_2 + \cdots I_n(A)$ • Safety considerations **Practical:** Connect cells in parallel to increase capacity. Measure voltage and current across different loads

Electrical Grade 10: Term 2		
WEEK	**Topic**	**CONTENT**
4	**Electronic Components**	**Introduction of Electronic Components** • What are electronic components? • Purpose of electronic components • Considerations when obtaining electronic components **Types of Components** • Switches (Functional operation, symbols) • SPST, SPDT, DPST, DPDT • Rotary Switch • Slide switches • Magnetic switches • Key switches • Applications and practical in simple circuits **Practical:** Identify/test/measure different electronic components
5		**The Capacitor** • Composition, construction, functional operation, symbols, characteristic curves and values • Basic principles of electrostatic charge: ○ $Q = CV\ (Coulomb)$ • Time constant ○ $t = RC\ (Seconds)$ ○ $T = 5RC\ (Seconds)$ • Charging rates and time constant including curves and calculations ○ $V_{Capacitor} = V_{Supply} \times 0.636\ (Volt)$ ○ $I_{Capacitor} = I_{Max} \times 0.364\ (Amp)$ • Graph • Application of capacitors in DC (Examples of smoothing circuit and RC time constant) • Capacitors in series . ○ $\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \cdots \frac{1}{C_n}\ (Farad)$ • Capacitors in parallel ○ $C_T = C_1 + C_2 + \cdots C_n\ (Farad)$ **Practical:** Calculation of charge: $Q = CV$ **Practical:** Calculation of total capacitance in series (2, 3 and 4 capacitors) **Practical:** Calculation of total capacitance in parallel (2, 3 and 4 capacitors) **Practical:** Charging characteristics of the capacitor. Include drawing of graph from data

Electrical Grade 10: Term 2		
WEEK	**Topic**	**CONTENT**
6		**Protective Devices** • Fast Blow and Slow Blow fuses ➢ Basic working principle ➢ Construction and parts ➢ Testing **Diode** • Symbol • Diode as a polarised component • Forward Biasing (concept only) • Reverse Biasing (concept only) • Current flow through the diode • Voltage across the diode • Application as a rectifier **LED** • Symbol • LED as a polarized component • Forward Biasing (concept only) • Reverse Biasing (concept only) • Current flow through the diode • Voltage across the LED • The Series Resistor ○ $R_{Series} = \frac{V_T - V_{LED}}{I_{LED}} (\Omega)$
7		**Practical:** Test the diode and LED for correct function and polarity using a multimeter **Practical:** Calculate the value of the series resistor needed to protect an LED. Test the circuit on a breadboard using the calculated values **Practical:** Build a half wave rectifier using a diode and 50 Hz supply - display on Oscilloscope **Practical:** Build a full wave rectifier using a diode bridge (4 diodes / 2 diodes) and 50 Hz supply – display on Oscilloscope
8 – 10	**Revision and Mid-year Exams**	**PAT Simulations 3 & 4 completed**

Electrical Grade 10: Term 3		
WEEK	**Topic**	**CONTENT**
1	**Domestic Installations**	**Electrical Energy Distribution – Supplier to the Consumer** • Domestic installations • Sequence of connection from supplier to consumer – Block diagram • SANS 10142-1 – Installation regulations ➢ Aim of the *SANS 10142-1 - Low Voltage Installations* ➢ Chapter 3 definitions ➢ Chapter 5 fundamental requirements ➢ Chapter 5.1 safety ➢ Chapter 5.2 basic provisions
2		**The Distribution Board** • Wiring diagram DB Board • Distribution Board wiring principles • SANS Chapter 6.6.1 – Distribution boards: general • SANS Chapter 6.6.2 – Distribution boards: Bus bars • SANS Chapter 6.7 – Protection • SANS Chapter 6.10 – Fuses **Protective Devices: Miniature Circuit Breakers** • Principle of operation • Electromagnetic type • Thermal type • Ratings • SANS Chapter 6.8 – Circuit breakers • SANS Chapter 6.9 – Disconnecting devices **Practical:** Wire a Distribution Board according to the SANS requirements
3		**Protective Devices: Earth Leakage** • Principle of operation • Safety considerations • Cabling and cable sizes • Correct identification and fitting of wiring for a domestic installation • Cable termination • Glands (PVC pressure glands) • Acknowledgement of Indigenous knowledge systems (PRATLEY connector boxes)
4		**Pipe Sizes** • Bending, fitting, sawing • PVC conduit and fittings • Practical: Install PVC piping for the domestic circuit **Protective Devices: Earthing** • The earth spike, lightning arrestor, earth systems and bonding (Acknowledgement of Indigenous knowledge systems) (Earth leakage developed in SA) • SANS Chapter 6.11 – Consumer's earth terminal • SANS Chapter 6.12 – Earthing • SANS Chapter 6.13 – Bonding

Electrical Grade 10: Term 3		
WEEK	**Topic**	**CONTENT**
5		**Testing and Troubleshooting (After Installation)** • Earth continuity testing • Insulation resistance tests between conductors • Insulation resistance tests between conductors and earth • Polarity tests (Plug Tester)
6		**Sub-circuits** • Lighting Circuits ➢ Lights in series (Voltage and current measurement) ➢ Lights in parallel (Voltage and current measurement) ➢ Two way switching (SPDT) ➢ Intermediate light switching (DPDT)
7		**Alternative Lighting Systems** • Fluorescent lights • Comparison between incandescent lamps and energy saving lighting • LED lighting • Day / Night light circuits • SANS Chapter 6.14 – Lighting **Practical:** Wire a lighting sub-circuit with two way and intermediate switching
8		**Plug Circuits** SANS Chapter 6.15 – Socket outlets **Practical:** Wire two plugs into a sub-circuit
9		**Fixed Appliances** • The geyser: Thermostatic control • The stove: Multi-heat switching • The oven: Thermostatic control • SANS Chapter 6.16 – Fixed appliances • SANS Chapter 7.1 – Bathrooms, showers and spas • SANS Chapter 7.2 – Swimming pools, paddling pools, ornamental pools, spas and fountains **Practical:** Wire stove and geyser sub-circuits
10		**Practical:** Do an insulation resistance test on the domestic installation **Practical:** Do a polarity test on the live domestic installation **PAT Project completed and moderated**

Electrical Grade 10: Term 4		
WEEK	**Topic**	**CONTENT**
1	**Principles of Magnetism**	**Introduction to Magnetism** • Define magnetism e.g. natural, electro-magnetism • Basic principles of magnetism • Rules of magnetism **Demonstration:** Magnetic fields around a permanent magnet using iron filings
2		**Magnetic Fields** • Concepts of ➢ Magnetic Flux (Φ) ➢ Flux Density(β) ➢ Inductance (L) • Definition of an inductor • No calculations **Demonstration:** Oersted's Experiment (Screwdriver Rule)
3		**Types of Inductors and inductor cores** • Air Core • Laminated Core • Ferrite Core • Torroid Core **Demonstration:** Magnetic fields around a coil using iron filings **Demonstration:** Magnetic field around a coil with and without a core **Calculations:** • Coils in series (Inductor) ○ $L_{Series} = L_1 + L_2 + \cdots L_n(Henry)$ • Coils in parallel (Inductor) ○ $\frac{1}{L_{Parallel}} = \frac{1}{L_1} + \frac{1}{L_2} + \cdots \frac{1}{L_n}(Henry)$ **Functional operation and application of relays / solenoids** • Symbol • Principal of operation • Construction of a relay • Parts of a relay • Normally open / normally closed **Practical:** Testing a relay using a multimeter **Demonstration:** Wire a relay and light to a switch and operate the relay **Demonstration:** Latching circuit with a relay

Electrical Grade 10: Term 4		
WEEK	**Topic**	**CONTENT**
4		**Introduction to a Simple Series DC Motor** • Basic parts of a DC motor • Current flow in a DC motor and direction of rotation • Flemings' Right Hand Rule • Armature • Yoke / Magnetic poles • Bearings / Bushes in endplates • Brushes • Commutation **Demonstration:** Show how the direction of rotation in DC motors can be changed
5	**Revision Term 1**	
6	**Revision Term 2**	
7	**Revision Term 3**	
8 – 10	**Examination**	

3.1.2 Electrical: Grade 11

Electrical Grade 11: Term 1		
WEEK	**Topic**	**CONTENT**
1	**Occupational Health and Safety**	**Occupational Health and Safety** • Basic introduction to regulations ➢ What are regulations? ➢ How to use regulations? ➢ Impact of regulations on the workshop ➢ Introduction and purpose of regulations • General Machinery Regulations 1988 ➢ Supervision of machinery ➢ Safeguarding of machinery ➢ Operation of machinery ➢ Working on moving or electrically alive machinery ➢ Devices to start and stop machinery ➢ Reporting of incidents in connection with machinery • Electrical Machinery Regulations 1988 ➢ Safety equipment ➢ Electrical control gear ➢ Switchboards ➢ Portable electric tools ➢ Earthing ➢ Conductors **Safety** • What is Ergonomics? • (Workplace conditions / comfort - Everything has a place and everything is in its place) • Unsafe actions • Unsafe conditions • Dangerous practices • Housekeeping principles **Signs in the workshop** • Information signs • Safety signs • Prohibition signs • Fire Safety signs • Regulatory signs • Designated areas **Practical:** Identification of safety signs and safety gear.

Electrical Grade 11: Term 1		
WEEK	**Topic**	**CONTENT**
		Revision of emergency procedures (Grade 10) **Practical:** Clean the workshop (Weekly activity) **Personal Safety** • Protective gear for machinery • Personal protection equipment • Eye protection • Coveralls / Overalls • Hearing protection **Practical:** Use personal protection equipment (During practical sessions) **Chemical Safety** (Printed Circuit Board manufacturing). Revision of Grade 10 PCB methods and safety **Practical:** Etch a PCB (Part of PAT completion)

Electrical Grade 11: Term 1		
WEEK	**Topic**	**CONTENT**
2	**Tools and Measuring Instruments**	**Tools** • Re-visit safe use of hand tools • Crimping Tool (Ferrules, lugs & plugs) **Safe use of Power Tools** • Grinder – Bench / Angle • Jigsaw – Bench / Handheld • Power Drill / Drill stand (revision) **Connectors** • Ferrules, lugs & plugs (Related to area of specialisation) • Single In-line connectors (Push-In connectors) **Skills** (Skills are developed throughout the year during practical sessions): • Safe use of tools • Correct use of tools • Intermediate soldering / de-soldering skills (using a solder wick) • Intermediate Printed Circuit Board manufacturing skills (design & make) • Cleaning and tidying the workshop after practical (Housekeeping) • Keeping the storeroom neat and tidy **Practical:** Practice of safe housekeeping practices and methods **Testing Equipment** • Line Tester, Clamp Meter & Power Factor Meter ➢ External parts and their functions ➢ Principle of operation ➢ Application ➢ Care ➢ Maintenance • Function Generator and Oscilloscope ➢ External parts and their functions ➢ Principle of operation ➢ Application ➢ Care ➢ Maintenance • Calculations on the Oscilloscope ➢ Time ➢ Frequency ➢ Phase difference ➢ Maximum value
		Practical: Measure voltage and current with a multimeter **Practical:** Conduct insulation test on an electrical motor between coil and chassis **Practical:** Basic use of the oscilloscope to display waveforms taken from the function generator **Practical:** Determine voltage and frequency values as displayed on Oscilloscope (Note: Oscilloscope does not measure and display current)

Electrical Grade 11: Term 1		
WEEK	**Topic**	**CONTENT**
3	**DC Machines**	**Introduction of DC Machines** • Difference between generators and motors • Revision of the DC motor working principle in Grade 10 **Construction of the DC Machine** • Armature • Commutation • Brushes • Yoke • Name Plate • Field windings • Lap • Wave **Purpose of the components / parts of the DC Machine** • Armature • Commutation • Brushes • Yoke • Field windings • Pole pairs • Inter-poles **Practical:** Identify the parts of the motor
4		**Principal of operation of the DC Machine** • Armature reaction • Reducing armature reaction • Commutation • Improving of commutation **Practical:** Perform insulation resistance test and continuity test on motor windings
5		**Types of DC Machines** • Series, shunt and compound machines ➢ Application of each type ➢ Relationship between speed and torque ➢ Characteristic curves (Effect of changes in load on speed and torque) • The Stepper Motor ➢ Field poles ➢ Basic working principles • Servo Motors ➢ Basic working principles ➢ Characteristic curves (Effect of changes in load on speed and torque) ➢ Speed control done through electronics – Pulse width modulation (Concept only)

Electrical Grade 11: Term 1		
WEEK	**Topic**	**CONTENT**
6		**Types of Losses in DC Machines** • Copper • Constant • Magnetic • Mechanical • Eddy Current • Efficiency (Calculations) **Advantages and disadvantages of the DC Machine.** **Maintenance of DC machines – Considerations**
7	**Single Phase AC Generation**	**Introducing Single Phase AC Generation** • Difference between DC and AC • Motivation for using AC rather than DC • Generation of a single phase supply by rotating a conductor loop through a two-pole magnetic field **Laws of Electricity** • Faraday's Law • Fleming's Right Hand Generator Rule • Flemings Left Hand Motor Rule (Revision) **Demonstration:** Rotate magnetic field through a coil and display on Oscilloscope
8		**The Effect and Calculation of:** • Magnetic field strengths ○ $H = \frac{N \times I}{l} (A/m)$ • Flux density (β) ○ $\beta = \frac{\phi}{A} (Tesla)$ • Pole pairs ○ $p = \frac{number\ of\ poles}{2}$ • Number of windings (*N*) • Area of the coil ○ $A = lb\ (m^2)$ • Frequency of rotation ○ $F = 1/T\ (Hertz)$ ○ $f_{Rotation} = Pole\ Pairs(p) \times Revolutions\ per\ Second(n)$ ○ $RPM = Fx60\ (rpm)$ • Lamination of the core

Electrical Grade 11: Term 1		
WEEK	**Topic**	**CONTENT**
9		**The Sinusoidal Waveform** • Instantaneous value (Calculations) ○ $\omega = 2\pi f\ (radians)$ ○ $\Theta = \omega t\ (Degrees)$ ○ $i = I_{Max} \times Sin\Theta$ (A) ○ $v = V_{Max} \times Sin\Theta$ (V) • Maximum value (Calculations) ○ $V_{Max} = V_{RMS} \times 1.414\ (V)$ • RMS value (No Mid-ordinate Rule) (Calculations) ○ $V_{RMS} = V_{Max} \times 0.707\ (V)$ • Average value over half cycle (Calculations) ○ $V_{Average} = V_{Max} \times 0.637\ (V)$
10		• Calculation of: • Instantaneous value ▪ $v = V_M\ Sin\theta\ (Volts)$ • Maximum value ▪ $V_M = 2\pi\beta AnN\ (Volts)$ ▪ $E = \beta lv\ (Volts)$ • RMS value ▪ $V_{RMS} = V_M \times 0.707\ (Volts)$ • Average value over half cycle (Mid-ordinate rule to show where average value comes from) ▪ $V_{Average} = V_M \times 0.637\ (Volts)$ **Practical:** Measure mains voltage using a multimeter **Practical:** Measure mains current usage using a Clamp Meter **PAT Simulations 1 & 2 completed**

Electrical Grade 11: Term 2		
WEEK	**Topic**	**CONTENT**
1	**Single Phase Transformers**	**Introduction to Transformers** • Magnetic Induction • Lenz's Law • Magneto magnetic force • Self and mutual inductance • Function and operation of transformers
2		• Losses in Transformers (No calculations) • Advantages and disadvantages • Construction and symbols of transformer and core types
3		**Application of Transformer Types including:** • Ideal transformer • Auto transformer • Centre Tap transformer • Voltage instrument transformers • Current instrument transformers
4		**Calculations related to Transformers** • Power calculations ➢ Full load ▪ $P = VI\cos\theta\ (Watt)$ ➢ VA ratings ▪ $S = VI\ (VA)$ • Primary and secondary voltage / current • Ratio calculations • $\frac{V_{Input}}{V_{Output}} = \frac{N_{Input}}{N_{Output}} = \frac{I_{Output}}{I_{Input}}$ Efficiency ○ $\eta = \frac{P_{Output}}{P_{Input}} \times 100\%$

Electrical Grade 11: Term 2		
WEEK	**Topic**	**CONTENT**
5	**RLC**	**Effect of Alternating Current on Resistors, Inductors and Capacitors (RLC)** • Components in series circuits 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 • Inductive Reactance ○ $X_L = 2\pi fL\ (\Omega)$ • Capacitive Reactance ○ $X_C = \frac{1}{2\pi fC}\ (\Omega)$ • Effect of frequency changes on XL and XC **Demonstration:** Show phase difference between RL and RC
6		• Impedance ○ $Z = \sqrt{R^2 + (X_L - X_C)^2}\ (\Omega)$ • Scalar: Representation of the Impedance Triangle • Power ○ $P = V \times I \cos\ \theta\ \ (Watt)$ • Power Factor ○ $\cos\theta = \frac{R}{Z}$ ○ $\cos\theta = \frac{V_R}{V_Z}$ • Phase Angle ○ $\theta = \cos^{-1}\frac{R}{Z}\ (Deg)$ ○ $\theta = \cos^{-1}\frac{V_R}{V_Z}\ (Deg)$
7		• Natural Resonance • Effect of frequency changes on the impedance and current flow • Resonance with its characteristic curves ○ $f_r = \frac{1}{2\pi\sqrt{LC}}\ (Hertz)$ • Q Factor ○ $q = \frac{1}{R}\sqrt{\frac{L}{C}}$ ○ $q = \frac{X_L}{R}\ (X_L is\ taken\ at\ Resonance)$ ○ $q = \frac{X_C}{R}\ (X_C is\ taken\ at\ Resonance)$ • Bandwidth ○ $BW = \frac{f_r}{q}\ (Hertz)$ • Frequency changes
8 – 10	**Mid-year Examinations**	**Simulations 3 & 4 completed**

Electrical Grade 11: Term 3		
WEEK	**Topic**	**CONTENT**
1	**Control Devices**	**Introduction to Control and Protection of AC Machines** • Principle of operation of protection (Theory session) ➢ Overcurrent and undervoltage protection ➢ Re-settable overcurrent protection (Motor protection) ➢ The Zero Volt Coil / No Volt Coil (Operator protection)
2		**The Direct On Line Starter / Contactor (DoL)** • Identification, operation and purpose of: ➢ The contactor ➢ Start button ➢ Stop button ➢ Overload protection ➢ On Delay Timer / Off Delay Timer • Setting overcurrent protection ○ $I_{Overcurrent\ Protect} = I_{Max} \times 125\%\ (Ampere)$ • Wiring diagram of the DoL • Testing & commissioning **Practical:** Connecting the DoL Starter to a light: switch on and off
3		**Introduction to the Programmable Logic Control Device (PLC)** • History of the PLC • What is hardware? • What is software? • Hard wiring vs. soft wiring • The programmed scan cycle of a PLC (Input, process, output) • Safety and PLC devices
4		**PLC Software – Introduction on the Computer** • The purpose of using software to program the PLC • Navigating the Graphic User Interface of the programming software used (How to use the software) • Using Ladder Logic to write a program for a PLC ➢ What is a rung? ➢ Ladder Logic symbols • Inputs • Outputs • Inverting inputs and outputs • AND / OR / NOT function ➢ Latching concepts in Ladder Logic • Retaining contact • Interlocking
5		**The interface Cable** • Loading the program from the computer to the PLC • Loading an existing program from the PLC to the computer **Practical:** Program a PLC as a Direct On Line Starter

Electrical Grade 11: Term 3		
WEEK	**Topic**	**CONTENT**
6	**Single Phase Motors**	**Single Phase Induction Motors** • The Universal Motor • Construction of the AC Motor • Comparison between AC and DC motors • Producing a rotating magnetic field in single phase motors • Considerations when selecting a motor to suit a load • How changes in load affects speed of a motor • Operation of split phase motors (Methods of splitting single phase supply)
7		**Capacitor Start Motor** (Note: This is a practical component – all aspects will be attended to as part of practical work in the workshop in conjunction with the theory) • Function of components • Diagram (Interpret the circuit diagram and wire the starter and motor on a panel) • Reversal of direction of rotation (Add practical session on reversal of direction) • Testing a motor • Visual inspection test • Insulation • Continuity of windings • Test earth continuity • Mechanical test • Practical application & use: connection of a CSM • Wire DoL to motor • Start and stop motor
8		**Practical:** Perform complete test on a CS Motor **Practical:** Wire CS Motor with DoL. Start and stop motor. Reverse direction of rotation **Practical:** Add a PLC and wire CS Motor with PLC and Contactor. Start and stop motor
9		**Capacitor Start & Run Motor** (Note: This is a practical component – all aspects will be attended to as part of practical work in the workshop in conjunction with the theory) • Function of components • Diagram • Reversal of direction of rotation (Add practical session on reversal of direction) • Testing • Visual inspection test • Insulation • Continuity of windings • Test earth continuity • Mechanical test • Practical application & use: connection of a CSM • Wire DoL to motor • Start and stop motor **Practical:** Perform complete test on a CS & R Motor

Electrical Grade 11: Term 3		
WEEK	**Topic**	**CONTENT**
10		**Practical:** Wire CS & R Motor to DoL. Start and stop motor. Reverse direction of rotation. No PLC **Practical:** Wire CS Motor with On Delay timer – Auto start. No PLC **PAT Project completed and moderated**

Electrical Grade 11: Term 4		
WEEK	**Topic**	**CONTENT**
1	**Power Supplies**	**DC Power Supplies** • What is a power supply unit (PSU)? • Block diagram of a linear power supply • The role different semiconductor components play in a PSU • **Semiconductors** ➢ The PN Diode • Construction • Principle of operation • Electron flow vs. conventional flow • P & N material • Forward Biasing • Reverse Biasing • Characteristic curve & symbol of the diode **Practical:** Construct a half wave rectifier and display the waveform on an oscilloscope
2		• The Zener Diode ➢ Construction ➢ Principle of operation ➢ Forward Biasing ➢ Reverse Biasing ➢ Avalanche breakthrough vs. controlled breakthrough ➢ Zener as a voltage regulator ➢ Characteristic curve & symbol
3		**Rectification (Half Wave and Full Wave)** • Waveforms • Circuit construction (Practical) • Representation of waves on Oscilloscope • Principle of filtering and waveforms • Block diagram • Circuit construction of the C and LC Filter (Practical) • Representation of waves on Oscilloscope • Ripple Factor – percentage only **Practical:** Construct a full wave rectifier and display the waveform on an oscilloscope

Electrical Grade 11: Term 4		
WEEK	**Topic**	**CONTENT**
4		**The NPN Transistor** • Construction • Principle of operation • Forward Biasing • Reverse Biasing • Characteristic curve & symbol **Regulating a Voltage** (Shunt regulation only using Zener Diode and transistor – focus on shunt as a high current solution) • Circuit diagram • Waveforms • Circuit construction (Practical) • Measurement with multimeter • Calculations: • Zener calculations – Series resistor **Practical:** Construct a voltage regulator circuit and adjust to various values
5	**Revision Term 1**	
6	**Revision Term 2**	
7	**Revision Term 3**	
8 – 10	**Examination**	

3.1.3 Electrical: Grade 12

Electrical Grade 12: Term 1		
WEEK	**Topic**	**CONTENT**
1	**Occupational Health and Safety**	**OHS ACT** • Definitions • Purpose of the act • General duties of employers to their employees • General duties of employers and self-employed persons to persons other than their employees • General duties of manufacturers and others regarding articles and substances for use at work • Duty to inform • General duties of employees at work • Duty not to interfere with, damage or misuse things • Functions of health and safety representatives • Report to inspector regarding certain incidents • Victimization forbidden • Offences, penalties and special orders of court **Safety Revision** • Unsafe actions • Unsafe conditions • Dangerous practices • Risk analysis • Human rights in the workplace • Work ethics • Revision of emergency procedures (Grade 10) **Practical:** Use personal protection equipment (During practical sessions) **Practical:** Clean the workshop (Weekly activity throughout the year) **Chemical Safety** (Printed Circuit Board manufacturing) • Revision of Grade 10 & PCB methods and safety done as part of PAT **Practical:** Etch a PCB (Part of PAT completion during the year)
2	**RLC**	Effect of alternating current on R, L and C components in series (revision of Grade 11) and parallel circuits • Concepts handled both in theory and practical experiments
3		• Inductive Reactance ○ $X_L = 2\pi fL\ (\Omega)$ • Capacitive Reactance ○ $X_C = \frac{1}{2\pi fC}\ (\Omega)$

Electrical Grade 12: Term 1		
WEEK	**Topic**	**CONTENT**
4		• Impedance ○ $Z_{Series} = \sqrt{R^2 + (X_L - X_C)^2}\ (\Omega)$ ○ $Z_{Parallel} = \frac{V_T}{I_T}(\Omega)$ • Power ○ $P = V \times I \cos\ \theta\ (Watt)$ • Phase Angle ➢ Series RLC ▪ $\theta = \cos^{-1}\frac{R}{Z}\ (Deg)$ ▪ $\theta = \cos^{-1}\frac{V_R}{V_Z}\ (Deg)$ ➢ Parallel RLC ▪ $\theta = \cos^{-1}\frac{I_R}{I_Z}\ (Deg)$ • Power Factor ➢ Series RLC ▪ $\cos\theta = \frac{R}{Z}$ ➢ Parallel RLC ▪ $\cos\theta = \frac{I_R}{I_Z}$ • Phasor and wave representation • Investigate practical implications and applications of RLC • Resonance with its characteristic curves ○ $f_r = \frac{1}{2\pi\sqrt{LC}}\ (Hertz)$ • Q Factor ○ $q = \frac{1}{R}\sqrt{\frac{L}{C}}$ ○ $q = \frac{X_L}{R}\ (X_L is\ taken\ at\ Resonance)$ ○ $q = \frac{X_C}{R}\ (X_C is\ taken\ at\ Resonance)$ • Bandwidth ○ $BW = \frac{f_r}{q}\ (Hertz)$
5		**Calculations** • Series and parallel combination circuits containing ONE resistor, ONE capacitor and ONE inductor • Frequency changes
6		• Phasor and wave representation • Resonance • Phasor diagram **Demonstration:** Show the effect of changing frequency in an RLC circuit toward resonance

Electrical Grade 12: Term 1		
WEEK	**Topic**	**CONTENT**
7	**Three Phase AC Generation**	**Principles of Three Phase AC Generation** • Distribution networks – Outline generation network to distribution network revision – Summary • Advantages and disadvantages of single vs. three phase systems • Waveform of single and three phase systems • Phasor diagram of single and three phase systems
8		**Three Phase Systems (3ϕ)** • Star • Delta • Delta vs. Star • Schematic (sketch without indication of components) • Diagrammatic (sketch with components) representations of three phase systems. (Overview of distribution network, power station to end user) • Only balanced loads
9		**Power in Three Phase (3ϕ) Systems and Calculations** • Active power ○ $P = \sqrt{3}V_L \times I_L \cos\theta$ • Reactive power • Apparent power
10		**Introduction to Star and Delta Calculations** • Line voltage and current • Phase voltage and current • Losses • Efficiency • Power factor correction: Only concept of power factor correction – no calculations for exam purposes **Application of Meters in Three Phase (3ϕ)** • Wattmeter • kWh meter (Energy meter) • Power Factor meter • Two and three wattmeter connections and calculations • All diagrams and circuits must be given, and then questions asked referring to diagrams / circuits. Balanced and unbalanced loads **PAT Simulations 1 & 2 completed**

Electrical Grade 12: Term 2		
WEEK	**Topic**	**CONTENT**
1	**Three Phase Transformers**	**Introduction to Three Phase (3ϕ) Transformers** • Principle of operation and connections of three phase transformers • Concept and understanding of losses • Three phase transformers compared to single phase transformers (delta/star, star/delta, delta/delta, star/star) • Construction of transformers • Application of transformers • Cooling • Safety • Protection
2		**Calculations (Balanced Loads only**) • Ratio • Line and Phase current, voltage and power • Power factor • Power • Load including losses and efficiency
3		**Practical:** Wiring of single phase transformers to three phase: star/star; star/delta; delta/star; delta/delta **Practical:** Testing transformers
4	**Three Phase Motors & Starters**	**Introduction to Three Phase (3ϕ) Motors** • Three phase squirrel cage induction motor • Principle of operation • Construction • Advantages • Applications • Calculations on slip, power and efficiency • Characteristic curve of speed vs. torque **Synchronous Speed** • What is synchronous speed? • Relation of synchronous speed to generated power

Electrical Grade 12: Term 2		
WEEK	**Topic**	**CONTENT**
5		**Electrical and Mechanical Aspects of Three Phase (3ϕ) Motors** • Fault-finding / Troubleshooting • Motor testing • Commissioning. The process involved in preparing the motor and starter to be used by the operator **Practical:** Conduct troubleshooting on a faulty motor and rectify the problem **Practical:** Conduct a motor test on a motor **Practical:** Commission a new motor with a starter **3Φ Direct On Line Starter with Overload** • Function of components on diagrams • Principle of operation • Diagram • Wiring on a panel • Calculation of the overload value and setting of the overload **Practical:** Connect a DoL Starter to a motor, set the overload. Start & stop the motor
6		**3Φ Forward and Reverse Starter with Overload** • Function of components on diagrams • Principle of operation • Diagram • Wiring on a panel & calculation of the overload value and setting of the overload **Practical:** Connect a 3Φ Forward and Reverse Starter to a three phase motor. Set the overload. Start & stop **3Φ Sequence Motor Control Starter with Overload (Without Timer)** • Function of components on diagrams • Principle of operation • Diagram • Wiring on a panel **Practical:** Connect a 3Φ Sequence motor starter to a squirrel cage motor. Set the overload. Start & stop

Electrical Grade 12: Term 2		
WEEK	**Topic**	**CONTENT**
7		**3Φ Sequence Motor Control Starter with Overload (With Timer)** • Function of components on diagrams • Principle of operation • Diagram • Wiring on a panel **Practical:** Connect a Sequence Motor starter. Set the overload and timer. Start & stop **3Φ Automatic Star Delta Starter with Overload** • Function of components on diagrams • Principle of operation • Diagram • Wiring on a panel (practical) & calculation of the overload value and setting of the overload **Practical:** Connect a Star Delta starter to a squirrel cage motor. Set the overload and timer. Start & stop
8 – 10	**Mid-year Examination**	**PAT Simulations 3 & 4 completed**

Electrical Grade 12: Term 3		
WEEK	**Topic**	**CONTENT**
1	**Programmable Logic Controllers**	**Introduction to the Programmable Logic Control Device** • History of the PLC (Revision of Grade 11) • Hard wiring vs. Soft wiring (revision) • The programmed scan cycle of a PLC (Input, process, output) (Revision) • Safety and PLC devices (Revision)
2		**PLC Software and Devices** Difference between analogue and digital Logic gates and truth tables of AND, OR, NAND, NOT, NOR inputs to a PLC (Digital) • Switches as input devices (N/O and N/C) • Using sensors as input devices No Theory of operation, only application of: ➢ Proximity ➢ Temperature ➢ Light ➢ Level ➢ Overload Outputs on a PLC (Transistor / Relay)
3		• Contactors / relays • Timers (On Delay / Off Delay) • Latching concepts (Interlocking / retaining circuits) • Markers / Flags (Memory elements) • Conversion of hard wired schematics (Control circuits) to Ladder Logic and labelling of symbols (Motor starters only) • Applications of PLCs: The PLC as a motor starter (Revision)

Electrical Grade 12: Term 3		
WEEK	**Topic**	**CONTENT**
4		**The Variable Speed Drive as a Programmable Motor Controller (Concepts only)** • Basic principle of operation • Introduction to VSD • Methods of speed control (Mechanical / Hydraulic / Electrical) • Basic block diagram (Rectifier / Regulator / Inverter) • Analog to digital conversion & digital control • Types of motors used with a VSD • Regenerative braking • Basic applications of VSD (Fans / Pumping systems / Heating / Ventilation / Air Conditioning systems) • Start-up and run profiles (With applications) (Programming – optional)
5		**Practical:** Problem solving using PLC applications: Sequence Motor Control Starter with overload and timer Do practical revision of hard wired starter before doing PLC Starter
6		**Practical:** Problem solving using PLC applications: the Star Delta Starter Do practical revision of hard wired starter before doing PLC Starter
7		**Practical:** Problem solving using PLC applications: the Forward Reverse Three Phase Starter Do practical revision of hard wired starter before doing PLC Starter
8 – 10	**Preparatory Examination**	**PAT Project completed and moderated**

Electrical Grade 12: Term 4		
WEEK	**Topic**	**CONTENT**
1	**Revision Term 1**	**Occupational Health and Safety** **RLC** **Three Phase AC Generation** **Three Phase Transformers**
2	**Revision Term 2**	**Three Phase Motors & Starters** **Switching & Control**
3	**Revision Term 3**	**Programmable Logic Controllers**
4 – 10	**National Senior Certificate**	**All**

3.2 Content Outline per Term: Electronics

3.2.1 Electronics: Grade 10

Electronics Grade 10: Term 1		
WEEK	**Topic**	**CONTENT**
1	**Occupational Health and Safety**	**Responsibilities** • What are your rights in the workshop? • What are your responsibilities in the workshop? **General Workshop Rules** • Housekeeping (Health hazards, safety hazards, workshop layout, workshop management) **Workshop Safety** • Unsafe acts • Unsafe conditions • Walkways (Colour codes), store areas, other designated areas • Information and safety signs • Signs in the workshop ➢ Information signs ➢ Safety signs ➢ Prohibition signs ➢ Fire safety signs ➢ Regulatory signs **Note:** Clean the workshop on a weekly basis **Emergency Procedures** • Placement of the Master Switch • Critical versus non-critical emergencies • Medical emergencies • Electrical shock / Electrocution procedures • Evacuation procedures • Principles of fire fighting **Practical:** Perform an evacuation exercise for the workshop
2		**Basic First Aid** • What is HIV/AIDS and infectious disease? • How are diseases transferred? • What to do when someone is bleeding • What to do when someone has been burnt • What to do in case of electrical shock • How to administer CPR **Practical:** Perform a first aid exercise (Choose a topic from basic first aid) **Chemical Safety** (Printed Circuit Board manufacturing) • Personal protection equipment • Handling chemicals (Mixing of chemicals, disposing of chemicals, corrosive chemicals) • Where to work with chemicals (Ventilation, lighting, designated area) • Chemical processes in making PCBs (Preparing PCBs, developing the circuitry, etching the board, protecting the board) • Environmental considerations

Electronics Grade 10: Term 1		
WEEK	**Topic**	**CONTENT**
3	**Tools and Measuring Instruments**	**Identification of Parts, Functions of Parts, Care, Maintenance, Correct and Safe Use of the following Tools:** • Screwdrivers (Flat and Phillips) • Files (Flat, Square, Round, Triangular and Half round) • Side Cutter • Long Nose pliers • Combination pliers • Wire Stripper • Utility Knife • Soldering Iron • Solder Sucker • Electric Hand Drill / Drill Press / PCB Drill (Dremel) • Hack Saw (Junior Hack Saw) • Breadboard • Fish Tape / Draw Wire • Bending Spring
4		**Practical Skills and Techniques** (These skills will be practiced in this week and honed throughout the year) • Safe and correct use of tools (Choose at least 4 specific tools on which skills will be practiced) • Introductory soldering / de-soldering skills • Introductory Printed Circuit Board manufacturing skills
5		**Safe use and care of Instruments** (These skills will be practiced in this week and honed throughout the year) • Continuity Tester • Analog Multimeter (Focus on demonstrations) • Digital Multimeter • Megger / Insulation Tester • The Oscilloscope (Teacher to set up instrument) **Practical:** Conduct simple continuity tests using the multimeter
6	**Basic Principles of Electricity**	**Atomic Theory** • Theory of current flow (Electron flow vs. conventional current flow) • Resistive characteristics of different materials • Conductors, semiconductors, insulators • What is a conductor / semiconductor / insulator? (2-3 examples of each and their characteristics. No further theory needed) • A wire is a conductor, but not all conductors are made of wire (Electrical shock and safety) • Types of materials used as conductors: copper, aluminium, gold, silver, steel and nickel chrome wire • Specific resistance (No calculations) • Negative and positive temperature coefficient (No calculations)

Electronics Grade 10: Term 1		
WEEK	**Topic**	**CONTENT**
7		**The Resistor** • What is a resistor? • Composition of a resistor • Types of resistors • Tolerance (Indicated value vs. measured value) (2% and 5%) • Colour code of resistors (4 band and 5 band resistors) • Power vs. size (1/8W, 1/4W, 1/2W, 2W and 5W) • Measuring the value of resistors • Calculating the value of resistors • Potentiometer (Construction, functional operation, symbols) • Rheostat (Difference between a Potentiometer and Rheostat (Construction, functional operation, symbols)
8		**Ohm's Law** • Ohm's law: $V = IR\ (\Omega)$ • Verify Ohm's Law with calculations • Pay attention to prefixes and unit conversions **Series Circuit as Voltage Divider** • Kirchhoff's Voltage Divider: ○ $V_T = V_1 + V_2 \ldots + V_n\ (V)$ • Resistors in series ○ $R_T = R_1 + R_2 \ldots + R_n\ (\Omega)$ **Parallel Circuit as Current Divider** • Kirchhoff's Current Divider (Combination circuits with calculations): ○ $I_T = I_1 + I_2 \ldots + I_n\ (A)$ • Resistors in parallel ○ $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} \ldots + \frac{1}{R_n}\ (\Omega)$
9		**Series / Parallel Circuits** • Calculations on combination circuits containing: ➢ 1 x Series and 2 x Parallel ➢ 2 x Series and 2 x Parallel ➢ 3 x Series and 3 x Parallel **Practical:** Measure voltage and current in a Series / Parallel Circuit ➢ 1 x Series and 2 x Parallel ➢ 2 x Series and 2 x Parallel ➢ 3 x Series and 3 x Parallel
10		**Power** • Definition of Power • Power calculations: ○ $P_T = VI\ (W)$ ○ $P_T = I^2R\ (W)$ ○ $P_T = \frac{V^2}{R}\ (W)$ **Practical:** Apply power calculations to Series / Parallel circuits **PAT Simulations 1 & 2 completed**

Electronics Grade 10: Term 2		
WEEK	**Topic**	**CONTENT**
1	**Power Sources**	**Energy** • What is energy? • Primary source of energy (The Sun) • Sources of energy (Wind, Sun, Coal, Nuclear, Geothermal, Hydro) • Storing energy (Ways in which energy can be conserved / stored) **The Electrical Cell** • The Voltaic Cell • Operation of the Voltaic Cell • Diagram of the Cell • Advantages / disadvantages **Primary Cells vs. Secondary Cells** • Lead Acid Battery • Principal of operation • Basic construction • Advantages / disadvantages • Applications • Safety considerations • Lithium Ion (Li-Ion) or Lithium Polymer (Li-Po) Battery • Principal of operation • Basic construction • Advantages / disadvantages • Applications • Safety considerations

Electronics Grade 10: Term 2		
WEEK	**Topic**	**CONTENT**
2		**Alternative Energy** • Solar / Photovoltaic Cell ➢ Symbol ➢ Basic principal of operation ➢ Basic construction / composition ➢ Advantages / disadvantages ➢ Functional application • Solar Cell vs Solar Panel • Generating electricity from the Sun • Reasons for using regulators • Reasons for using batteries with solar panels • Block diagram of a solar electricity generation system for domestic use **Potential Difference (PD)** • Understanding the concept of PD ○ $V = \frac{E}{Q}\ (Volt)$ **Electromotive Force (EMF)** • Understanding the concept of EMF • Difference between EMF and PD ○ $V_{EMF} = V_{PD} + V_r\ (Volt)$ **Internal Resistance** • What is Internal Resistance? • Advantages / disadvantages of Internal Resistance • Internal Resistance calculations ○ $\mathrm{E_{EMF}} = \mathrm{IR} + \mathrm{Ir}\ (\mathrm{Volt})$ ○ $\mathrm{R_{Total}} = \mathrm{R} + \mathrm{r}\ (\Omega)$
3		**Capacity and Power (VA) Rating** • Understanding the concept of Voltage Drop and Current Drain due to overload • Determine how long a battery will be able to deliver current to a load • Calculations: Ampere Hour ○ $Battery\ Capacity = I_{Charge} \times T_{Charge}(AH)$ **Practical:** Calculate internal resistance of a cell / battery in series with a resistor **Connecting Cells in Series** • Voltage and current rating ○ $V_T = V_1 + V_2 + \cdots V_n(V)$ ○ $I_T = I_1 = I_2 = \cdots I_n(A)$ **Practical:** Connect cells in series to form a battery. Measure voltage and current **Connecting Cells in Parallel** • Voltage and current rating ○ $V_T = V_1 = V_2 = \cdots V_n(V)$ ○ $I_T = I_1 + I_2 + \cdots I_n(A)$ • Safety considerations **Practical:** Connect cells in parallel to increase capacity. Measure voltage and current across different loads

Electronics Grade 10: Term 2		
WEEK	**Topic**	**CONTENT**
4	**Electronic Components**	**Introduction of Electronic Components** • What are electronic components? • Purpose of electronic components • Considerations when obtaining electronic components **Types of Components** • Switches (Functional operation, symbols) • SPST, SPDT, DPST, DPDT • Rotary Switch • Slide switches • Magnetic switches • Key switches • Applications and practical in simple circuits **Practical:** Identify/test/measure different electronic components
5		**The Capacitor** • Composition, construction, functional operation, symbols, characteristic curves and values • Basic principles of electrostatic charge: ○ $Q = CV\ (Coulomb)$ • Time constant ○ $t = RC\ (Seconds)$ ○ $T = 5RC\ (Seconds)$ • Charging rates and time constant including curves and calculations ○ $V_{Capacitor} = V_{Supply} \times 0.636\ (Volt)$ ○ $I_{Capacitor} = I_{Max} \times 0.364\ (Amp)$ • Graph • Application of capacitors in DC (Examples of smoothing circuit and RC time constant) • Capacitors in series ○ $\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \cdots \frac{1}{C_n}\ (Farad)$ • Capacitors in parallel ○ $C_T = C_1 + C_2 + \cdots C_n (Farad)$ **Practical:** Calculation of charge: $Q = CV$ **Practical:** Calculation of total capacitance in series (2, 3 and 4 capacitors) **Practical:** Calculation of total capacitance in parallel (2, 3 and 4 capacitors) **Practical:** Charging characteristics of the capacitor. Include drawing of graph from data

Electronics Grade 10: Term 2		
WEEK	**Topic**	**CONTENT**
6		**Protective Devices** • Fast Blow and Slow Blow fuses ➢ Basic working principle ➢ Construction and parts ➢ Testing **Diode** • Symbol • Diode as a polarised component • Forward Biasing (Concept only) • Reverse Biasing (Concept only) • Current flow through the diode • Voltage across the diode • Application as a rectifier **LED** • Symbol • LED as a polarized component • Forward Biasing (Concept only) • Reverse Biasing (Concept only) • Current flow through the diode • Voltage across the LED • The Series Resistor ○ $R_{Series} = \frac{V_T - V_{LED}}{I_{LED}} (\Omega)$
7		**Practical:** Test the diode and LED for correct function and polarity using a multimeter **Practical:** Calculate the value of the series resistor needed to protect an LED. Test the circuit on a breadboard using the calculated values **Practical:** Build a half wave rectifier using a diode and 50 Hz supply – display on Oscilloscope **Practical:** Build a full wave rectifier using a diode bridge (4 diodes / 2 Diodes) and 50 Hz supply – display on Oscilloscope
8 – 10	**Revision and Mid-year Exams**	**PAT Simulations 3 & 4 completed**

Electronics Grade 10: Term 3		
WEEK	**Topic**	**CONTENT**
1	**Logics**	**Introduction to Logics** • Digital and Analogue (Explain the difference) • The use of number systems in digital electronics • Decimal to Binary • Binary to Decimal • Addition and subtraction of Binary (Test in Decimal)
2		**Truth Table & Boolean Expression (IEC and American Symbols)** • Basic 2 input logic functions of: ➢ NOT ➢ AND ➢ NAND (Combination of AND gate and a NOT gate) ➢ OR ➢ NOR (Combination of OR and NOT) ➢ X-OR ➢ X-NOR • Equivalent circuits using switches to simulate gates **Practical:** Simulation of logic circuits using switches / relays **Practical:** Simulation of Logic gates using Logic ICs
3		**Diode Logic** • Principle of operation of Diode Logic • Equivalent circuit diagrams of Logic gates using Diode Logic **Practical:** Simulation of logic circuits using Diode Logic. AND, OR, NAND, NOR
4		**Combinational Circuits** • Definition of Combinational Circuits • Combinational Circuits using 2, 3 and 4 Operands • Truth Table & Boolean Expression (IEC and American symbols) • Basic 2-input logic functions of Combinational Circuits • AND / OR / NOT / NOR / NAND / XOR / XNOR • 4 x 2-input Gate Combinations maximum
5		**Practical:** Simulation of combinational logic circuits using Logic ICs **Practical:** Simulation of combinational logic circuits using Logic ICs

Electronics Grade 10: Term 3		
WEEK	**Topic**	**CONTENT**
6	**Communication Systems**	**Introduction to Communication Systems** • Purpose of communication systems • Types of communication systems (What are they?) • Commercial broadcasting (SABC, FM Radio and DSTV etc) • Commercial communication (Telephone systems, security companies, air traffic control, cell phones etc) • Community communication (Disaster management, emergency services, amateur radio, research etc) • Internet communication • Computer networks **Radio Communication – Basic Concepts of:** • A radio • An electromagnetic radio wave • Transmitter • Receiver • Feed line • Antenna • Interference & electromagnetic compatibility
7		**Principles of Modulation** • Frequency • Wavelength • Speed of radio frequency • Units of frequency
8		**The Radio Antenna** • The relationship between frequency and wavelength – No calculations • Types of radio antenna • Omni directional antenna 1/4λ • Dipole 1/2 λ • Directional antenna – Yagi-Uda array • Standing Wave Ratio (SWR) Good vs. bad SWR • Antenna Gain (Gain over an Isotropic antenna)
9		**Feed lines** • Basic concept and use of a feed line • Losses in feed lines (Basic concepts only) • Impedances of feed lines (50Ω vs. 75Ω) • How to fit an antenna connector to a feed line • Practical: Construct a simple 1/4 wave vertical antenna and fit a connector to a feed line
10		**Radio Wave Propagation** • Ground Wave propagation (Lower frequencies 0-3 MHz) • Sky Wave propagation (High frequency 3-50 MHz) • Line of Sight Propagation (Very high to ultra-high frequencies 50 MHz and up) **PAT Project completed and moderated**

Electronics Grade 10: Term 4		
WEEK	**Topic**	**CONTENT**
1	**Principles of Magnetism**	**Introduction to Magnetism** • Define Magnetism e.g. natural and electro-magnetism • Basic principles of Magnetism • Rules of Magnetism **Demonstration:** Magnetic fields around a permanent magnet using iron filings
2		**Magnetic Fields** • Magnetic Flux (Φ) • Flux Density(β) • Inductance (L) • Definition of an Inductor **Demonstration:** Oersted's Experiment (Screwdriver Rule)
3		**Types of Inductors and Inductor Cores** • Air Core • Laminated Core • Ferrite Core • Torroid Core **Demonstration:** Magnetic fields around a coil using iron filings **Demonstration:** Magnetic fields around a coil with and without a core **Calculations:** • Coils in series (Inductor) ○ $L_{Series} = L_1 + L_2 + \cdots L_n (Henry)$ • Coils in parallel (Inductor) ○ $\frac{1}{L_{Parallel}} = \frac{1}{L_1} + \frac{1}{L_2} + \cdots \frac{1}{L_n} (Henry)$ **Functional Operation and Application of Relays / Solenoids** • Symbol • Principal of operation • Construction of a relay • Parts of a relay • Normally open / Normally closed **Practical:** Testing a relay using a multimeter **Demonstration:** Wire a relay and light to a switch and operate the relay **Demonstration:** Latching Circuit with a relay

Electronics Grade 10: Term 4		
WEEK	**Topic**	**CONTENT**
4		**Introduction to a Simple Series DC Motor** • Basic parts of a DC motor • Current flow in a DC motor and direction of rotation • Flemings' Right Hand Rule • Armature • Yoke / Magnetic poles • Bearings / Bushes in endplates • Brushes • Commutation **Demonstration:** Show how the direction of rotation in DC motors can be changed
5	Revision Term 1	
6	Revision Term 2	
7	Revision Term 3	
8 – 10	Examination	

3.2.2 Electronics: Grade 11

Electronics Grade 11: Term 1		
WEEK	**Topic**	**CONTENT**
1	**Occupational Health and Safety**	**Occupational Health and Safety** • Basic introduction to regulations ➢ What are regulations? ➢ How to use regulations ➢ Impact of regulations on the workshop ➢ Introduction and purpose of the regulations • General Machinery Regulations 1988 ➢ Supervision of machinery ➢ Safeguarding of machinery ➢ Operation of machinery ➢ Working on moving or electrically alive machinery ➢ Devices to start and stop machinery ➢ Reporting of incidents in connection with machinery • Electrical Machinery Regulations 1988 ➢ Safety equipment ➢ Electrical control gear ➢ Switchboards ➢ Portable electric tools ➢ Earthing ➢ Conductors **Safety** • What is Ergonomics? (Workplace Conditions / Comfort – Everything has a place and everything is in its place) • Unsafe actions • Unsafe conditions • Dangerous practices • Housekeeping principles • Signs in the workshop • Information signs • Safety signs • Prohibition signs • Fire Safety signs • Regulatory signs • Designated areas • Practical: Identification of safety signs and safety gear • Revision of emergency procedures (Grade 10) **Practical:** Clean the workshop (Weekly activity)

Electronics Grade 11: Term 1		
WEEK	**Topic**	**CONTENT**
		Personal Safety • Protective gear for machinery • Personal protection equipment • Eye protection • Coveralls / Overalls • Hearing protection **Practical:** Use personal protection equipment (During practical sessions) **Chemical Safety** (Printed Circuit Board manufacturing) • Revision of Grade 10 PCB methods and safety **Practical:** Etch a PCB (Part of PAT completion)

Electronics Grade 11: Term 1		
WEEK	**Topic**	**CONTENT**
2	**Tools and Measuring Instruments**	**Tools** • Re-visit safe use of hand tools • Crimping tool (Ferrules, lugs & plugs) **Safe use of Power Tools** • Grinder – Bench / Angle • Jigsaw – Bench / Handheld • Power Drill / Drill stand (Revision) **Connectors** • Ferrules, lugs & plugs (Related to area of specialisation) • Single In line connectors (Push In connectors) **Skills** (Skills are developed throughout the year during practical sessions): • Safe use of tools • Correct use of tools • Intermediate soldering / de-soldering skills (Using a solder wick) • Intermediate Printed Circuit Board Manufacturing skills (Design & make) • Cleaning and tidying the workshop after practical (Housekeeping) • Keeping the storeroom neat and tidy **Practical:** Practice of safe housekeeping practices and methods **Testing Equipment** • Line Tester, Clamp Meter & Power Factor Meter ➢ External parts and their functions ➢ Principle of operation ➢ Application ➢ Care ➢ Maintenance • Function Generator and Oscilloscope ➢ External parts and their functions ➢ Principle of operation ➢ Application ➢ Care ➢ Maintenance • Calculations on the Oscilloscope ➢ Time ➢ Frequency ➢ Phase difference ➢ Maximum value
		Practical: Measure voltage and current with a multimeter **Practical:** Conduct insulation test on an electrical motor between coil and chassis **Practical:** Basic use of the oscilloscope to display waveforms taken from the function generator **Practical:** Determine voltage and frequency values as displayed on Oscilloscope (Note: Oscilloscope does not measure and display current)

Electronics Grade 11: Term 1		
WEEK	**Topic**	**CONTENT**
3	**Waveforms**	**Introduction to Waveforms** • Uses of waveforms • Different types of waves • Waveforms and their applications • Square Wave • Saw tooth Wave • Triangular Wave • Rectangular Wave • Radio Wave **Definition, Symbol & Unit of:** • The Sinusoidal Wave ➢ Instantaneous value ➢ Maximum value / Minimum value ➢ Peak to peak value ➢ RMS value Vrms = 0.707 x Em ➢ Average value over half cycle (Vavg = Vmax x 0.637) ➢ Time period ➢ Frequency ➢ Duty cycle ➢ Form factor ➢ Concept of Phase and Phase difference ➢ Harmonic frequencies (Concept only) • Difference between a sound wave and an electromagnetic wave (Concept only – self propagating vs. medium needed) • Electromagnetic waves (Concept only – combination of electrical and magnetic wave – unique characteristics) • Speed of Radio waves • Frequency and wavelength **Demonstration:** Function Generator and the Oscilloscope used to measure and display waveforms
4		**Pulse Technique** • Pulse polarity • Pulse time • Rise time / Fall time • What is a clock pulse, leading edge, trailing edge? **Calculations** • Pulse time • Pulse frequency • Rise time • Fall time • Period and frequency • λ (wavelength) & frequency **Practical:** Set up and measure different waveforms generated by the function generator on the Oscilloscope

Electronics Grade 11: Term 1		
WEEK	**Topic**	**CONTENT**
5		**Wave Shaping Circuits** • Diode using discrete components only • Clipping Circuits (Positive Clipping only) ➢ Simple Series ➢ Series Biased ➢ Simple Parallel ➢ Biased Parallel
6		• Clamping Circuits (Positive clamping only) ➢ Clamping Circuit – Diode ➢ Clamping Circuit – Zener Diode • Integrator & Differentiator ➢ No calculations ➢ Input and output waveforms on oscilloscope ➢ Construction on breadboard ➢ Measurement of output waveform **Practical:** Construct each type of clipping and clamping circuit on breadboard using diodes
7	**RLC**	**Effect of Alternating Current on Resistors, Inductors and Capacitors (RLC)** • Components in series circuits 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 • Inductive Reactance ○ $X_L = 2\pi fL\ (\Omega)$ • Capacitive Reactance ○ $X_C = \frac{1}{2\pi fC}\ (\Omega)$ • Effect of frequency changes on XL and XC **Demonstration:** Show phase difference between RL and RC
8		• Impedance ○ $Z = \sqrt{R^2 + (X_L - X_C)^2}\ (\Omega)$ • Scalar: Representation of the Impedance Triangle • Power ○ $P = V \times I \cos\ \theta\ \ (Watt)$ • Power Factor ○ $\cos\theta = \frac{R}{Z}$ ○ $\cos\theta = \frac{V_R}{V_Z}$ • Phase Angle ○ $\theta = \cos^{-1}\frac{R}{Z}\ (Deg)$ ○ $\theta = \cos^{-1}\frac{V_R}{V_Z}\ (Deg)$

Electronics Grade 11: Term 1		
WEEK	**Topic**	**CONTENT**
9		• Natural Resonance • Effect of frequency changes on the impedance and current flow • Resonance with its characteristic curves ○ $f_r = \frac{1}{2\pi\sqrt{LC}}(Hertz)$ • Q Factor ○ $q = \frac{1}{R}\sqrt{\frac{L}{C}}$ ○ $q = \frac{X_L}{R}\ (X_L is\ taken\ at\ Resonance)$ ○ $q = \frac{X_C}{R}\ (X_C is\ taken\ at\ Resonance)$ • Bandwidth ○ $BW = \frac{f_r}{q}(Hertz)$ • Frequency changes
10		**Calculations** • Series combination circuits containing ONE resistor, ONE capacitor and ONE inductor • Phasor and wave representation • Resonance • Bandwidth • Q Factor **PAT Simulations 1 & 2 completed**

Electronics Grade 11: Term 2		
WEEK	**Topic**	**CONTENT**
1	**Semiconductor Devices**	**Introduction to Semiconductor Devices** • Component data • Where to source data on all types of electronic components • How to read a data sheet • Pin configuration • Typical operating values • Working temperature • Equivalent components • Packages (Dual In Line, TO 92, basic packages) • Through-hole components vs. surface mount devices **Semiconductors** • Electron flow vs. Conventional flow • Semiconductors & solid state • Silicon vs. Germanium • Doping • P & N material • Majority carriers / Minority carriers
2		**PN Diode** • Construction of a PN Diode • Depletion layers • Biasing – forward and reverse • Characteristic curve & symbol • Calculation of Diode Load Line **Practical:** The Diode Load Line **Zener Diode** • Construction • Principle of operation • Forward Biasing • Reverse Biasing • Avalanche breakthrough vs. controlled breakthrough • Zener as a voltage regulator • Characteristic curve & symbol • Zener calculations **Practical:** Determine the value of the series resistor for a Zener diode

Electronics Grade 11: Term 2		
WEEK	**Topic**	**CONTENT**
3		**The NPN Transistor** • Construction • Principle of operation • Purpose of Biasing & Thermal Runaway • Forward Biasing • Reverse Biasing • Base Curve • Emitter Output Curve • Regions of operation (Saturation, active and off) • The Transistor DC Load Line • Transistor power related to the load line (Vcc and Vce) • Influence of the DC Load Line on the characteristics of the transistor • Symbol **Application of Transistors** • Transistor as a switch • Transistor as an amplifier (Mention only – circuits to follow under amplifiers) • Transistor Gain • Current Gain • Voltage Gain **Practical:** Determine the DC Load line of a transistor **Practical:** Build a circuit using the transistor as a switch
4		**The PNP Transistor** • Construction • Principle of operation • Relation to NPN • Symbol • Application – Sample circuits only **Practical:** Build a circuit using the transistor as a switch
5		**Thyristor – SCR** • Construction • Principle of operation • Purpose of Biasing • Symbol • Characteristic curves • Application (Relaxation Oscillator, Phase control, Switch mode applications, DC-DC Converter [buck/boost]) • Circuit diagram **Practical:** Construct a Relaxation Oscillator and show waveform on oscilloscope **Practical:** Construct a light dimmer circuit

Electronics Grade 11: Term 2		
WEEK	**Topic**	**CONTENT**
6		**TRIAC** • Construction • Principle of operation • Purpose of Biasing • Symbol • Characteristic curves • Application (Relaxation Oscillator, Phase control, Switch mode applications, DC-DC Converter [buck/boost]) • Circuit diagram **Practical:** Construct a light dimmer circuit
7		**DIAC** • Construction • Principle of operation • Purpose of Biasing • Symbol • Characteristic curves • Application (Relaxation Oscillator, Phase control, Switch mode applications, DC-DC Converter [buck/boost]) • Circuit diagram application
8 – 10	**Second Term Examinations**	PAT Simulations 3 & 4 **completed**

Electronics Grade 11: Term 3		
WEEK	**Topic**	**CONTENT**
1	**Power Supplies**	**DC Power Supplies** • Concept of transformation • Rectification (half wave and full wave) ➢ Waveforms ➢ Circuit construction (Practical) ➢ Representation of waves on Oscilloscope
2		**Filtering (Ripple Factor, C, LC) and waveforms** • Block diagram • Circuit diagram and construction of a filter on breadboard • Representation of waves on Oscilloscope • Ripple Factor
3		**Voltage Regulation** (Series & shunt regulation using Zener Diode and transistor) • Circuit diagram • Waveforms • Measurement with multimeter • Zener calculations of the series resistor **Practical:** Connect a series regulator circuit on a breadboard **Practical:** Connect a shunt regulated circuit on a breadboard

Electronics Grade 11: Term 3		
WEEK	**Topic**	**CONTENT**
4	**Amplifiers**	**Introduction to Amplifiers** • Definition of an amplifier • Types of amplifiers (Class A, B, AB and C) using transistors • Principle of operation of a transistor amplifier • Connection • Characteristics • Circuit diagrams **Input and output signals of:** • Common Base (no biasing) • Common Collector (no biasing) • Common Emitter (with different types of biasing)
5		**Biasing of transistor amplifiers** • Types of biasing applied to the Common Emitter amplifier ➢ Fixed Base Biasing • Simple circuit diagram • Advantages & disadvantages • Collector feedback biasing • Basic circuit diagram • Advantages & disadvantages
6		• Voltage Divider Biasing ➢ Circuit diagram ➢ Function of components in the circuit ➢ Advantages & disadvantages **Calculation of:** • Transistor DC Load Line (Common Emitter amplifier with fixed current biasing) • Reference to regions of operation as well as Vcc and Vce • The interpretation of a load line in conjunction with an AC signal (active region) to determine the values of the base and collector current, using emitter output curve to derive amplification classes • Influence of DC biasing on the load line and Q point
7		**Feedback in Amplifiers** • What is feedback? (Applications & purpose) • Negative feedback (Basic Introduction only – block diagrams) ➢ Advantages and disadvantages ➢ Reasons for using negative feedback ➢ Applications of negative feedback • Positive feedback ➢ Advantages and disadvantages ➢ Reasons for using positive feedback ➢ Applications of positive feedback
8		**The Common Emitter Amplifier** • Input waveform • Output waveform • Breadboard construction • Representation of waves on Oscilloscope **Practical:** Class A Audio amplifier (Construction, testing & measurement)

Electronics Grade 11: Term 3		
WEEK	**Topic**	**CONTENT**
9	**Sensors and Transducers**	**Introduction to Sensors and Transducers** • Definition of sensors and transducers • Piezo Electric Effect • Wheatstone bridge principles of resistance measurement **Functional operation of Sensors and Transducers:** • Sound ➢ Dynamic Microphone ➢ Electret Microphone **Practical:** Connect a microphone to an amplifier and the output of the amplifier to an oscilloscope and display on screen • Light ➢ The LDR ➢ Photodiode ➢ Phototransistor ➢ Opto-coupler **Practical:** Use a Wheatstone bridge with a sensor to show changes in light
10		• Temperature ➢ The Thermistor ➢ Thermocouple – Working principle and special conditions for use (Not a linear resistive output – to be used with a lookup table) **Practical:** Use a Wheatstone bridge with a sensor to show changes in temperature Other types of sensors – application only • Gas / Humidity sensor • Load cells / Strain sensors • Proximity sensors **Practical:** Use a Wheatstone bridge with a sensor to show changes in proximity of metal / humidity **PAT Project completed and moderated**

Electronics Grade 11: Term 4		
WEEK	**Topic**	**CONTENT**
1	**Communication Systems**	**The Role of Tuned Circuits in Communication Electronics** • Tuned circuits • Natural Oscillation • The LC Tuned Circuit as heart of the oscillator • The need for positive feedback in an oscillator • The crystal as a highly stable tuned circuit (Piezo Electric Effect) • Types of Oscillators – Block diagrams and basic principle of operation only • The Variable Frequency Oscillator (VFO) • The Voltage Controlled Oscillator (VCO) • The Phase Locked Loop (PLL) **Practical:** Simulate an RC oscillator and display wave on oscilloscope
2		**Transmitters and Receivers** • Basic principle of operation • What is modulation? • Waveforms • Block diagrams • Principle of operation • Types of modulation & related devices ➢ Continuous Wave modulation (CW) ➢ CW (Morse Code) Transmitter ➢ Regenerative Receiver ➢ Amplitude Modulation (AM) ➢ The AM Transmitter ➢ The AM Receiver
3		• Single Sideband Suppressed Carrier Modulation (SSB) • The SSB Transmitter • The Super Heterodyne Receiver • Frequency Modulation (FM) • The FM Transmitter • The FM Receiver • Frequency Shift Keying (FSK)
4		**Demonstration:** Construction of a Simple Radio Receiver **Practical:** Build an FM Transmitter and test using an FM receiver
5	**Revision Term 1**	
6	**Revision Term 2**	
7	**Revision Term 3**	
8 – 10	**Examination**	

3.2.3 *Electronics: Grade 12*

Electronics Grade 12: Term 1		
WEEK	**Topic**	**CONTENT**
1	**Occupational Health and Safety**	**OHS ACT** • Definitions • Purpose of the act • General duties of employers to their employees • General duties of employers and self-employed persons to persons other than their employees • General duties of manufacturers and others regarding articles and substances for use at work • Duty to inform • General duties of employees at work • Duty not to interfere with, damage or misuse things • Functions of health and safety representatives • Report to inspector regarding certain incidents • Victimization forbidden • Offences, penalties and special orders of court **Safety Revision** • Unsafe actions • Unsafe conditions • Dangerous practices • Risk analysis • Human rights in the workplace • Work ethics • Revision of emergency procedures (Grade 10) **Practical:** Use personal protection equipment (During practical sessions) **Practical:** Clean the workshop (Weekly activity throughout the year) **Chemical Safety** (Printed Circuit Board Manufacturing) • Revision of Grade 10 & PCB methods and safety done as part of PAT **Practical:** Etch a PCB (Part of PAT completion during the year)
2	**RLC**	Effect of alternating current on R, L and C components in series (revision of Grade 11) and parallel circuits • Concepts handled both in theory and practical experiments
3		• Inductive Reactance ○ $X_L = 2\pi fL\ (\Omega)$ • Capacitive Reactance ○ $X_C = \frac{1}{2\pi fC}\ (\Omega)$

Electronics Grade 12: Term 1		
WEEK	**Topic**	**CONTENT**
4		• Impedance ○ $Z_{Series} = \sqrt{R^2 + (X_L - X_C)^2}\ (\Omega)$ ○ $Z_{Parallel} = \frac{V_T}{I_T}(\Omega)$ • Power ○ $P = V \times I \cos\ \theta\ (Watt)$ • Phase Angle ➢ Series RLC ▪ $\theta = \cos^{-1}\frac{R}{Z}\ (Deg)$ ▪ $\theta = \cos^{-1}\frac{V_R}{V_Z}\ (Deg)$ ➢ Parallel RLC ▪ $\theta = \cos^{-1}\frac{I_R}{I_Z}\ (Deg)$ • Power Factor ➢ Series RLC ▪ $\cos\theta = \frac{R}{Z}$ ➢ Parallel RLC ▪ $\cos\theta = \frac{I_R}{I_Z}$ • Phasor and wave representation • Investigate practical implications and applications of RLC • Resonance with its characteristic curves ○ $f_r = \frac{1}{2\pi\sqrt{LC}}(Hertz)$ • Q Factor ○ $q = \frac{1}{R}\sqrt{\frac{L}{C}}$ ○ $q = \frac{X_L}{R}\ (X_L is\ taken\ at\ Resonance)$ ○ $q = \frac{X_C}{R}\ (X_C is\ taken\ at\ Resonance)$ • Bandwidth ○ $BW = \frac{f_r}{q}(Hertz)$
5		**Calculations** • Series and parallel combination circuits containing ONE resistor, ONE capacitor and ONE inductor • Frequency changes
6		• Phasor and wave representation • Resonance • Phasor diagram **Demonstration:** Show the effect of changing frequency in an RLC circuit toward resonance

Electronics Grade 12: Term 1		
WEEK	**Topic**	**CONTENT**
7	**Semiconductor Devices**	**The Field Effect Transistor** • Basic construction, symbols, functional operation, characteristics • Types of FET (NFET, JFET, MOSFET) • Characteristic curves & typical operating voltages • Application as a switch • Application as an amplifier **Practical:** Construct an amplifier using an FET
8		**Unijunction and Darlington Transistor** • Basic construction, symbols, functional operation, characteristics • Characteristic curves & typical operating voltages • Application as a switch • Application as a Saw Tooth generator • Application as an amplifier **Practical:** Construct a Saw Tooth generator on a breadboard and display the waveform on an oscilloscope
9		**Introducing Integrated Circuits** • Integrated Circuits – the 741 Op-Amp ➢ Basic construction, symbol, functional operation ➢ Typical operating voltages ➢ Characteristics of an ideal Op-Amp & application as an amplifier ➢ Gain: Open Loop and Closed Loop gain ➢ Application as an Inverting Amplifier ➢ Application as a Non-inverting Amplifier **Calculations** • Inverting Amplifier ○ $Vout = Vin(-Rf/Rin)$ • Non-inverting Amplifier ○ $Vout = Vin(Rf/Rin + 1)$ • Gain ○ $Av = Rf/Rin$ **Practical:** Build a non-inverting amplifier on a breadboard using a 741 Op-Amp. Use a Function Generator and Oscilloscope to show input and output waveforms
10		• Integrated Circuits – the 555 Timer ➢ Basic construction, symbol, functional operation ➢ Characteristic curves & typical operating voltages ➢ Application as a timer **Practical:** Build a clock pulse generator using a 555 Timer IC on a breadboard and display the output on an oscilloscope **PAT Simulations 1 & 2 completed**

Electronics Grade 12: Term 2		
WEEK	**Topic**	**CONTENT**
1	**Switching Circuits**	**Principle of Operation of Switching Circuits using Operational Amplifiers and Timers** • Multivibrators ➢ Bistable Multivibrator • Circuit diagram and operation • Measurement of input and output waveforms **Practical:** Construct a Bistable Multivibrator on a breadboard using a 741 Op-Amp / 555 Timer with LEDs
2		• Mono-stable Multivibrator ➢ Circuit diagram and operation ➢ Measurement of input and output waveforms **Practical:** Construct a Mono-stable Amplifier on a breadboard using a 741 Op-Amp / 555 Timer and LEDs
3		• Astable Multivibrator ➢ Circuit diagram and operation ➢ Measurement of input and output waveforms **Practical:** Construct an Astable Amplifier on a breadboard using a 741 Op-Amp / 555 Timer and show output using LEDs and the Oscilloscope
4		• Schmidt Trigger ➢ Circuit diagram and operation ➢ Display the input waveform in relation to the output waveform on the Oscilloscope **Practical:** Construct a Schmidt Trigger on a breadboard using a 741 Op-Amp
5		• Comparator and Summing Amplifier ➢ Circuit diagram and operation ➢ Display the input waveform in relation to the output waveform on the Oscilloscope ➢ Calculations: ▪ $Vout = Vin\ x\ Gain$ ▪ $Vout = Vin1\ x\ \left(\frac{Rf}{Rin1}\right) + Vin2\ x\ \left(\frac{Rf}{Rin2}\right) \ldots . + VinN\ x\ \left(\frac{Rf}{RinN}\right)$ ➢ Measurement of input and output waveform
6		**Practical:** Construct a comparator on a breadboard using a 741 Op-Amp **Practical:** Construct a summing amplifier on a breadboard using a 741 Op-Amp
7		• Differentiator and Integrator ➢ Circuit diagram and operation ➢ Display the input waveform in relation to the output waveform on the Oscilloscope ➢ Influence of time constant on the output waveform **Practical:** Construct a differentiator on a breadboard using a 741 Op-Amp **Practical:** Construct an integrator on a breadboard using a 741 Op-Amp

Electronics Grade 12: Term 2		
WEEK	**Topic**	**CONTENT**
8 – 10	Mid-year Examinations	**PAT Simulations 3 & 4 completed**

Electronics Grade 12: Term 3		
WEEK	**Topic**	**CONTENT**
1	**Amplifiers**	**Amplifier Theory** • Determination of a typical load line by means of Ohm's Law (Revision) • Basic concept of class A, B and C amplifiers AB • Principles of negative feedback / the Decibel and Log
2		**Resistor Capacitor Coupled Amplifier (NPN Transistor)** • Basic operation • Circuit diagram & practical • Input and output curves • Frequency Response curve • Gain & loss in decibel calculations **Practical:** Construct a two stage RC Coupled amplifier on a breadboard and show the input in relation to the output of the different stages
3		**Transformer Coupled Amplifier (NPN Transistor)** • Basic operation • Circuit diagram • Input and output curves • Frequency Response curve
4		**Push Pull Amplifier (NPN / PNP Transistor)** • Basic operation • Circuit diagram & practical • Input and output curves • Frequency Response curve • Gain & loss in decibel calculations • Typical biasing
5		**Radio Frequency Amplifier** • Basic operation • Circuit diagram • Input and output curves • Frequency Response curve • Typical biasing **Practical:** Construct a simple RF Amplifier
6		**Hartley and Colpitts Oscillator (NPN or FET Transistor)** • Basic operation • Circuit diagram • Output waveform • Tank Circuit **Practical:** Construct a Hartley or Colpitts Oscillator on a breadboard and show the output wave on an oscilloscope

Electronics Grade 12: Term 3		
WEEK	**Topic**	**CONTENT**
7		**RC Phase Shift Oscillator (NPN or FET Transistor)** • Basic operation • Circuit diagram • Output waveform • Tank Circuit **Practical:** Construct an RC Phase Shift Oscillator on a breadboard and show the output wave on an oscilloscope
8 – 10	**Preparatory Examination**	PAT Project **completed and moderated**

Electronics Grade 12: Term 4		
WEEK	**Topic**	**CONTENT**
1	**Revision Term 1**	**Occupational Health and Safety** **RLC** **Semiconductor Devices**
2	**Revision Term 2**	**Switching Circuits**
3	**Revision Term 3**	**Amplifiers**
4 - 10	**National Senior Certificate**	**All**

3.3 Content Outline per Term: Digital

3.3.1 Digital: Grade 10

Digital Grade 10: Term 1		
WEEK	**Topic**	**CONTENT**
1	**Occupational Health and Safety**	**Responsibilities** • What are your rights in the workshop? • What are your responsibilities in the workshop? **General Workshop Rules** • Housekeeping (Health hazards, safety hazards, workshop layout, workshop management) **Workshop Safety** • Unsafe acts • Unsafe conditions • Walkways (Colour codes), store areas, other designated areas • Information and safety signs • Signs in the workshop • Information signs • Safety signs • Prohibition signs • Fire Safety signs • Regulatory signs **Note:** Clean the workshop on a weekly basis **Emergency Procedures** • Placement of the Master Switch • Critical versus non-critical emergencies • Medical emergencies • Electrical shock / Electrocution procedures • Evacuation procedures • Principles of fire fighting **Practical:** Perform an evacuation exercise for the workshop
2		**Basic First Aid** • What is HIV/AIDS and infectious disease? • How are diseases transferred? • What to do when someone is bleeding • What to do when someone has been burnt • What to do in case of electrical shock • How to administer CPR **Practical:** Perform a first aid exercise (Choose a topic from basic first aid) **Chemical Safety** (Printed Circuit Board Manufacturing) • Personal protection equipment • Handling chemicals (Mixing of chemicals, disposing of chemicals, corrosive chemicals) • Where to work with chemicals (Ventilation, lighting, designated area) • Chemical processes in making PCBs (Preparing PCBs, developing the circuitry, etching the board, protecting the board) • Environmental considerations

Digital Grade 10: Term 1		
WEEK	**Topic**	**CONTENT**
3	**Tools and Measuring Instruments**	**Identification of the Parts, Functions of Parts, Care, Maintenance, Correct and Safe Use of the following Tools:** • Screwdrivers (Flat and Phillips) • Files (Flat, Square, Round, Triangular and Half round) • Side Cutter • Long Nose pliers • Combination pliers • Wire Stripper • Utility Knife • Soldering Iron • Solder Sucker • Electric Hand Drill / Drill Press / PCB Drill (Dremel) • Hack Saw (Junior Hack Saw) • Breadboard • Fish Tape / Draw Wire • Bending Spring
4		**Practical Skills and Techniques** (These skills will be practiced in this week and honed throughout the year) • Safe and correct use of tools (Choose at least 4 specific tools on which skills will be practiced) • Introductory soldering / de-soldering skills • Introductory Printed Circuit Board Manufacturing skills
5		**Safe Use and Care of Instruments** (These skills will be practiced in this week and honed throughout the year) • Continuity Tester • Analog Multimeter (Focus on demonstrations) • Digital Multimeter • Megger / Insulation Tester • The Oscilloscope (Teacher to set up instrument) **Practical:** Conduct simple continuity tests using the multimeter
6	**Basic Principles of Electricity**	**Atomic Theory** – Theory of current flow (Electron flow vs. Conventional current flow) – Resistive characteristics of different materials – Conductors, semiconductors, insulators – What is a conductor / semiconductor / insulator? – 2-3 examples of each and their characteristics. No further theory needed – A wire is a conductor, but not all conductors are made of wire (Electrical shock and safety) – Types of materials used as conductors: copper, aluminium, gold, silver, steel and nickel chrome wire – Specific resistance (No calculations) – Negative and positive temperature coefficient. (No calculations)

Digital Grade 10: Term 1		
WEEK	**Topic**	**CONTENT**
7		**The Resistor** • What is a resistor? • Composition of a resistor • Types of resistors • Tolerance (Indicated value vs. measured value) (2% and 5%) • Colour code of resistors (4 band and 5 band resistors) • Power vs. size (1/8W, 1/4W, 1/2W, 2W and 5W) • Measuring the value of resistors • Calculating the value of resistors • Potentiometer (Construction, functional operation, symbols) • Rheostat (Difference between a Potentiometer and Rheostat (Construction, functional operation, symbols)
8		**Ohms Law** • Ohm's Law: $V = IR\ (\Omega)$ • Verify Ohm's Law with calculations • Pay attention to prefixes and unit conversions **Series Circuit as Voltage Divider** • Kirchhoff's Voltage Divider: ○ $V_T = V_1 + V_2 \ldots + V_n\ (V)$ **Parallel Circuit as a Current Divider** • Kirchhoff's Current Divider (combination circuits with calculations): ○ $I_T = I_1 + I_2 \ldots + I_n\ (A)$
9		**Series / Parallel Circuits** • Calculations on combination circuits containing: ➢ 1 x Series and 2 x Parallel ➢ 2 x Series and 2 x Parallel ➢ 3 x Series and 3 x Parallel **Practical:** Measure voltage and current in a Series / Parallel Circuit ➢ 1 x Series and 2 x Parallel ➢ 2 x Series and 2 x Parallel ➢ 3 x Series and 3 x Parallel
10		**Power** • Definition of Power • Power calculations: ○ $P_T = VI\ (W)$ ○ $P_T = I^2R\ (W)$ ○ $P_T = \frac{V^2}{R}\ (W)$ **Practical:** Apply power calculations to Series / Parallel circuits **PAT Simulations 1 & 2 completed**

Digital Grade 10: Term 2		
WEEK	**Topic**	**CONTENT**
1	**Power Sources**	**Energy** • What is energy? • Primary source of energy (The Sun) • Sources of energy (Wind, Sun, Coal, Nuclear, Geothermal, Hydro) • Storing energy (Ways in which energy can be conserved / stored) **The Electrical Cell** • The Voltaic Cell • Operation of the Voltaic Cell • Diagram of the cell • Advantages / disadvantages **Primary Cells vs. Secondary Cells** • Lead Acid Battery • Principal of operation • Basic construction • Advantages / disadvantages • Applications • Safety considerations • Lithium Ion (Li-Ion) or Lithium Polymer (Li-Po) Battery • Principal of operation • Basic construction • Advantages / disadvantages • Applications • Safety considerations

Digital Grade 10: Term 2		
WEEK	**Topic**	**CONTENT**
2		**Alternative Energy** • Solar / Photovoltaic Cell ➢ Symbol ➢ Basic Principal of operation ➢ Basic construction / composition ➢ Advantages / disadvantages ➢ Functional application • Solar Cell vs Solar Panel • Generating electricity from the Sun • Reasons for using regulators • Reasons for using batteries with solar panels • Block diagram of a solar electricity generation system for domestic use **Potential Difference (PD)** • Understanding the concept of PD ○ $V = \frac{E}{Q}(Volt)$ **Electromotive Force (EMF)** • Understanding the concept of EMF • Difference between EMF and PD **Internal Resistance** • What is internal resistance? • Advantages / disadvantages of internal resistance • Internal resistance calculations ○ $E = IR + Ir$
3		**Capacity and Power (VA) Rating** • Understanding the concept of voltage drop and current drain due to overload • Determine how long a battery will be able to deliver current to a load • Calculations: Ampere Hour ○ $Battery\ Capacity = I_{Charge} \times T_{Charge}(AH)$ **Practical:** Calculate internal resistance of a cell / battery in series with a resistor **Connecting Cells in Series** • Voltage and current rating ○ $V_T = V_1 + V_2 + \cdots V_n(V)$ ○ $I_T = I_1 = I_2 = \cdots I_n(A)$ **Practical:** Connect cells in series to form a battery. Measure voltage and current **Connecting Cells in Parallel** • Voltage and current rating ○ $V_T = V_1 = V_2 = \cdots V_n(V)$ ○ $I_T = I_1 + I_2 + \cdots I_n(A)$ • Safety considerations **Practical:** Connect cells in parallel to increase capacity. Measure voltage and current across different loads

Digital Grade 10: Term 2		
WEEK	**Topic**	**CONTENT**
4	**Electronic Components**	**Introduction of Electronic Components** • What are electronic components? • Purpose of electronic components • Considerations when obtaining electronic components **Types of Components** • Switches (Functional operation, symbols) • SPST, SPDT, DPST, DPDT • Rotary Switch • Slide switches • Magnetic switches • Key switches • Applications and practical in simple circuits **Practical:** Identify / test / measure different electronic components
5		**The Capacitor** • Composition, construction, functional operation, symbols, characteristic curves and values • Basic principles of electrostatic charge: ○ $Q = CV\ (Coulomb)$ • Time constant ○ $t = RC\ (Seconds)$ ○ $T = 5RC\ (Seconds)$ • Charging rates and time constant including curves and calculations • Graph • Application of capacitors in DC (Examples of smoothing circuit and RC Time constant) • Capacitors in series ○ $\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \cdots \frac{1}{C_n}\ (Farad)$ • Capacitors in parallel ○ $C_T = C_1 + C_2 + \cdots C_n (Farad)$ **Practical:** Calculation of charge: $Q = CV$ **Practical:** Calculation of total capacitance in series (2, 3 and 4 capacitors) **Practical:** Calculation of total capacitance in parallel (2, 3 and 4 capacitors) **Practical:** Charging characteristics of the capacitor. Include drawing of graph from data

Digital Grade 10: Term 2		
WEEK	**Topic**	**CONTENT**
6		**Protective Devices** • Fast Blow and Slow Blow fuses ➢ Basic working principles ➢ Construction and parts ➢ Testing **Diode** • Symbol • Diode as a polarised component • Forward Biasing (Concept only) • Reverse Biasing (Concept only) • Current flow through the diode • Voltage across the diode • Application as a rectifier **LED** • Symbol • LED as a polarized component • Forward Biasing (Concept only) • Reverse Biasing (Concept only) • Current flow through the diode • Voltage across the LED • The Series Resistor ○ $R_{Series} = \frac{V_T - V_{LED}}{I_{LED}} (\Omega)$
7		**Practical:** Test the Diode and LED for correct function and polarity using a multimeter **Practical:** Calculate the value of the series resistor needed to protect an LED. Test the circuit on a breadboard using the calculated values **Practical:** Build a half wave rectifier using a diode and 50 Hz supply – Display on Oscilloscope **Practical:** Build a full wave rectifier using a diode bridge (4 diodes / 2 diodes) and 50 Hz supply – Display on Oscilloscope
8 – 10	**Revision and Mid-year Exams**	PAT Simulations 3 & 4 **completed**

Digital Grade 10: Term 3		
WEEK	**Topic**	**CONTENT**
1	**Logics**	**Introduction to Logics** – Digital and Analogue (Explain the difference) – The use of number systems in digital electronics – Decimal to Binary – Binary to Decimal – Addition and subtraction of Binary (Test in Decimal)
2		**Truth Table & Boolean Expression** (IEC and American Symbols) • Basic 2 input logic functions of: ➢ NOT ➢ AND ➢ NAND (Combination of AND gate and a NOT gate) ➢ OR ➢ NOR (Combination of OR and NOT) ➢ X-OR ➢ X-NOR • Equivalent circuits using switches to simulate gates **Practical:** Simulation of logic circuits using switches / relays **Practical:** Simulation of Logic gates using Logic ICs
3		**Diode Logic** • Principle of operation of Diode Logic • Equivalent circuit diagrams of Logic gates using Diode Logic **Practical:** Simulation of logic circuits using Diode Logic. AND, OR, NAND, NOR, X-NOR
4		**Combinational Circuits** • Definition of combinational circuits • Combinational circuits using 2, 3 and 4 Operands • Truth Table & Boolean Expression (IEC and American Symbols) • Basic 2 input logic functions of combinational circuits • AND/OR/NOT/NOR/NAND / XOR / XNOR • 4 x 2-input Gate combinations maximum
5		**Practical:** Simulation of combinational logic circuits using Logic ICs **Practical:** Simulation of combinational logic circuits using Logic ICs

Digital Grade 10: Term 3		
WEEK	**Topic**	**CONTENT**
6	**Communication Systems**	**Introduction to Communication Systems** • Purpose of communication systems • Types of communication systems (What are they?) • Commercial broadcasting (SABC, FM radio and DSTV etc) • Commercial communication (Telephone systems, security companies, air traffic control, cell phones etc) • Community communication (Disaster management, emergency services and amateur radio, research etc) • Internet communication • Computer networks **Radio Communication** • Basic Concepts of: ➢ A radio ➢ An electromagnetic radio wave ➢ Transmitter ➢ Receiver ➢ Feed line ➢ Antenna ➢ Interference & electromagnetic compatibility
7		**Principles of Modulation** • Frequency • Wavelength • Speed of radio frequency • Units of frequency
8		**The Radio Antenna** • The relationship between frequency and wavelength – No calculations • Types of radio antenna • Omni directional antenna 1/4λ • Dipole 1/2 λ • Directional antenna – Yagi-Uda array • Standing wave ratio (SWR) – Good vs. bad SWR • Antenna gain (Gain over an Isotropic antenna)
9		**Feed Lines** • Basic concept and use of a feed line ➢ Losses in feed lines (Basic concepts only) ➢ Impedances of feed lines (50Ω vs. 75Ω) • How to fit an antenna connector to a feed line **Practical:** Construct a simple 1/4 wave vertical antenna and fit a connector to a feed line
10		**Radio Wave Propagation** • Ground wave propagation (Lower frequencies 0-3 MHz) • Sky wave propagation (High frequency 3-50 MHz) • Line of sight propagation (Very high to ultra-high frequencies 50 MHz and up) **PAT Project completed and moderated**

Digital Grade 10: Term 4		
WEEK	**Topic**	**CONTENT**
1	**Principles of Magnetism**	**Introduction to Magnetism** • Define magnetism e.g. natural, electro-magnetism • Basic principles of magnetism • Rules of magnetism **Demonstration:** Magnetic fields around a permanent magnet using iron filings
2		**Magnetic Fields** • Magnetic Flux (Φ) • Flux density (β) • Inductance (L) • Definition of an Inductor **Demonstration:** Oersted's experiment (Screwdriver rule)
3		**Types of Inductors and Inductor Cores** • Air Core • Laminated Core • Ferrite Core • Torroid Core **Demonstration:** Magnetic field around a coil using iron filings **Demonstration:** Magnetic field around a coil with and without a core **Calculations:** • Coils in series (Inductor) ○ $L_{Series} = L_1 + L_2 + \cdots L_n (Henry)$ • Coils in parallel (Inductor) ○ $\frac{1}{L_{Parallel}} = \frac{1}{L_1} + \frac{1}{L_2} + \cdots \frac{1}{L_n} (Henry)$ **Functional Operation and Application of Relays / Solenoids** • Symbol • Principal of operation • Construction of a relay • Parts of a relay • Normally open / Normally closed **Practical:** Testing a relay using a multimeter **Demonstration:** Wire a relay and light to a switch and operate the relay **Demonstration:** Latching Circuit with a relay

Digital Grade 10: Term 4		
WEEK	**Topic**	**CONTENT**
4		**Introduction to a Simple Series DC Motor** • Basic parts of a DC motor • Current flow in a DC motor and direction of rotation • Flemings' Right Hand Rule • Armature • Yoke / Magnetic poles • Bearings / Bushes in endplates • Brushes • Commutation **Demonstration:** Show how the direction of rotation in DC motors can be changed
5	**Revision Term 1**	
6	**Revision Term 2**	
7	**Revision Term 3**	
8 – 10	**Examination**	

1.1.2

3.3.2 Digital: Grade 11

Digital Grade 11: Term 1		
WEEK	**Topic**	**CONTENT**
1	**Occupational Health and Safety**	**Occupational Health and Safety** • Basic introduction to regulations ➢ What are regulations? ➢ How to use regulations ➢ Impact of regulations on the workshop ➢ Introduction and purpose of the regulations • General Machinery Regulations 1988 ➢ Supervision of machinery ➢ Safeguarding of machinery ➢ Operation of machinery ➢ Working on moving or electrically alive machinery ➢ Devices to start and stop machinery ➢ Reporting of incidents in connection with machinery • Electrical Machinery Regulations 1988 ➢ Safety equipment ➢ Electrical control gear ➢ Switchboards ➢ Portable electric tools ➢ Earthing ➢ Conductors **Safety** • What is Ergonomics? (Workplace conditions / comfort – Everything has a place and everything is in its place) • Unsafe actions • Unsafe conditions • Dangerous practices • Housekeeping principles • Signs in the workshop • Information signs • Safety signs • Prohibition signs • Fire Safety signs • Regulatory signs • Designated areas • Practical: Identification of safety signs and safety gear • Revision of emergency procedures (Grade 10)

Digital Grade 11: Term 1		
WEEK	**Topic**	**CONTENT**
		Practical: Clean the workshop (Weekly activity) **Personal Safety** • Protective gear for machinery • Personal protection equipment • Eye protection • Coveralls / Overalls • Hearing protection **Practical:** Use personal protection equipment (During practical sessions) **Chemical Safety** (Printed Circuit Board manufacturing) • Revision of Grade 10 PCB methods and safety **Practical:** Etch a PCB (Part of PAT completion)

Digital Grade 11: Term 1		
WEEK	**Topic**	**CONTENT**
2	**Tools and Measuring Instruments**	**Tools** • Re-visit safe use of hand tools • Crimping Tool (Ferrules, lugs & plugs) **Safe use of Power Tools** • Grinder – Bench / Angle • Jigsaw – Bench / Handheld • Power Drill / Drill stand (Revision) **Connectors** • Ferrules, lugs & plugs (Related to area of specialisation) • Single In Line connectors (Push In connectors) **Skills** (Skills are developed throughout the year during practical sessions): • Safe use of tools • Correct use of tools • Intermediate soldering / de-soldering skills (Using a solder wick) • Intermediate Printed Circuit Board manufacturing skills (Design & make) • Cleaning and tidying the workshop after practical (Housekeeping) • Keeping the storeroom neat and tidy **Practical:** Practice of safe housekeeping practices and methods **Testing Equipment** • Line Tester, Clamp Meter & Power Factor Meter ➢ External parts and their functions ➢ Principle of operation ➢ Application ➢ Care ➢ Maintenance • Function Generator and Oscilloscope ➢ External parts and their functions ➢ Principle of operation ➢ Application ➢ Care ➢ Maintenance

Digital Grade 11: Term 1		
WEEK	**Topic**	**CONTENT**
		• Calculations on the Oscilloscope ➢ Time ➢ Frequency ➢ Phase difference ➢ Maximum value **Practical:** Measure voltage and current with a multimeter **Practical:** Conduct insulation test on an electrical motor between coil and chassis **Practical:** Basic use of the oscilloscope to display waveforms taken from the function generator **Practical:** Determine voltage and frequency values as displayed on Oscilloscope. (Note: Oscilloscope does not measure and display current)
3	**Waveforms**	**Introduction to Waveforms** • Uses of waveforms • Different types of waves • Waveforms and their applications • Square Wave • Saw tooth Wave • Triangular Wave • Rectangular Wave • Radio Wave **Definition, Symbol & Unit of:** • The Sinusoidal Wave ➢ Instantaneous value ➢ Maximum value / Minimum value ➢ Peak to peak value ➢ RMS value Vrms = 0.707 x Em ➢ Average value over half cycle (Vavg = Vmax x 0.637) ➢ Time period ➢ Frequency ➢ Duty cycle ➢ Form factor ➢ Concept of phase and phase difference ➢ Harmonic frequencies (Concept only) • Difference between a sound wave and an electromagnetic wave (Concept only – Self propagating vs. medium needed) • Electromagnetic waves (Concept only – combination of electrical and magnetic wave – unique characteristics) • Speed of radio waves • Frequency and wavelength **Demonstration:** Function Generator and the Oscilloscope used to measure and display waveforms

Digital Grade 11: Term 1		
WEEK	**Topic**	**CONTENT**
4		**Pulse Technique** • Pulse polarity • Pulse time • Rise time / Fall time • What is a clock pulse, leading edge, trailing edge? **Calculations** • Pulse time • Pulse frequency • Rise time • Fall time • Period and frequency • λ (wavelength) & frequency **Practical:** Set up and measure different waveforms generated by the function generator on the Oscilloscope
5		**Wave Shaping Circuits** • Diode using discrete components only • Clipping circuits (Positive clipping only) ➢ Simple Series ➢ Series Biased ➢ Simple Parallel ➢ Biased Parallel
6		• Clamping Circuits (Positive clamping only) ➢ Clamping Circuit – Diode ➢ Clamping Circuit – Zener Diode • Integrator & Differentiator ➢ No calculations ➢ Input and output waveforms on oscilloscope ➢ Construction on breadboard ➢ Measurement of output waveform **Practical:** Construct each type of clipping and clamping circuit on a breadboard using diodes
7	**RLC**	**Effect of Alternating Current on Resistors, Inductors and Capacitors (RLC)** • Components in series circuits 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 • Inductive Reactance ○ $X_L = 2\pi fL\ (\Omega)$ • Capacitive Reactance ○ $X_C = \frac{1}{2\pi fC}\ (\Omega)$ • Effect of frequency changes on XL and XC **Demonstration:** Show phase difference between RL and RC

Digital Grade 11: Term 1		
WEEK	**Topic**	**CONTENT**
8		• Impedance ○ $Z = \sqrt{R^2 + (X_L - X_C)^2}\ (\Omega)$ • Scalar: Representation of the Impedance Triangle • Power ○ $P = V \times I \cos\ \theta\ (Watt)$ • Power Factor ○ $\cos\theta = \frac{R}{Z}$ ○ $\cos\theta = \frac{V_R}{V_Z}$ • Phase Angle ○ $\theta = \cos^{-1}\frac{R}{Z}\ (Deg)$ ○ $\theta = \cos^{-1}\frac{V_R}{V_Z}\ (Deg)$
9		• Natural Resonance • Effect of frequency changes on the impedance and current flow • Resonance with its characteristic curves ○ $f_r = \frac{1}{2\pi\sqrt{LC}}\ (Hertz)$ • Q Factor ○ $q = \frac{1}{R}\sqrt{\frac{L}{C}}$ ○ $q = \frac{X_L}{R}\ (X_L\ is\ taken\ at\ Resonance)$ ○ $q = \frac{X_C}{R}\ (X_C\ is\ taken\ at\ Resonance)$ • Bandwidth ○ $BW = \frac{f_r}{q}(Hertz)$ • Frequency changes
10		**Calculations** • Series combination circuits containing ONE resistor, ONE capacitor and ONE inductor • Phasor and wave representation • Resonance • Bandwidth • Q Factor **PAT Simulations 1 & 2 completed**

Digital Grade 11: Term 2		
WEEK	**Topic**	**CONTENT**
1	**Semiconductor Devices**	**Introduction to Semiconductor Devices** • Component data • Where to source data on all types of electronic components • How to read a data sheet • Pin configuration • Typical operating values • Working temperature • Equivalent components • Packages (Dual In Line, TO 92, basic packages) • Through-hole components vs. Surface mount devices **Semiconductors** • Electron flow vs. conventional flow • Semiconductors & solid state • Silicon vs. Germanium • Doping • P & N material • Majority carriers / Minority carriers
2		**PN Diode** • Construction of a PN Diode • Depletion layers • Biasing – Forward and reverse • Characteristic curve & symbol • Calculation of Diode Load Line **Practical:** The Diode Load Line **Zener Diode** • Construction • Principle of operation • Forward Biasing • Reverse Biasing • Avalanche breakthrough vs. controlled breakthrough • Zener as a voltage regulator • Characteristic curve & symbol • Zener calculations **Practical:** Determine the value of the series resistor for a Zener Diode

Digital Grade 11: Term 2		
WEEK	**Topic**	**CONTENT**
3		**The NPN Transistor** • Construction • Principle of operation • Purpose of Biasing & Thermal Runaway • Forward Biasing • Reverse Biasing • Base Curve • Emitter Output Curve • Regions of operation (Saturation, active and off) • The Transistor DC Load Line • Transistor power related to the load line (Vcc and Vce) • Influence of the DC Load Line on the characteristics of the transistor • Symbol **Application of Transistors** • Transistor as a switch • Transistor as an amplifier (Mention only – circuits to follow under amplifiers) • Transistor gain • Current gain • Voltage gain **Practical:** Determine the DC Load line of a transistor **Practical:** Build a circuit using the transistor as a switch
4		**The PNP Transistor** • Construction • Principle of operation • Relation to NPN • Symbol • Application – sample circuits only **Practical:** Build a circuit using the transistor as a switch
5		**Thyristor – SCR** • Construction • Principle of operation • Purpose of Biasing • Symbol • Characteristic curves • Application (Relaxation Oscillator, Phase Control, Switch mode applications, DC-DC Converter [buck/boost]) • Circuit diagram **Practical:** Construct a Relaxation Oscillator and show waveform on oscilloscope **Practical:** Construct a light dimmer circuit

Digital Grade 11: Term 2		
WEEK	**Topic**	**CONTENT**
6		**TRIAC** • Construction • Principle of operation • Purpose of Biasing • Symbol • Characteristic curves • Application (Relaxation Oscillator, Phase Control, Switch mode applications, DC-DC Converter [buck/boost]) • Circuit dagram **Practical:** Construct a light dimmer circuit
7		**DIAC** • Construction • Principle of operation • Purpose of Biasing • Symbol • Characteristic curves • Application (Relaxation Oscillator, Phase Control, Switch mode applications, DC-DC Converter [buck/boost]) • Circuit diagram application
8 – 10	**Second Term Examinations**	**PAT Simulation 3 & 4 completed**

Digital Grade 11: Term 3		
WEEK	**Topic**	**CONTENT**
1	**Logics**	**Logic Gate Theory** • Identify and interpret Logic gates and symbols ➢ NOT ➢ AND ➢ NAND ➢ OR / NOR ➢ X-OR / X-NOR • Apply Logic gates with a maximum of three inputs • Truth Table • Boolean Expression • Following theory, practical combination circuits to be built • Converting a Logic Circuit to a Boolean Expression
2		**Boolean Algebra** • Apply commutative and distributive laws • Product of sums (POS) • Sum of products (SOP)
3		**De Morgan's Theorem** • Combinational / Complex circuits ➢ Half and Full Adder ➢ Three Input Alarm ➢ Complex circuit of choice

Digital Grade 11: Term 3		
WEEK	**Topic**	**CONTENT**
4		**Karnaugh Maps** • How to do the Karnaugh Map • Simplifying Boolean Expressions (Maximum 4 operands)
5		**Logic Probe** • Positive & Negative Logic • Active low • Active high **Practical:** Test logic gate outputs using a Logic Probe **Resistor Transistor Logic** • NPN transistors only • Input gates only • AND, OR and NOT gates in RTL only **Practical:** Construct RTL logic gates using transistors and resistors (AND, OR and NOT)
6		**Transistor Logic** • Explain why TTL / CMOS logic is used • Differences between TTL and CMOS • Advantages and disadvantages • Applications of TTL – no practical circuits of TTL **Logic ICs Practical Circuits** • 40, 70 and 74 series • NAND Gate combinational / equivalent circuits • NOR Gate combinational / equivalent circuits **Practical:** Construct logic circuits using Logic ICs
7	**Power Supplies**	**Introduction to Power Supplies** • Why use power supply units? **Linear Power Supplies** • Series regulated PSU ➢ Basic principle of operation ➢ Circuit diagram – series regulator circuit • Shunt regulated PSU ➢ Basic principle of operation ➢ Basic principle of operation ➢ Circuit diagram – shunt regulator circuit • Advantages and disadvantages of the Linear PSU
8		• Switch Mode PSU ➢ Basic principle of operation ➢ Basic equivalent circuit of a Switch Mode PSU ➢ Applications ➢ Block diagram of the stages ➢ Importance of efficiency ➢ Advantages and disadvantages • Comparison between Switch Mode PSU and Linear PSU

Digital Grade 11: Term 3		
WEEK	**Topic**	**CONTENT**
9	**Sensors and Transducers**	**Introduction to Sensors and Transducers** • Definition of sensors and transducers • Piezo Electric Effect • Wheatstone bridge principles of resistance measurement **Functional operation of Sensors and Transducers:** • Sound ➢ Dynamic Microphone ➢ Electret Microphone **Practical:** Connect a microphone to an amplifier and the output of the amplifier to an oscilloscope and display on screen • Light ➢ The LDR ➢ Photodiode ➢ Phototransistor ➢ Opto-coupler **Practical:** Use a Wheatstone bridge with a sensor to show changes in light
10		• Temperature ➢ The Thermistor ➢ Thermocouple – working principle and special conditions for use. (Not a linear resistive output – to be used with a lookup table) **Practical:** Use a Wheatstone bridge with a sensor to show changes in temperature Other types of sensors – application only • Gas / Humidity sensor • Load cells / Strain sensors • Proximity sensors **Practical:** Use a Wheatstone bridge with a sensor to show changes in proximity of metal / humidity **PAT Project completed and moderated**

Digital Grade 11: Term 4		
WEEK	**Topic**	**CONTENT**
1	**Communication Systems**	**The Role of Tuned Circuits in Communication Electronics** • Tuned circuits • Natural oscillation • The LC tuned circuit as heart of the oscillator • The need for positive feedback in an oscillator • The crystal as a highly stable tuned circuit (Piezo Electric Effect) • Types of oscillators – block diagrams and basic principle of operation only • The Variable Frequency Oscillator (VFO) • The Voltage Controlled Oscillator (VCO) • The Phase Locked Loop (PLL) **Practical:** Simulate an RC oscillator and display wave on oscilloscope
2		**Transmitters and Receivers** • Basic principle of operation • What is modulation? • Waveforms • Block diagrams • Principle of operation • Types of modulation & related devices ➢ Continuous Wave modulation (CW) ➢ CW (Morse Code) Transmitter ➢ Regenerative Receiver ➢ Amplitude Modulation (AM) ➢ The AM Transmitter ➢ The AM Receiver
3		➢ Single Sideband Suppressed Carrier Modulation (SSB) ➢ The SSB Transmitter ➢ The Super Heterodyne Receiver ➢ Frequency Modulation (FM) ➢ The FM Transmitter ➢ The FM Receiver ➢ Frequency Shift Keying (FSK)
4		**Demonstration:** Construction of a simple radio receiver **Practical:** Build an FM Transmitter and test using an FM receiver
5	**Revision Term 1**	
6	**Revision Term 2**	
7	**Revision Term 3**	
8 – 10	**Examination**	

Digital Grade 12: Term 1		
WEEK	**Topic**	**CONTENT**
1	**Occupational Health and Safety**	**OHS ACT** • Definitions • Purpose of the act • General duties of employers to their employees • General duties of employers and self-employed persons to persons other than their employees • General duties of manufacturers and others regarding articles and substances for use at work • Duty to inform • General duties of employees at work • Duty not to interfere with, damage or misuse things • Functions of health and safety representatives • Report to inspector regarding certain incidents • Victimization forbidden • Offences, penalties and special orders of court **Safety Revision** • Unsafe actions • Unsafe conditions • Dangerous practices • Risk analysis • Human rights in the workplace • Work ethics • Revision of emergency procedures (Grade 10) **Practical:** Use personal protection equipment (During practical sessions) **Practical:** Clean the workshop (Weekly activity throughout the year) **Chemical Safety** (Printed Circuit Board manufacturing) • Revision of Grade 10 & PCB methods and safety done as part of PAT **Practical:** Etch a PCB (Part of PAT completion during the year)

Digital Grade 12: Term 1		
WEEK	**Topic**	**CONTENT**
2	**Semiconductor Devices**	**Introducing of Integrated Circuits** • Integrated circuits – the 741 Op-Amp ➢ Basic construction, symbol, functional operation ➢ Typical operating voltages ➢ Characteristics of an ideal Op-Amp & application as an amplifier ➢ Gain: Open Loop and Closed Loop gain ➢ Application as an inverting amplifier ➢ Application as a non-inverting amplifier **Calculations** • Inverting Amplifier ○ $Vout = Vin(-Rf/Rin)$ • Non-inverting Amplifier ○ $Vout = Vin(Rf/Rin + 1)$ • Gain ○ $Av = Rf / Rin$ **Practical:** Build a non-inverting amplifier on a breadboard using a 741 Op-Amp. Use a Function Generator and Oscilloscope to show input and output waveforms
3		• Integrated circuits – the 555 Timer ➢ Basic construction, symbol, functional operation ➢ Characteristic curves & typical operating voltages ➢ Application as a timer **Practical:** Build a clock pulse generator using a 555 Timer IC on a breadboard and display the output on an oscilloscope

Digital Grade 12: Term 1		
WEEK	**Topic**	**CONTENT**
4	**Switching Circuits**	**Principle of Operation of Switching Circuits using Operational Amplifiers and Timers** **Multivibrators** • Bistable Multivibrator ➢ Circuit diagram and operation ➢ Measurement of input and output waveforms **Practical:** Construct a Bistable Multivibrator on a breadboard using a 741 Op-Amp / 555 Timer with LEDs
5		• Mono-stable Multivibrator ➢ Circuit diagram and operation ➢ Measurement of input and output waveforms **Practical:** Construct a Mono-stable Amplifier on a breadboard using a 741 Op-Amp / 555 Timer and LEDs
6		• Astable Multivibrator ➢ Circuit diagram and operation ➢ Measurement of input and output waveforms **Practical:** Construct an Astable Amplifier on a breadboard using a 741 Op-Amp / 555 Timer and show output using LEDs and the Oscilloscope
7		• Schmidt Trigger ➢ Circuit diagram and operation ➢ Display the input waveform in relation to the output waveform on the Oscilloscope **Practical:** Construct a Schmidt Trigger on a breadboard using a 741 Op-Amp
8		• Comparator and Summing Amplifier ➢ Circuit diagram and operation ➢ Display the input waveform in relation to the output waveform on the Oscilloscope ➢ Calculations: ▪ $Vout = Vin\ x\ Gain$ ▪ $Vout = Vin1\ x\ \left(\frac{Rf}{Rin1}\right) + Vin2\ x\ \left(\frac{Rf}{Rin2}\right) \ldots . + VinN\ x\ \left(\frac{Rf}{RinN}\right)$ Measurement of input and output waveforms
9		**Practical:** Construct a comparator on a breadboard using a 741 Op-Amp **Practical:** Construct a summing amplifier on a breadboard using a 741 Op-Amp
10		• Differentiator and Integrator ➢ Circuit diagram and operation ➢ Display the input waveform in relation to the output waveform on the Oscilloscope ➢ Influence of time constant on the output waveform **Practical:** Construct a differentiator on a breadboard using a 741 Op-Amp **Practical:** Construct an integrator on a breadboard using a 741 Op-Amp **PAT Simulation 1 & 2 completed**

Digital Grade 12: Term 2		
WEEK	**Topic**	**CONTENT**
1	**Digital and Sequential Devices**	**Decoders and Encoders** • Seven segment displays & decoder / driver • LCD / LED displays & drivers
2		**Practical:** Connect a 7 segment display to a 4-bit BCD 7 segment display driver
3		**Elementary principles of Combination Circuits without Memory Elements** • Functional principles, circuit diagram and use of • Half Adder • Full Adder • Bit Parallel Binary Adder **Practical:** Connect a binary adder using a 4008B CMOS IC to add two four bit binary numbers
4		**Elementary principles of Memory Elements** • Application of Logic gates as the building blocks for memory elements ➢ RS and the clocked RS Latch • Logic Gate composition • Block diagram symbol • Operation ➢ JK Flip Flop and Clocked JK Latch • Logic Gate composition • Block diagram symbol • Operation ➢ D Flip Flop and clocked D Latch • Logic Gate composition • Block Diagram symbol • Operation **Practical:** Connect a 4013B CMOS IC to form an Astable Multivibrator using a clock pulse from a function generator
5		**Elementary principles of Counters** • Ripple counters • Synchronous counters • Asynchronous counters • Up / Down counters • Self-stopping counters
6		• Application of counters: counters as frequency dividers • Application of counters: Decade Counter • Application of counters: Binary Coded Decimal Counter **Practical:** Connect a 4017B Johnson Counter with a 555 Timer to form a counter that will light up 6 LEDs in sequence
7		**Elementary principles of Registers** • Shift registers – Serial Load Shift Register (Serial Input, Serial output) SISO • Serial Input – Parallel Output SIPO • Shift registers – Parallel Load Shift Register • Parallel Input – Serial Output PISO • Parallel Input – Parallel Output PIPO **Practical:** Connect a 4015 B CMOS IC to form SISO Shift register
8 – 10	**Mid-year Examinations**	**PAT Simulation 3 & 4 completed**

Digital Grade 12: Term 3		
WEEK	**Topic**	**CONTENT**
1	**Microcontrollers**	**Introduction to Microcontrollers** • History of microcontrollers • Uses of microcontrollers **Hardware of Microcontrollers** • Block diagram of a microcontroller • Basic function & concepts of microcontrollers • What is a microcontroller? • Difference between a microcontroller and a microprocessor • A digital IC that can be programmed to control a process • Discreet Logic vs. Integrated Logic devices **Parts of a Microcontroller** – Concepts only • CPU with registers • Memory • Input / Output pins • Timers • Analog to digital converters
2		**Communication in a Microcontroller** • What is meant with communication in a microcontroller? ➢ Serial vs. parallel communication ➢ Asynchronous vs. synchronous communication • Communication Peripherals ➢ Serial Communication Interface (SCI) or Universal Asynchronous Receiver Transmitter (UART) ➢ Serial Peripheral Interface (SPI) ➢ Inter-integrated Bus (I2C) • Communication protocols ➢ RS-232 ➢ RS-485
3		**Software of Microcontrollers** • Definition of an algorithm • Definition of a program • Relationship between algorithms and flowcharts • Instruction set / Flow diagram • Definition of a Flow diagram • Data flow diagram symbols in PICAXE • Instructions and conventions • Data flow lines • Legal vs. illegal data flows • Conditional statement (IF statement) • Looping (Repetition) • Definition of debugging

Digital Grade 12: Term 3		
WEEK	**Topic**	**CONTENT**
4		**PICAXE** • Using PicAXE programming software • Using Logicator or similar flowchart software to program PICAXE using the following functions: ➢ Input / Outputs ➢ Analogue to digital conversion ➢ Timers ➢ Counters • Tutorials • Simulating before programming • Debugging a program • Interface Cable (USB or RS232) • Programming the PICAXE ➢ Uploading and downloading programs from the PICAXE microcontroller
5		**Practical:** Use a flow diagram to simulate a flashing LED and then program PICAXE to run as a flashing LED. Add input to start and stop flashing. Connect an Oscilloscope to the output of the PICAXE
6		**Practical:** Use a flow diagram to simulate a Schmidt Trigger then program PICAXE to run the program. Use a potentiometer on the input to adjust the threshold and switch the output accordingly. Connect an oscilloscope to show the input and output voltages
7		**Practical:** Use a flow diagram to simulate a Pulse Width Modulator (PWM) then program PICAXE to run the program. Control an RC servo motor using the PICAXE as a PWM module. Connect an oscilloscope to show the input and output voltages **Practical:** Develop a solution of your own design
8 - 10	**Preparatory Examination**	**PAT Project completed and moderated**

SECTION 4

4.1 Introduction

Assessment is a continuous planned process of identifying, gathering and interpreting information about the performance of learners, using various forms of assessment. It involves four steps: generating and collecting evidence of achievement; evaluating this evidence; recording the findings; and using this information to understand and thereby assist the learner's development in order to improve the process of learning and teaching.

Assessment involves activities that are undertaken throughout the year. In Grades 10 – 12 assessment should be both informal (Assessment for Learning) and formal (Assessment of Learning). In both cases regular feedback should be provided to learners to enhance the learning experience.

Evidence of all assessments including tests, simulations and tasks should be placed in the learner's script. It is imperative that all items are marked clearly. Items that are loose should be pasted into the script to become a permanent part of a learner's record.

All items in the learner script must contain the following references:

- Date
- Topic
- Homework assignments including a textbook page and exercise reference
- Evidence of scrutiny and interaction from the teacher in red pen
- All teacher actions / interventions in the script should be dated
- Learners are required to mark all self-assessments in pencil and all corrections must be shown in pencil.

As the script is a formal assessment document, the learner is required to cover and keep the script neat and clean. The teacher is required to provide guidance in this respect.

Apart from the learner script, no additional file or portfolio is required.

4.2 Informal or Daily Assessment (Assessment for Learning)

Assessment for Learning has the purpose of continuously collecting information on learners' achievement that can be used to improve their learning.

Informal assessment is a daily monitoring of learners' progress. This is done through observations, discussions, practical demonstrations, learner-teacher conferences, informal classroom interactions, etc. Informal assessment may be as simple as stopping during the lesson to observe learners or to discuss with learners how learning is progressing. Informal assessment should be used to provide feedback to the learners and to inform planning for teaching, but need not be recorded. It should not be seen as separate from learning activities taking place in the classroom. Learners or teachers can mark these assessment tasks.

Self-assessment and peer assessment actively involve learners in assessment. This is important as it allows learners to learn from and reflect on their own performance. The results of the informal daily assessment tasks are not formally recorded unless the teacher wishes to do so. In such instances, a simple checklist may be used to record this assessment. However, teachers may use the learners' performance in these assessment tasks to provide verbal or written feedback to learners, the school management team and parents. This is particularly important if barriers to learning or poor levels of participation are encountered. The results of daily assessment tasks are not taken into account for promotion and certification purposes.

The following outline provides teachers with informal programmes for assessment that may be followed in order to achieve effective curriculum delivery.

Informal assessment tasks do not contribute towards promotion and progression of the learner. Its sole intention is the development of knowledge and skills in preparation of formal assessment.

ASSESSMENT TASKS	TERM 1	TERM 2	TERM 3	TERM 4
Tests (class, theory and revision tests)	1	1	1	Consolidation
Assignment	1	1	1	0
Class work / case studies / work sheets	Weekly	Weekly	Weekly	Consolidation
Homework (theory and practical)	Weekly	Weekly	Weekly	Consolidation
Workshop / practical	Weekly	Weekly	Weekly	Consolidation

Evidence of informal assessment will be found in the learner's script. The nature of these tasks is described under assessment for learning.

4.3 Formal Assessment (Assessment of Learning)

All assessment tasks that make up a formal programme of assessment for the year are regarded as formal assessment. Formal assessment tasks are marked and formally recorded by the teacher for progression and certification purposes. All formal assessment tasks are subject to moderation for the purpose of quality assurance and to ensure that proper standards are maintained.

Formal assessment provides teachers with a systematic way of evaluating how well learners are progressing in a grade and in a particular subject. Examples of formal assessments include projects, oral presentations, demonstrations, performances, tests, examinations, practical tasks, etc. Formal assessment tasks form part of a year-long formal Programme of Assessment in each grade and subject.

PROGRAMME OF ASSESSMENT		
School-based Assessment SBA	Practical Assessment Task PAT	Final Examination
25%	25%	50%

The formal assessment requirements for Electrical Technology are as follows:

- School-based Assessment (SBA): SBA, which is written at the end of term 1, 2 and 3, shows the learner's progress throughout the year and accounts for 25% of the learner's promotion mark;
- In Grades 10 and 11 all SBA is set and moderated internally.
- In Grade 12 the formal assessment (25%) is internally set and marked but externally moderated.
- Computer simulation software may be used to simulate practical work in preparation for the actual practical assessment tasks and practical work sessions. The learner will however still be required to make use of real world components and real world instruments when conducting practical work and tasks. Simulation software will therefore not replace the practical work completed by learners. Such software is a scaffolding mechanism used to enhance teaching and learning.
- Practical Assessment Task (PAT): PAT accounts for the skills the learner has mastered. This is assessed at intervals and requires the learner to engage in multiple practical sessions. During these weekly sessions, skills such as simulation, experimentation, hand skills, tool skills, machine skills and workshop practice are honed and perfected to the point where the learner may engage in the tasks set out for that particular term. The PAT accounts for 25% of the learner's promotion mark.

- In Grades 10 – 11 the Practical Assessment Task is set and marked internally but externally moderated.
- In Grade 12 the Practical Assessment Task is externally set, internally marked and externally moderated.
- Final examination: At the end of each academic year every learner is required to write a final examination, which is compiled in such a way that it represents the entire theoretical content covered throughout the year. The Final examination paper accounts for 50% of the learner's promotion mark and is externally set, marked and moderated.

Formal assessments should cater for a range of cognitive levels and abilities of learners as shown below:

Cognitive Levels	Percentage of Task
Lower order: knowledge	30%
Middle order: comprehension and application	50%
Higher order: analysis, evaluation and synthesis	20%

4.4 Projects

Learners will only do one project per subject per annum.

In Electrical Technology, the PAT will serve as the project for learners in Grades 10 – 12. The PAT for Grade 12 is set by the Department of Basic Education and the PAT for Grades 10 – 11 is set internally by the teacher.

A project (in this case the PAT) should require the learner to:

- Plan / prepare / investigate / research to solve the identified problem / task
- Perform the task / carry out instructions (according to criteria given)
- Develop the project according to the given criteria
- Allow for some innovation and creativity.

To set the project, the teacher should:

- Determine the content / skills / knowledge to be addressed
- Set clear criteria and give extensive instructions to guide the learner (the learner should know exactly what to do and what is expected)
- Keep the scope manageable
- Determine which resources will be required to complete the project and ensure that learners have access to these resources
- Determine the time frame / duration / due date
- Determine mark distribution and compile an assessment tool.

4.5 Assessment

4.5.1 Programme of Assessment

The Programme of Assessment is designed to spread formal assessment tasks in all subjects in a school throughout a term. Without this programme, tests and tasks are crowded into the last few weeks of the term creating unfair pressure on the learners.

The following is the Programme of Assessment for Grades 10 – 11.

GRADES 10 – 11 ASSESSMENT REQUIREMENTS							
ASSESSMENT TASKS	**TERM 1**	**TERM 2**	**TERM 3**	**TERM 4**	**% OF FINAL PROMOTION MARK**		**MARK WEIGHTING**
Tests	1		1		10	25	250 total converted to mark out of 100
Mid-year examination		1			15		
Practical Assessment Task	☑	☑	☑		25		250 total converted to mark out of 100
Final examination				1	50		200
TOTAL - PROMOTION MARK							**400**

The table below shows the compilation of the school based assessment mark:

Description	Time Frame	Weighting of final mark	Mark Allocation
Control test 1	Term 1 January - April	5%	50
Mid-year examination	Term 2 May - June	15%	150
Control test 2	Term 3 July - October	5%	50
Total		25%	250

The following is the Programme of Assessment for Grade 12:

GRADE 12 ASSESSMENT REQUIREMENTS							
ASSESSMENT TASKS	**TERM 1**	**TERM 2**	**TERM 3**	**TERM 4**	**% OF FINAL PROMOTION MARK**		**MARK Weighting**
Tests	1				5	25	450 total converted to mark out of 100
Mid-year and preparatory examination		1	1		20		
Practical Assessment Task (PAT)	☑	☑	☑		25		250 total converted to mark out of 100
Final examination				1	50		200
TOTAL – PROMOTION MARK							400

The table below shows the compilation of the school based assessment mark:

Description	Time Frame	Weighting of final 25%	Marks
Control test	Term 1	5%	50
Mid-year examination	Term 2	10%	200
Preparatory examination	Term 3	10%	200
Total		25%	450

4.5.2 Tests

- A test for formal assessment should not comprise of a series of small tests, but should cover a substantial amount of content and the duration should be at least 60 minutes with a minimum of 50 marks (Allocate 1 mark per fact).
- Each test must cater for a range of cognitive levels.
- The forms of assessment used should be grade and development level appropriate. The design of these tasks should cover the content of the subject and include a variety of tasks designed to achieve the objectives of the subject.

4.5.3 Examinations

- Each examination must cater for a range of cognitive levels.
- For Grades 10, 11 and 12, the three-hour final examination in Electrical Technology comprises 50% (200 marks) of a learner's total mark. All question papers set by the teacher throughout the year, including the final examination paper, must be moderated by the head of department at the school and approved by the district curriculum advisors / facilitator. This is done to ensure that the prescribed weightings are adhered to by the teacher.
- In the Grade 12 examination only Grade 12 content will be assessed. However, prior knowledge from Grades 10 – 11 may be necessary to interpret and answer some of the questions.

4.5.3.1 Examination Weighting in Electrical

Topic	Grade 10		Grade 11		Grade 12	
	Percentage	Marks +/- 4 Marks	Percentage	Marks +/- 4 Marks	Percentage	Marks +/- 4 Marks
Occupational Health and Safety	6%	12	3%	6	4%	8
Tools and measuring instruments	10%	20	3%	6		
Basic Principles of Electricity	16%	32				
Power Sources	10%	20				
Electronic Components	13%	26				
Domestic Installations	32%	64				
Principles of Magnetism	13%	26				
DC Machines			13%	26		
Single Phase AC Generation			13%	26		
Single Phase Transformers			13%	26		
RLC			10%	20	21%	42
Control Devices			16%	32		
Single Phase Motors			16%	32		
Power Supplies			13%	26		
Three Phase AC Generation					17%	34
Three Phase Transformers					13%	26
Three Phase Motors & Starters					17%	34
Programmable Logic Controllers (PLC)					28%	56
Total	100%	200 Marks	100%	**200 Marks**	100%	200 Marks

4.5.3.2 Examination Weighting in Electronics

Topic	Grade 10		Grade 11		Grade 12	
	Percentage	Marks +/- 4 Marks	Percentage	Marks +/- 4 Marks	Percentage	Marks +/- 4 Marks
Occupational Health and Safety	6%	12	3%	6	4%	8
Tools and measuring instruments	10%	20	3%	6		
Basic Principles of Electricity	16%	32				
Power Sources	10%	20				
Electronic Components	13%	26				
Logics	16%	32				
Communication Systems	16%	32	13%	26		
Principles of Magnetism	13%	26				
Waveforms			13%	26		
RLC			13%	26	21%	42
Semiconductor Devices			23%	46	17%	34
Power Supplies			26%	52		
Sensors and Transducers			6%	12		
Switching Circuits					29%	58
Amplifiers					29%	58
Total	100%	200 Marks	100%	200 Marks	100%	200 Marks

4.5.3.3 Examination Weighting in Digital Electronics

Topic	Grade 10		Grade 11		Grade 12	
	Percentage	Marks +/- 4 Marks	Percentage	Marks +/- 4 Marks	Percentage	Marks +/- 4 Marks
Occupational Health and Safety	6%	12	3%	6	4%	8
Tools and measuring instruments	10%	20	3%	6		
Basic Principles of Electricity	16%	32				
Power Sources	10%	20				
Electronic Components	13%	26				
Logics	16%	32	20%	40		
Communication Systems	16%	32	13%	26		
Principles of Magnetism	13%	26				
RLC			12%	24		
Waveforms			13%	26		
Power Supplies			6%	12		
Switching and Control Circuits					29%	58
Semi-Conductors			24%	48	9%	18
Sensors and Transducers			6%	12		
Digital and Sequential Devices					29%	58
Microcontrollers					29%	58
Total	100%	200 Marks	100%	200 Marks	100%	200 Marks

4.6 Recording

Recording is a process in which the teacher documents the level of a learner's performance in a specific assessment task. It indicates learner progress towards the achievement of the knowledge as prescribed in the Curriculum and Assessment Policy Statements. Records of learner performance should provide evidence of the learner's conceptual progression within a grade and her / his readiness to progress or be promoted to the next grade. Records of learner performance should also be used to verify the progress made by teachers and learners in the teaching and learning process.

Teachers will record actual marks against the respective tasks by using a record sheet and also report in percentages against the subject on the learner's report cards.

4.7 Reporting

Reporting is a process of communicating learner performance to learners, parents, schools and other stakeholders. Learner performance can be reported in a number of ways which include report cards, parents' meetings, school visitation days, parent-teacher conferences, phone calls, letters, class or school newsletters, etc. Teachers in all grades report in percentages against the subject.

- In order for the school to report back to the parents on the progression of the learner from term to term, regular feedback is given in the form of report cards. When compiling SBA term marks it is proposed that teachers make use of the control tests, examination marks and simulation / skills tasks marks to show how the learner is progressing.
- The weighting of the term mark will be done in accordance with the tables in paragraph 4.5.1 above. The following rating scale will apply for reports:

CODES AND PERCENTAGES FOR RECORDING AND REPORTING

RATING CODE	DESCRIPTION OF COMPETENCE	PERCENTAGE
7	Outstanding achievement	80 – 100%
6	Meritorious achievement	70 – 79%
5	Substantial achievement	60 – 69%
4	Adequate achievement	50 – 59%
3	Moderate achievement	40 – 49%
2	Elementary achievement	30 – 39%
1	Not achieved	0 – 29%

Note: The seven point scale should have clear descriptors that give detailed information for each level.

4.8 Moderation of assessment

Moderation refers to the process which ensures that the assessment tasks are fair, valid and reliable. Moderation should be implemented at school, district, provincial and national levels. Comprehensive and appropriate moderation practices should be in place for the quality assurance of all subject assessments.

4.8.1 PAT moderation

Moderation of each term's PAT phases can start as early as the following term i.e. simulation 1 & 2 can be moderated as soon as the second term starts. The final product (project) will be moderated upon completion.

The moderation process is as follows:

- During face moderation learners may be selected at random to demonstrate the different skills developed during the making of the PAT. All simulations will be moderated.
- Learners being moderated will have access to their completed project during moderation and may refer to the simulations they completed earlier in the year.
- Learners may not ask assistance from other learners during moderation.
- All projects must be on display for the moderator.
- The moderator will select at random a representative sample of projects in accordance with the moderation policy.
- Upon completion the moderator will, if needed, adjust the marks of the group up or downwards, depending on the decision reached as a result of moderation.
- Normal examination protocols for appeals will be adhered to if a dispute arises from adjustments made.

4.8.2 SBA moderation

Moderation of written tests and examinations will be conducted by the curriculum advisors / facilitator or a peer teacher. Grade 10 and 11 tasks are internally moderated except for the PAT that is externally moderated. The curriculum advisors / facilitator must moderate a sample of these tasks during school visits to verify the standard of the internal moderation. Moderation of written tests constitutes a re-mark of the learner's work to ensure assessment by the teacher is correct.

Grade 12 tasks should be moderated on three tiers: school, district and province.

School-based moderation requires the HOD to check / control the following:

(a) Learner compliance

- Work done by learners complies with the following requirements:

- Date
- Topic
- Homework assignments reflecting a textbook page and exercise reference
- Learner scripts are required to show scrutiny and interaction from the teacher in red pen
- All teacher actions / interventions in the script must be dated
- Learners are required to mark all self-assessments in pencil and all corrections to be shown in pencil.

(b) Safety

- Learners are required to dress appropriately when entering the workshop
- Personal safety should be adhered to
- Learner conduct in the workshop must be orderly and appropriate
- Learners are required to enact safety drills, practise safe operating procedures, perform housekeeping tasks and assist in workshop preventative maintenance such as cleaning, painting, sanding, etc.

(c) Practical Assessment Tasks / Session in the workshop

- Learners are required to actively engage in practical assessment tasks, assignments, simulations and experiments
- Learners who are un-cooperative will receive de-merits or a zero mark allocation for that particular section of work
- Learners who act unsafely in a workshop, placing other learners in danger, will be removed from the workshop and will have to perform additional tasks / engage in corrective behaviour tasks to show improvement in safety awareness and skill. This will be done outside of normal contact time.

(d) Teacher compliance

- Preparation done by the teacher includes:
- Keeping to pace setters / work schedule
- Work schedule dates are planned and achieved dates are indicated
- Lesson preparation for each topic
- Lesson preparation and dates in learners' books are aligned
- Worksheets / tasks / homework assignments in lesson preparation aligns with learners' books
- Work is done every day in the learners' books
- Workbooks are regularly checked and dated by the teacher
- Tests have memorandums before the test is written
- Examinations and major tests are moderated by a peer teacher / facilitator from district.

(e) Workshop management

- Storeroom is indexed, neat and clean
- Inventory is kept up to date every 6 months
- Workshop is clean and neat
- Preventative maintenance schedule is drawn up
- Workshop budget is prepared and ready
- Procurement schedule for PAT and consumable items are kept up to date
- Replacement of old equipment is planned and rolled out

- OHS Act adhered to at all times.

(f) Classroom management

- Classroom is neat and clean
- Posters and exhibits are evident
- Pin boards are neatly populated
- Teacher workstation / desk is neat and clean
- Filing is neat and tidy.

4.9 Practical Assessment Task (PAT)

The Department of Basic Education issues a Practical Assessment Task for Grade 12 every year. The format of the Grade 12 PAT is duplicated for Grades 10 – 11.

In all grades each learner must do a Practical Assessment Task for the year:

- Grades 10 – 11: Teachers will set and assess the Practical Assessment Task and it will be moderated externally by the subject specialists.
- Grade 12: The practical assessment tasks for Grade 12 will be assessed by the teacher and will be externally moderated by the provincial subject specialists.
- The date for the external moderation will be decided by the province in which the school is situated.
- The provincial education departments or schools may not change or use the task of the previous year.
- Providing the resources for the Practical Assessment Task is the responsibility of the school and schools should ensure that adequate time and funding is allocated for the completion of the Practical Assessment Task.

Practical sessions should be scheduled in such a way that learners have enough time to practise skills needed for the completion of the PAT. Weekly practice sessions are necessary for the learner to hone the needed skills. A guideline of 2 hours out of 4 hours per week (5 day cycle) is given for Grades 10 – 12.

The ratio of learners per teacher for all practical work is 1 teacher per 15 learners or part thereof. For groups exceeding 15, this means that multiple teachers would be required inside the workshop while practical work is being conducted. Alternatively, groups should be split into numbers below 15 to ensure that a ratio of 1:15 is not exceeded at any time. The motivation for smaller groups lies in the differentiation and mentoring of technical skills that require one on one contact between teacher and learner. The safety of learners is paramount and smaller groups would ensure compliance with the OHS Act 87 of 1993.

NB: The completed PAT project will be made up from different phases and tasks.

Practical sessions should be scheduled in such a way that learners have enough time to practise skills needed for the completion of the PAT. Weekly practice sessions are necessary for the learner to hone the needed skills. A guideline of 2 hours per week is given for Grades 10 – 11.

In cases where the Grades 10 – 11 PAT tasks and topics are set by the teacher internally, the head of department at the school and Electrical Technology district subject facilitator are required to approve each task before it is implemented in the workshop.

Provinces may opt to develop PATs for Grades 10 – 11 to ensure a unified curriculum approach. These PATs may however not contradict the design principles outlined in the Grade 12 PAT.

The compilation of the PAT Grades 10 – 12 mark is detailed in the table below:

Description	Time Frame	Weighting of Final 25%	Marks
Simulation / Experiment 1	January – March	4%	40
Simulation / Experiment 2	January – March	4%	40
Simulation / Experiment 3	April – June	4%	40
Simulation / Experiment 4	April – June	4%	40
Final Product	July – September	9%	90
Total		25%	250

Although the final PAT product only needs to be completed in the third term, learners should start working on phase 4 from the first term in order to avoid running out of time to complete the PAT.

4.10 Progression / Promotion

A learner needs to achieve at least 30% of the final mark to pass Electrical Technology.

4.11 General

This document should be read in conjunction with:

4.11.1 National policy pertaining to the programme and promotion requirements of the National Curriculum Statements Grades R – 12; ***and***

4.11.2 The policy document, *National protocol for Assessment Grades R – 12.*