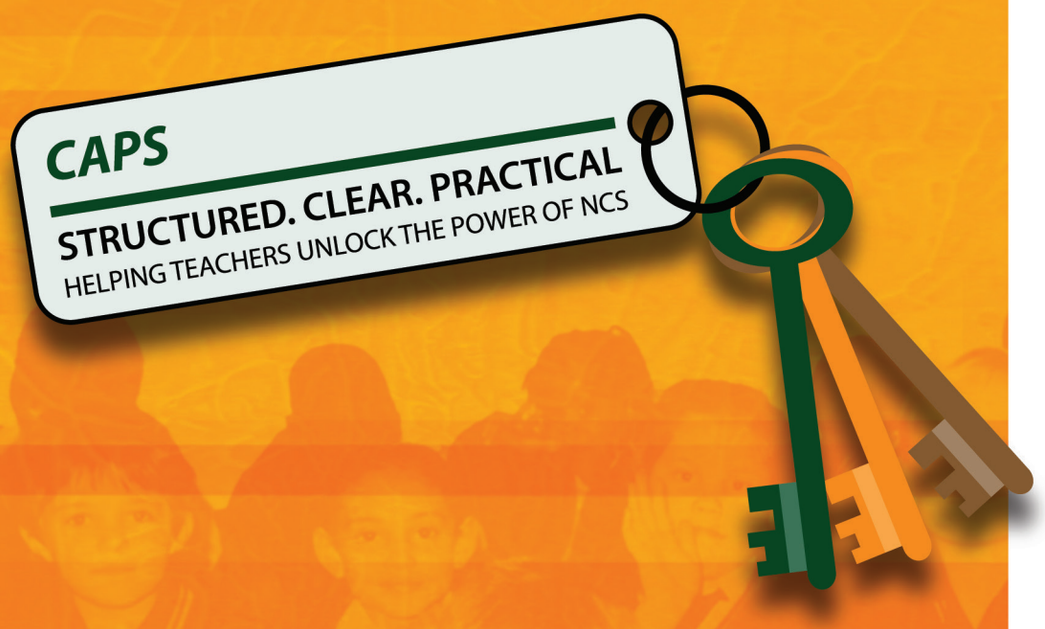
MECHANICAL TECHNOLOGY

National Curriculum Statement (NCS)

Curriculum Assessment Policy Statement



GRADES 10 – 12

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CURRICULUM AND ASSESSMENT POLICY STATEMENT (CAPS) GRADES 10 – 12

MECHANICAL 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

CONTENTS

SECTION 1

INTRODUCTION TO THE CURRICULUM AND ASSEMENT POLICY STATEMENTS FOR MECHANICAL 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 set 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

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	
Three Electives	2
	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 pursue additional subjects, additional time must be allocated for the offering of these subjects.

SECTION 2

MECHANICAL TECHNOLOGY

2.1 What is Mechanical Technology?

Mechanical Technology focuses on concepts and principles in the mechanical (motor, mining, shipping, rail, power-generation etc.) environment and on technological processes. It embraces practical skills and the application of scientific principles. This subject aims to create and improve the engineering and manufacturing environment to enhance the quality of life of both the individual and society alike, and ensure the sustainable use of the natural environment and resources.

The subject Mechanical Technology will consist of a compulsory generic core and a specialised elective in one of the above disciplines.

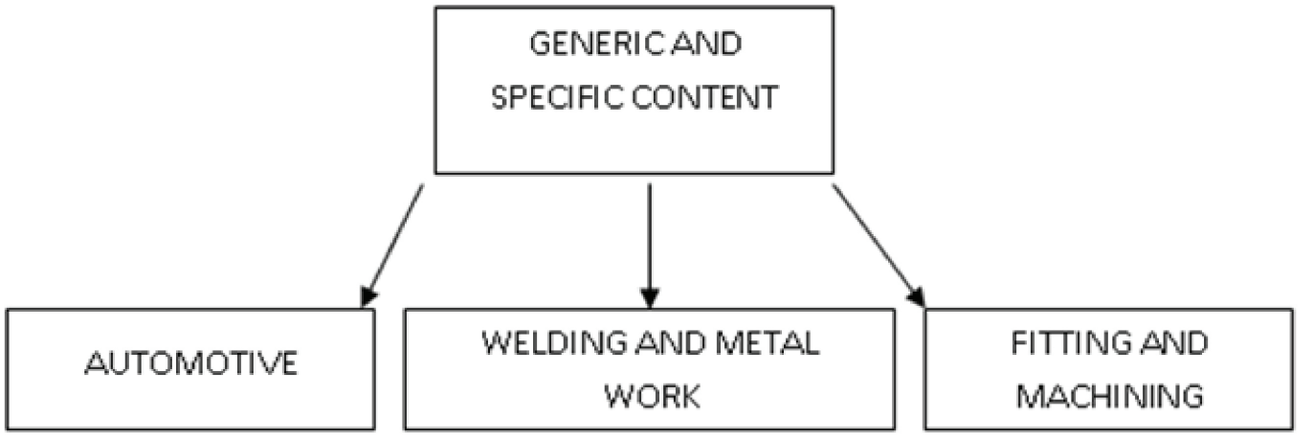
Embedded in this subject are the following disciplines:

Automotive: encompassing petrol and diesel driven vehicles, motor cycles, lawnmowers and tractor mechanics;

Fitting and Machining: includes turning, milling, cutting, shaping, fitting of keys, couplings, bushes, shafts and bearings;

Welding and Metalwork: includes welding (gas, electric, MIG/MAGS), developments, working with sheet metal and the manufacturing of structures.

This field does NOT include Panel Beating, Spray Painting, Motor Body Building, parts of Farm Mechanics and Air-conditioning.



The foundations of Mechanical Technology

During the activities, the learner engages in investigating, diagnosing, adjusting, removing, replacing, designing, manufacturing and applying the necessary skills to provide solutions to problems in mechanical systems, processes and components. Mechanical Technology is however not limited to these processes.

It affords learners with opportunities for life-long learning, self-development, empowerment, awareness of human rights, and exposure to socio-economic and environmental injustices, access to latest international trends and innovations, and an awareness of the process of globalisation.

Valuing indigenous knowledge systems, it acknowledges the rich history and heritage of this country as important contributors to nurturing the values contained in the Constitution.

Apply solutions – vocational specific learning

This learning describes a core set of skills that can be developed through projects, simulations and real life applications that are needs driven and sensitive to environmental impact. An integrating approach, to structure projects that develop the learner's skills, knowledge, values and attitudes in a holistic way, should be adopted.

- **Repair / Make / Maintenance:**

This aspect provides the opportunity for the learner to use tools, equipment and materials to solve / for monitoring the identified problems, needs or opportunities. The making should be according to the specific design or the manufacturer's specifications. Repairs include the removal of defective parts and the replacement of fixed or new parts. All work must always be undertaken in a safe and healthy environment. The necessary safety measures and precautions against injuries should be applied with due consideration to HIV /AIDS.

- **Evaluate**:

The learner has to evaluate products, actions, decisions and results throughout the process, and where necessary changes or improvements should be recommended and implemented. Evaluation should be done against the applicable criteria that may be given or developed. This stage requires the use of probing questions, fair testing and analysis.

- **Communicate**:

The assessment evidence of the process followed in any project is: the ability to analyse, investigate, plan, design, draw, report, evaluate and communicate. All reports, designs, assessment forms and assessment records should be kept in a Portfolio file.

Links with GET, Alternative Education and Training and Career Pathways

Links with GET: The study of Mechanical Technology builds on the systems and controls, structures and processes as found in the technology curriculum statement for the GET. It serves to further develop the learner's knowledge and understanding of gears, levers and pulleys. The learner is also exposed to the use and application of mechanical advantages, designs, and the structures as applied in design to promote safety and efficiency.

Career Pathways: The curriculum is designed to incorporate the career fields of Fitting and Machining, Automotive, and Welding and Metalworking. Elements of entrepreneurship have been included to provide learners with the ability to identify business opportunities in the engineering industry.

2.1.1 Fitting and Turning

Focuses on the manufacturing and machining of machines parts using processes such as lathe turning, milling, cutting, shaping, fitting of keys, couplings, bushes, shafts and bearings.

Turning is a machining process in which a cutting tool, typically a non-rotary tool bit, moves more or less linearly while the work piece rotates.

Turning can be done manually, in a traditional form of lathe, or by using an automated lathe. Today the most common type of such automation is computer numerical control, better known as CNC. (CNC is also commonly used with many other types of machining besides turning.)

When turning, a piece of relatively rigid material is rotated and a cutting tool is traversed along axes of motion to produce precise diameters and depths. Turning can be either on the outside of the cylinder or on the inside (also known as boring) to produce tubular components of various geometries.

The turning processes are typically carried out on a lathe, considered to be the oldest machine tools, and can be of four different types, namely straight turning, taper turning, profiling or external grooving. These types of turning processes can produce various shapes of materials such as straight, conical, curved or grooved work pieces. In general, turning

uses simple, single-point cutting tools. Each group of work piece materials have an optimum set of tool angles which have been developed through the years.

Milling operates on the principle of rotary motion. A milling cutter is spun about an axis while a work piece is advanced through it in such a way that the cutters are able to shave chips of material. This non-continuous cutting operation means that no surface cut by a milling machine will ever be completely smooth; at a very close level (microscopic for very fine feed rates), it will always contain regular ridges.

2.1.2 Automotive

Encompassing petrol and diesel driven vehicles, motor cycles, lawnmowers, generators and tractor mechanics.

The automotive industry is a term that covers a wide range of companies and organisations involved in the design, development, manufacture, repair marketing, aftermarket products and selling of motor vehicles, motorcycles, mopeds and recovery and repair of damaged and stolen vehicles. It is one of the world's most important economic sectors by revenue.

Modern automotive engineering, along with aerospace engineering and marine engineering, is a branch of vehicle engineering, incorporating elements of mechanical, electrical, electronic, software and safety engineering as applied to the design, manufacture and operation of motorcycles, automobiles, buses and trucks and their respective engineering subsystems. This includes entities such as:

Safety Engineering, Fuel Economy/Emissions, Vehicle Dynamics (ride, handling, steering, braking, comfort and traction), Design of the chassis systems of suspension (steering, braking, structure (frame), wheels and tires, and traction control); Vehicle Electronics (responsible for operational controls such as the throttle, brake and steering controls; as well as many comfort and convenience systems such as the HVAC, infotainment and lighting systems. It would not be possible for automobiles to meet modern safety and fuel economy requirements without electronic controls); Shift Quality (as influenced by the powertrain (engine, transmission), and the vehicle (driveline, suspension, engine and powertrain mounts, etc.); Drivability (cold starts and stalls, RPM dips, idle response, launch hesitations and stumbles, and performance levels).

2.1.3 Welding and Metalwork

Includes welding (gas, electric, MIG/MAGS), developments, working with sheet metal and the manufacturing of structures.

Welding is a fabrication or sculptural process that joins materials, usually metals or thermoplastics, by causing coalescence. This is often done by melting the work pieces and adding a filler material to form a pool of molten material (the weld pool) that cools to become a strong joint, with pressure sometimes used in conjunction with heat, or by itself, to produce the weld. This is in contrast with soldering and brazing, which involve melting a lower-melting-point material between the work pieces to form a bond between them, without melting the work pieces.

Many different energy sources can be used for welding, including a gas flame, an electric arc, a laser, an electron beam, friction and ultrasound. While often an industrial process, welding may be performed in many different environments, including open air, under water and in outer space. Welding is a potentially hazardous undertaking and precautions are required to avoid burns, electric shock, vision damage, inhalation of poisonous gases and fumes, and exposure to intense ultraviolet radiation.

Modern welding techniques include manual methods like shielded metal arc welding, now one of the most popular welding methods, as well as semi-automatic and automatic processes such as gas metal arc welding, submerged arc welding, flux-cored arc welding and electroslag welding. Developments continued with the invention of laser beam welding, electron beam welding, electromagnetic pulse welding and friction stir welding in the latter half of the century. Robot welding is commonplace in industrial settings, and researchers continue to develop new welding methods and gain greater understanding of weld quality.

Metalworking is the process of working with metals to create individual parts, assemblies, or large scale structures. The term covers a wide range of work from large ships and bridges to precise engine parts and delicate jewellery. It therefore includes a correspondingly wide range of skills, processes and tools. Metalworking is a science, art, hobby, industry and trade. Modern metalworking processes, though diverse and specialized, can be categorized as forming, cutting, or joining processes. Today's machine shop includes a number of machine tools capable of creating a precise, useful work piece.

2.2 Specific aims

- The learner in Mechanical Technology needs to be interested in any form of mechanical entities. This can be cars, planes, trains, welding, maintenance etc.
- In order to be successful, the learner must also enrol preferably in Mathematics, Physical Science and Engineering Graphics and Design, as they all form part of the technical studying field.
- Mechanical Technology in essence is applied science, as the field of work includes trigonometry, Newton’s laws and chemical equations when dealing with certain welding techniques, fuel combustion, fuel injection, cooling systems etc.

The main topics in Mechanical Technology are:

- Safety – Occupational Health and Safety (OHS) Act;
- Tools and equipment;
- Materials – ferrous and non-ferrous materials and alloys, and the iron-carbon equilibrium diagram;
- Terminology – manufacturing processes with reference to lathes (diameter turning, taper cutting, screw cutting) and milling machines (cutting methods, dividing head, centring of cutter);
- Joining methods – permanent (welding) and semi-permanent (bolts, nuts and rivets) joints;
- Forces – forces, moments, Young’s modulus, stress and strain;
- Maintenance;
- Systems and control:
- Mechanical – gears, belts, pulleys, power transmission, chains, clutches, cams, levers, etc.;
- Hydraulics – pistons, valves, Pascal’s law;
- Pneumatics;
- Electrical wiring – starting and charging circuits;
- Electronic applications – anti-lock braking system (ABS), fuel injection, air bag control, etc.;
- Engines – diesel and petrol, four and two stroke;
- Pumps – centrifugal, water; and
- Turbines – super and turbo chargers.

2.3 Requirements to offer Mechanical Technology

(a) Each learner should have

i. A textbook;

ii. Access to a variety of mechanical engineering and industrial magazines and reference books;

iii. Drawing equipment; and

iv. A calculator.

(a) Learners should have access to computers with a CAD programme at school.

(b) The school should subscribe to at least one or two industrial and mechanical engineering magazines for the teacher to keep abreast with the latest developments in the industrial environment. These magazines could also be lent out to learners (in the same way as library books). These resources must be readily available in the classroom or in the library.

(c) The teacher should have a variety of reference books, charts and brochures in the classroom to stimulate the learners' interest in the subject.

(d) The teacher should have access to the internet to be able to source, download and print relevant and new information, as the industry environment is a dynamic one with constant new trends and developments. The teacher should also have electronic mail facilities, as new information from subject advisors and other sources need to be downloaded via electronic mail. The teacher needs to be trained in the context and content of the subject.

(e) Schools offering Mechanical Technology must have a well-equipped workshop for learners to complete the practical assessment tasks. The classroom/workshop needs to be secure, with doors that lock, and burglar-proof. Enough storage space should be available to store and lock all resources. Resources to offer Mechanical Technology as a subject are the responsibility of the school. The school should build up a collection of models, e.g. by asking learners, parents and/or mechanical, electrical and electronic repair workshops and suppliers to donate models.

(f) Subject advisers must provide regular support to the teachers.

2.4 Subject offering by learners taking Mechanical Technology

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

Choice 1	Choice 2
Mathematics	Technical Mathematics
Physical Science	Technical Science
Mechanical Technology	Mechanical Technology
Engineering Graphics & Design	Engineering Graphics & Design

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

- Computer Applications Technology
- Information Technology
- Electrical Technology
- Civil Technology

Exercising these options 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 needs to take the subject in Grade 10, 11 and 12 and not only in Grade 12.

2.5 Human Resources

Mechanical Technology requires a trained subject specialist. It is preferred that the teacher offering mechanical technology is an artisan / technician / technical teacher in a Mechanical-related area. Industry-related experience and workshop management skills are essential as is a tertiary qualification in technical teaching.

Mechanical 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

2.6 Equipped Workshop

Mechanical 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 Mechanical 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 Mechanical 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.

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.

2.7 Sustainable Support

Mechanical Technology is a subject that requires sustained support. The Mechanical 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 Mechanical Technology should take note of the implications that the Mechanical 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 to acquire consumable materials for experiments, demonstrations and simulations.

Apart from the PAT resources 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.

2.8 Career opportunities in Mechanical Technology

- Apprenticeship to become an artisan such as a motor mechanic, fitter and turner, welder, boiler maker, tractor mechanic etc.
- Continued studies at a college in the NCV in a vocational career pathway
- Engineering studies in the fields of aviation, air-conditioning, motor cars, engines, ship building, power systems, electrical power stations etc.
- Studies at Higher Education Institutions (HEI's) and Skills training institutions with reference to the various mechanical streams
- Entering the world of work as an entrepreneur in various fields such as precision machining, programming of lathes and milling machines, fitment of accessories to cars and trucks to enhance performance, maintenance of many different mechanical installations
- Research and development of new and current entities in the mechanical field of work
- Mechanical Technology does not have the distinction of being a Grade 12 exemption subject; it has the advantage of giving learners the background of what is expected from them when enrolling in any mechanical study opportunities.
- Specific career opportunities:
    - Engineering – aviation, motor, trains, shipping, metallurgic etc.
    - Fitter
    - Machinist
    - Gunsmith
    - Motor mechanic
    - Diesel mechanic
    - Motorbike mechanic
    - Farm mechanic
    - Technician
    - Instrument specialist
    - Vehicle designer
    - Auto electrician
    - Specialized engine tuner and diagnostic analyst
    - Suspension builder
    - Blacksmith
    - Jeweller
    - Rigger
    - Welder

- Boilermaker
- Panel beater
- Exhaust fitter
- Brake and clutch fitter and machinist
- Upholsterer
- Draughtsman
- Toolmaker
- Automotive machinist and fitter
- Engine rebuilder
- Transmission machinist
- Roof truss developer
- Technical teacher
- Lecturer
- Technical trainer etc.

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.

FITTING AND MACHINING PROGRESSION			
	GRADE 10	**GRADE 11**	**GRADE 12**
GENERIC	• **Safety** Basic first aid HIV/Aids Awareness OHS act Safe and hazardous conditions • **Tools** Hand tools Measuring tools • **Materials** Characteristics and uses • **Joining Methods** Drill and key sizes Semi-permanent joining • **Forces** Types of forces Basic calculations • **Maintenance** Properties of lubricants Lack of maintenance • **Engines** Operating principles of 2 and 4 stroke internal combustion engines	• **Safety** Basic first Aid HIV/Aids Awareness OHS act Machine specific safety measures • **Tools** Purpose made tooling and equipment • **Materials** Equipment used during manufacturing of steel Properties of engineering materials • **Maintenance** Malfunction of power tools due to lack of maintenance	• **Safety** First Aid HIV/Aids Awareness OHS act Machine specific safety measures • **Materials** Properties and Uses Methods of enhancing the properties of steel

FITTING AND MACHINING PROGRESSION			
	GRADE 10	**GRADE 11**	**GRADE 12**
SPECIALISATION	• **Terminology** Readings on vernier calipers and micrometres lathe function and purpose Cutting procedures Screw cutting • **Systems and control** Identify various drive systems Velocity calculations Screw threads	• **Tools** Purpose made tooling and equipment • **Terminology** Lathe work Taper turning Screw cutting Milling machine safety and parts Milling operations • **Forces** Effects of forces Moments Basic calculations on stress • **Maintenance** Causes of malfunction on lathes, milling machines and power tools • **Joining Methods** ISO metric V tread Calculations on size of drills and bolts • **Systems and control** Functions, advantages and disadvantages of compound drives Velocity calculations Transfer of movement Hydraulics and pneumatics • **Pumps** Purpose and operation of various pumps	• **Terminology** Indexing Dovetail slides DRO programming Irregular work pieces Manufacturing a spur gear • **Tools** Principles and functions of engineering equipment Calculations on depth and screw thread micrometres • **Forces** Basic calculations on forces, moments and stress and strain • **Maintenance** Suitable preventative maintenance Coefficient of friction • **Joining Methods** Calculations on size of drills for bolts and nuts ISO metric Calculations on size of drills for bolts and nuts Square thread • **Systems and control** Mechanical components Velocity calculations Transfer of movement Hydraulics/Pneumatics

3.1 Content outline per term: Fitting and Machining

3.1.1 Fitting and Machining: Grade 10

MECHANICAL TECHNOLOGY: FITTING AND MACHINING

GRADE 10

GRADE 10: TERM 1 – FITTING AND MACHINING

WEEK	TOPIC	CONTENT
1 - 3 **12 hours**	**SAFETY (Generic)**	Organise and manage activities responsibly and effectively, including self-management and HIV/Aids awareness; Safety precautions taken into account during performance-based activities in order to avoid injuries or incidents. Explain his/her rights, human rights, contributions and responsibilities. **Understanding of the OHS Act** Learners must be fully aware of all the safety precautions to be taken during performance-based activities, in order to avoid injuries or incidents. Refer specifically to the following tools/machines/equipment: • Different hand tools • Pedestal drill • Lathe • Milling machine • Bench grinder • Guillotine • Bending machine • Power saws • Two and/or four post lift, trolley jack and trestles **Identify safe and hazardous acts and conditions e.g. speed of emery wheels, etc.** Apply personal hygiene measures. Refer specifically to the following tools/machines/equipment (refer to Topic 2: Tools): • Different hand tools • Pedestal drill • Pedestal grinder • Guillotine • Compressors • Fire extinguishing apparatus **Practical:** Identify safe and hazardous acts and conditions (e.g. speed of emery wheels, Maximum lift on hydraulic equipment etc.) Apply personal hygiene measures. **Note:** Clean workshop on a weekly basis

GRADE 10: TERM 1 – FITTING AND MACHINING

WEEK	TOPIC	CONTENT
4 - 7 **16 hours**	**TERMINOLOGY (Machining) (Specific)**	**Simple readings on:** • Vernier callipers • Outside, inside and depth micrometers **Lathe:** • Classification • Types of bed: V and flat and gap • Functions of: ➢ Feed shaft ➢ Head stock ➢ Lead screw ➢ Tail stock ➢ Carriage • Function and purpose of the 3- and 4-jaw chuck • Coolants (Application and advantages and disadvantages) • Cutting tool (high speed steel): ➢ Clearance angles ➢ Cutting angles ➢ Differentiate between high speed steel cutting tools and tungsten tip tools ➢ Tool holders and boring bars (Types and uses) • Apply cutting procedures for diameter turning and facing • Taper turning (Methods, Advantages and disadvantages): ➢ Compound slide ➢ Tail stock ➢ Taper turning attachment ➢ Cutting tool • Screw cutting (Compound slide – Theory only): ➢ Characteristics and elements of metric V-thread ➢ Parallel ➢ Half of the included angle of the thread ➢ Use of the screw thread pitch gauge and screw cutting gauge **Practical:** • Use the abovementioned measuring instruments and demonstrate the measurement of given sizes. • Facing and parallel turning of a work piece on the centre lathe. • Machining of an outside taper using the compound slide only on the same work piece used for the facing and parallel turning

GRADE 10: TERM 1 – FITTING AND MACHINING

WEEK	TOPIC	CONTENT
8 - 9 **8 hours**	**TOOLS (Generic)**	Basic tools and equipment: • Spanners: ring-, flat- and combination- • Sockets and accessories • Pliers: combination, circlip, diagonal, long nose and water pump pliers, vice grip • Hammers: ball peen, soft face, cross pane, mallet • Chisels, hacksaws, scribers, punches • Screwdrivers: flat, Phillips/star and off set • Allen keys • Files, smooth; second cut and bastard: flat-, square-, triangle-, round and half round shapes • Stocks and dies Identify and explain the functions of the THREE types of drilling machines, namely sensitive (pedestal and pillar types), radial and portable drills Application of measuring and marking-off instruments: • Steel Rule • Square • Scriber • Tape measure • Combination set • Punches **Practical:** Use the marking-off instruments to mark-off a plate (at least 5mm thick) with 5 holes.
10 **4 hours**	**REVISION**	
11 **4 hours**	**CONTROL TEST**	

GRADE 10: TERM 2 – FITTING AND MACHINING

WEEK	TOPIC	CONTENT

1 - 2
8 hours
	JOINING METHODS (Generic)	Basic calculations on the size of drills and key sizes:
		• Drill sizes for screw cutting
		• Width, thickness and length of keys
		
		Application of hand threading with the aid of the tap and die set
		
		Semi-permanent joining methods:
		• Bolts
		• Studs
		• Locking devices
		• Nuts
		• Split pins
		• Rivets
		• Keys – Identification, fitting and uses of the following types:
		  • Parallel
		  • Taper
		  • Gib head
		  • Woodruff keys
		Practical:
		Use the marking-off plate from Topic "Tools" and drill and tap two (2) holes.

GRADE 10: TERM 2 – FITTING AND MACHINING

WEEK	TOPIC	CONTENT
3 - 6 **16 hours**	**FORCES** **(Generic)**	**Forces:** Differentiate between the different types of forces found in engineering components: • Pulling force (Tensile) • Compressive force • Shearing force Components of forces: • Triangle and parallelogram of forces – resultant of two forces graphically only; • Graphical and mathematical solution of the horizontal and vertical component of a single force acting at an angle. **Moments:** Moments found in engineering components (basic calculations): Definition: Moment = force x perpendicular distance (Spanner used to tighten a nut or bolt) **Stress (Basic calculations on):** • Square bar • Round bar **Practical:** Use basic calculations to determine forces, moments and stress

GRADE 10: TERM 2 – FITTING AND MACHINING

WEEK	TOPIC	CONTENT
7 - 8 **8 hours**	**MAINTENANCE (Generic)**	Properties of lubricants: • Viscosity • Pour point • Flash point Grading of oil according to viscosity: (SAE standards) • Transmission oil • Engine oil • Differential oil • Cutting fluid • Grease Friction: • Characteristics • Application Define the following types of maintenance: • Preventive • Predictive • Reliability centred maintenance Identify the outcome of the lack of maintenance on equipment used in the workshop: • Excessive wear • Overheating/seizing; and distortion (lack of cooling and lubrication) • Failure e.g. hydraulics/pneumatics, controls and cables Disadvantages of an unbalanced work piece or machine part **Practical:** Analyse and predict the outcome of the lack of maintenance on equipment used in the workshop
9 - 11 **12 hours**	**MID-YEAR EXAMINATION**	

GRADE 10: TERM 3 – FITTING AND MACHINING

WEEK	TOPIC	CONTENT
1 **4 hours**	**MATERIALS (Generic)**	Characteristics, composition and use of: • Ferrous metals and alloys: ➢ Low carbon steel ➢ Medium carbon steel ➢ High carbon steel ➢ Cast iron: ▪ Grey cast iron ▪ White cast iron ➢ Stainless steel (manganese, chrome, vanadium, titanium, tungsten, molybdenum and cobalt) • Non-ferrous elements: ➢ Copper, tin, lead, zinc, aluminium, nickel • Non-ferrous alloys: ➢ Brass, bronze, phosphor bronze, white metal, duralumin and solder **Practical:** • Collect a sample of 5 non-ferrous elements and 5 non-ferrous alloys • Give 2 uses for each sample collected

GRADE 10: TERM 3 – FITTING AND MACHINING

WEEK	TOPIC	CONTENT
2 – 9 **32 hours**	**SYSTEMS AND CONTROL (Drive systems) (Specific)**	**MECHANICAL:** Identify different drive systems referring to (application, advantages, disadvantages): • Spur gears • Pulleys and belt drives • Chain drives **Basic velocity calculations on:** • Gears: ($N_1T_1 = N_2T_2$) (two gears) • Pulleys: $N_1D_1 = N_2D_2$ • Belt speed: $V = \pi DN$ **Identification and application on the following screw threads (properties, uses, profiles and angles):** • ISO Metric V-thread (fine and coarse) • Square thread • Acme thread **Practical:** Use basic calculations to determine basic velocity on gears and pulleys, including belt speed.
10	**REVISION**	
11	**TEST**	

GRADE 10: TERM 4 – FITTING AND MACHINING

WEEK	TOPIC	CONTENT
1 – 2 **8 hours**	**ENGINES (Generic)**	Operating principles of 2 and 4 stroke internal combustion engines. (Single cylinder spark ignition engines only): • Stroke • Dead centre • Cycle **Practical:** Demonstrate knowledge of the operating principles of the 2 and 4 stroke internal combustion spark ignition engines
3	**REVISION**	
4 – 9	**FINAL EXAMINATION**	

3.1.2 Fitting and Machining: Grade 11

FITTING AND MACHINING

GRADE 11: TERM 1 – FITTING AND MACHINING

WEEK	TOPIC	CONTENT
1 – 3 **12 hours**	**SAFETY (Generic)**	HIV/AIDS Awareness Knowledge of basic First Aid measures Analyse the OHS Act and regulations where applicable Applying machine-specific safety measures when dealing with: • Grinding machines (portable, bench and surface) • Cutting machines (drilling machines, power saw, band saw) • Press machines • Joining equipment (arc, gas) • Handling and storage of gas cylinders • Hydraulic operated equipment – hydraulic press **Practical:** Perform a first aid exercise to demonstrate action to be taken when a fellow learner hurts him/herself in the workshop.

GRADE 11: TERM 1– FITTING AND MACHINING

WEEK	TOPIC	CONTENT
4 – 6 **12 hours**	**TERMINOLOGY** **Machining** **(Specific)**	**Lathe:** • Safety measures • Set up of irregular work pieces – 4 jaw chuck • Steadies (purpose and use) • Mandrels (purpose and use) • Taper turning (compound slide method – inside and outside tapers) ➢ Calculations for setting over of compound slide • Screw cutting ➢ Description of the pitch and leads for single- and multi-start screw threads ➢ Uses of screw thread dial gauge, pitch gauge, centre gauge and graduated collar when screw thread cutting is carried out ➢ Methods to determine the locating positions on the dial gauge ➢ Calculations of depth of V-threads ➢ Square thread (calculations of the helix, leading and following angles for the cutting tools) **Practical – Lathe:** • Set-up of an irregular work piece in a 4-jaw chuck • Use the lathe to do taper turning • Use the lathe to do V-thread screw cutting **Milling machine:** • Safety measures • Milling machine parts • **Calculations on:** • Centring of cutter • Cutting of key ways – parallel • Milling cutters (identification and uses): • Side and face cutter • End mill • Flute mill • T-slot mill • Helical cutter • Involute gear tooth cutter **Practical – Milling machine:** • Centring of cutter • Cutting of parallel key way

GRADE 11: TERM 1 – FITTING AND MACHINING

WEEK	TOPIC	CONTENT
7 – 8 **8 hours**	**TOOLS (Generic)**	The principles and functions of the following purpose-made tooling and equipment: • Stocks and dies (characteristics and drill sizes) • Grinding machines (portable, bench) • Cutting machines (drilling machines, power saw, horizontal band saw) • Guillotine machine (manual and power driven) • Press machines **Practical:** Explain the safety precautions to be followed when using the various cutting and grinding machines.
9 **4 hours**	**TOOLS (Specific)**	The principles and functions of the following purpose-made tooling and equipment: • Dial indicators • Telescopic gauges • Torque wrenches • Inside micrometres (simple readings from the instruments, use of attachments) **Practical:** Demonstrate competent use of: • Dial indicators • Telescopic gauges • Torque wrenches • Inside micrometres
10	**REVISION**	
11	**CONTROL TEST**	

GRADE 11: TERM 2 – FITTING AND MACHINING

WEEK	TOPIC	CONTENT
1 - 4 **16 hours**	**FORCES** **(Specific)**	**Forces:** Effects of forces, moments and torques on engineering components applying design principles Basic calculations on: Forces found in engineering components: • System of forces (maximum of three forces) • Resultant and equilibrant **Moments:** Moments found in engineering components: (By calculation only) Law of moments: Sum of LHM = Sum of RHM A simply supported beam with two vertical point loads acting on the beam supported by two supports. **Basic calculations on stress:** • Square tubing • Round tubing **Practical:** Use basic calculations to determine forces, moments and stress

GRADE 11: TERM 2 – FITTING AND MACHINING

WEEK	TOPIC	CONTENT
5 **4 hours**	**MAINTENANCE** **(Generic)**	Identify causes of malfunction of pedestal drill, power saw and pedestal grinder: • Lack of lubrication or incorrect lubrication • Overloading • Friction **Practical:** Analyse and predict the outcome of the lack of maintenance on equipment used in the workshop.
6 **4 hours**	**MAINTENANCE** **(Specific)**	Identify causes of malfunction of lathes and milling machines. • Lack of lubrication or incorrect lubrication • Overloading • Friction • Balancing **Practical:** Analyse and predict the outcome of the lack of maintenance on equipment used in the workshop:

WEEK	TOPIC	CONTENT
7 - 8 **8 hours**	**JOINING METHODS (Specific)**	Identify the characteristics of the ISO metric V-thread. Use basic calculations for the ISO metric V-thread: • Root diameter • Crest diameter • Effective diameter • Pitch • Lead for multi-start screw threads **Practical:** Use basic calculations to determine the following for ISO metric V-thread: • The drill size to tap a V-thread • Tap hole(s) according to bolt size
9 - 11	**MID-YEAR EXAMINATION**	

GRADE 11: TERM 3 – FITTING AND MACHINING

WEEK	TOPIC	CONTENT
1 - 4 **16 hours**	**MATERIALS (Generic)**	Function and operation of the following equipment used during the manufacturing of steel: • Blast furnace – refining of iron ore • Open-hearth furnace • Bessemer converter • Electric arc furnace • Rotor plant Distinguish between the following properties of engineering materials: • Hardness • Plasticity • Elasticity • Ductility • Malleability • Brittleness • Toughness

GRADE 11: TERM 3 – FITTING AND MACHINING

WEEK	TOPIC	CONTENT
5 - 9 **20 hours**	**SYSTEMS AND CONTROL** **Drive systems (Specific)**	**MECHANICAL COMPONENTS:** Uses, functions, advantages and disadvantages of the following compound drives: • Gear train • Pulley systems (i.e. block and tackle) • V-Belt drives • Chain drives **Basic velocity calculations on:** • Gears (compound) Including idler gears • Pulley systems and • Belts (v-belts) **Transfer of movement:** • Spur gears ➢ Gear Ratio ➢ Power transmission **HYDRAULICS / PNEUMATICS** **Basic calculations on:** Pistons and reservoirs (only a single cylinder): volume, pressure, force, area **Description, identification and application of:** Valves, pipes, pressure gauges **Practical:** Practically determine the transfer of movement of mechanical and hydraulic operating systems mentioned above including drive systems through a simple designed project
10	**REVISION**	
11	**CONTROL TEST**	

GRADE 11: TERM 4 – FITTING AND MACHINING

WEEK	TOPIC	CONTENT
1 **4 hours**	**PUMPS (Specific)**	**Identify the following pumps by referring to purpose, construction and operating principles:** • Mono pumps • Centrifugal pumps • Reciprocating pumps • Gear pumps
2 – 3	**REVISION**	
4 – 9	**EXAMINATION**	

3.1.3 Fitting and Machining: Grade 12

FITTING AND MACHINING

GRADE 12

GRADE 12: TERM 1 – FITTING AND MACHINING

WEEK	TOPIC	CONTENT
1 - 3 **12 hours**	**SAFETY (Generic)**	HIV/AIDS Awareness Knowledge of basic First Aid measures Analyse the OHS Act and regulations where applicable to the following machines: • Grinding machines (portable, bench and surface) • Cutting (drilling machines, power saw, band saw) • Shearing machines (manual and power driven) • Press machines • Joining (arc, gas) • Handling and usage of gas cylinders Knowledge and application of basic workshop layouts: • Process layout • Product layout Referring to the OHS Act, analyse the responsibilities of the: • Employer • Employee **Practical:** Compare the process and product layout of 2 different manufacturing or maintenance workshops

GRADE 12: TERM 1 – FITTING AND MACHINING

WEEK	TOPIC	CONTENT
4 - 5 **8 hours**	**TERMINOLOGY** **Machining** **(Specific)**	**Lathe:** • Safety measures • Taper turning (compound slide method – inside and outside tapers) ➢ Calculations for setting over of compound slide and tail stock • Screw cutting ➢ Description of the pitch and leads for single- and multi-start screw threads ➢ Uses of screw thread dial gauge, pitch gauge, centre gauge and graduated collar when screw thread cutting is carried out ➢ Methods to determine the locating positions on the dial gauge ➢ Calculations of depth of V-threads and square threads ➢ Square thread (calculation of helix, leading and following angles for the cutting tools) ➢ Methods of cutting multi-start screw threads (Theory only): • Set over of compound slide • Change gear **Milling machine:** • Safety measures • Calculations on: ➢ Centring of cutter ➢ Cutting of keyways • Identifying and apply the following milling processes and describe the advantages and disadvantages: ➢ Gang milling ➢ Straddle milling ➢ Down cut ➢ Up cut **Practical:** • Use a lathe to do taper turning • Use a lathe to do multi-start screw cutting • Use a milling machine to show compliance on down cut and up cut milling • Use a milling machine to cut a parallel keyway

GRADE 12: TERM 1 – FITTING AND MACHINING

WEEK	TOPIC	CONTENT
6 - 8 **12 hours**	**TERMINOLOGY** **Machining** **(Specific)**	**Indexing:** • Calculations on the indexing for a square, pentagon and hexagon – including the depth of cut • Calculations of the following indexing processes: ➢ Rapid ➢ Simple ➢ Angular ➢ Differential **Dovetail slides:** • Calculation for internal and external dove tail with precision rollers • Calculation of included angle. • Test for accuracy **Write a Digital Read Out (DRO) Program to incorporate cutting a recess on a work piece:** • Explain the difference between DRO and CNC systems • Programming on a 3-axis digital readout system (“DRO”) on milling machines • Absolute and incremental reference systems • Tools change position • Allowance for diameter thickness **Balancing of irregular work pieces on a lathe:** • Graphical solution to balance an unbalanced work piece on a face plate **Manufacturing of spur gear:** • Involute gear tooth form with a module of no more than 3 • Calculations on: ➢ Number of teeth ➢ Pitch circle diameter ➢ Module ➢ Outside diameter ➢ Addendum ➢ Dedendum ➢ Full depth – cutting depth ➢ Working depth ➢ Clearance ➢ Circular pitch, choral tooth thickness, choral tooth addendum ➢ Indexing **Practical:** Use a milling machine to cut a spur gear.

GRADE 12: TERM 1 – FITTING AND MACHINING

WEEK	TOPIC	CONTENT
9 **4 hours**	**TOOLS** **(Specific)**	**Describe the principles and functions of advanced engineering equipment:** • Brinell and Rockwell hardness testers • Moments and forces testers • Tensile testers **Simple calculations on:** • Depth micrometre • Screw thread micrometre (included angle) **Practical:** • Do tests by using the above advanced engineering equipment • Use micrometres to take different measurements
10	**REVISION**	
11	**CONTROL TEST**	

GRADE 12: TERM 2 – FITTING AND MACHINING

SPECIFIC CONTENT

WEEK	TOPIC	CONTENT
1 - 4 **16 weeks**	**FORCES** **(Specific)**	**Forces:** Basic calculations: • System of forces (maximum of four forces) • Resultant and equilibrant **Moments:** Moments found in engineering components: (By calculation only) A simply supported beam with two vertical point loads and one uniformly distributed load (UDL) acting on the beam including reactions at the supports (only two) **Stress/Strain:** Basic calculations on: • Stress, • Strain (Stress/Strain diagram only for mild steel), • Safety factor, • Modulus of elasticity and • Change in length. **Practical:** Use basic calculations to determine forces, moments and stress

WEEK	TOPIC	CONTENT
5 - 6 **8 hours**	**MAINTENANCE (Specific)**	**Suitable preventative maintenance in operating systems for:** • Gear, • Belt and • Chain drives. **The use of the following materials for bushes and gears:** • Thermoplastic composites : ➢ Nylon ➢ Teflon ➢ Poly Vinyl Composite (PVC) ➢ Vesconite • Thermo hardened (Thermosetting) composites ➢ Carbon Fibre ➢ Glass Fibre ➢ Bakelite **Minimum and maximum coefficient of friction for the following different materials:** • Copper, • Cast iron, • Thermo composites, • Stainless steel, • White metal, and • Rubber **Practical:** Collect and identify samples of Thermoplastic and Thermo hardened composites

GRADE 12: TERM 2 – FITTING AND MACHINING

WEEK	TOPIC	CONTENT
7 - 8 **8 hours**	**JOINING METHODS (Specific)**	Use basic calculations on the size of drills for bolts and nuts (ISO metric): • Root diameter • Crest diameter • Effective diameter • Pitch • Lead for multi-start screw threads Use basic calculations on the size of drills for bolts and nuts (Square thread): • Crest diameter • Effective diameter • Pitch • Lead for multi-start screw threads • Helix angle • Following angle – cutting tool – support by means of a clear drawing • Leading angle – cutting tool - support by means of a clear drawing • Clearance angle - support by means of a clear drawing **Practical:** Use basic calculations to determine the dimensions of a square thread
9 - 11	**MID-YEAR EXAMINATION**	

GRADE 12: TERM 3 – FITTING AND MACHINING

SPECIFIC CONTENT

WEEK	TOPIC	CONTENT
1 - 2 **8 hours**	**MATERIALS (Generic)**	**Identify materials by:** • Sound test • Bending test • Filing test and • Machining test **Methods of enhancing the properties of steel (only heated temperature and cooling apply):** • Tempering • Case hardening • Hardening • Annealing • Normalising **Practical:** Test FOUR different types of materials using the: • Sound test • Bending test • Filing test • Machining test

GRADE 12: TERM 3 – FITTING AND MACHINING

WEEK	TOPIC	CONTENT
3 - 6 **16 hours**	**SYSTEMS AND CONTROL** **Drive systems (Specific)**	**MECHANICAL COMPONENTS:** Uses, functions, advantages and disadvantages of the following drive systems: • Gears • Pulleys • Belts (V- and flat) and • Chains **Basic power and velocity calculations on:** • Gears – Transmission of torque (T=Fr) and power ($P=2\pi NT/60$) • Gears (compound): Angular velocity and direction of rotation – including idler gears • V-belts, chains and pulleys: Linear velocity ($V=\pi DN$), and angular velocity ($N_1D_1=N_2D_2$) **HYDRAULICS / PNEUMATICS** **Applied calculations on:** • Pistons and reservoirs – hydraulic jack (ram and plunger) • The force exerted in a closed circuit. **Identification and use of hydraulic components indicated by the symbols:** • Motor • Pump • Filter • One-way valve • Spring-loaded double-action control valve • Pressure gauge • Non-return valve • Reservoir **Practical – hydraulics:** Design and illustrate schematically a double-action hydraulic control system **Practical – mechanical systems:** Use basic calculations to determine the outcome of the abovementioned drive systems
7 - 11	**TRIAL EXAMINATION**	

GRADE 12: TERM 4 – FITTING AND MACHINING

WEEK	TOPIC	CONTENT
1 – 3	REVISION	
4 – 9	EXAMINATION	

AUTOMOTIVE PROGRESSION			
	GRADE 10	GRADE 11	GRADE 12
GENERIC	• **Safety** (HIV/Aids Awareness); • **Tools** Hand tools Measuring tools; • **Materials** Characteristics and uses • **Forces** Types of forces Basic calculations • **Maintenance** Properties of lubricants Friction Lack of maintenance • **Joining Methods** Calculations on drill and key sizes Semi-permanent joining methods • **Engines** Operating principles of 2 and 4 stroke internal combustion engines	• **Safety** Basic first Aid HIV/Aids Awareness OHS act Machine specific safety measures • **Tools** Purpose made tooling and equipment • **Materials** Equipment used during manufacturing of steel Properties of engineering materials • **Maintenance** Malfunction of power tools due to lack of maintenance	• **Safety** First Aid HIV/Aids Awareness OHS act Machine-specific safety measures • **Materials** Properties and Uses Methods of enhancing the properties of steel

	AUTOMOTIVE PROGRESSION		
	GRADE 10	GRADE 11	GRADE 12

SPECIALISATION	• **Terminology** Single plate clutch Manual gearbox Function and operation of drive shafts • **Maintenance** Lubrication systems Temperature control Cooling systems Maintain fluid levels • **Systems and** control Basic carburetion Air filters Hydraulic brake system • **Engines** Identification and function of engine components Conventional lay-outs	• **Tools** Purpose-made tooling and equipment, dial indicators, telescopic gauges and measuring instruments • **Terminology** Workshop administration • **Forces** Automotive calculations and application • Maintenance Engine lubrication Oil pumps purpose and operation Oil control • Systems and control Final drives Purpose and layout of drive systems Hydraulic brakes Axles Steering control Suspension layouts Electricity conventional ignition systems Starting circuit Supplemental systems, traction control and air bag control • Engines CI engines Injectors Valve assemblies	• Tools Application of diagnostic equipment • Forces Automotive calculations • Maintenance Use test equipment to diagnose faults • Systems and control Operation and function of the automatic gearbox Steering geometry Electricity • Engines Crankshafts Construction and operation of turbo chargers

3.2 Content outline per term: Automotive

3.2.1 Automotive: Grade 10

MECHANICAL TECHNOLOGY: AUTOMOTIVE

GRADE 10 – TERM 1

WEEK	TOPIC	CONTENT
1 - 3 **12 hours**	**SAFETY (Generic)**	Organise and manage activities responsibly and effectively including self-management and HIV/Aids awareness; Safety precautions taken into account during performance-based activities in order to avoid injuries or incidents. Explain his/her rights, human rights, contributions and responsibilities. **Understanding of the OHS Act** Learners must be fully aware of all the safety precautions to be taken during performance-based activities in order to avoid injuries or incidents. Refer specifically to the following tools/machines/equipment: • Hand tools • Pedestal drill • Bench grinder • Lathe • Milling machine • Guillotine • Compressors • Fire extinguishing apparatus • Bending machine • Power saws • Two and/or four post lift, trolley jack and trestles **Practical:** Identify safe and hazardous acts and conditions (e.g. speed of emery wheels, Maximum lift on hydraulic equipment, etc.) Apply personal hygiene measures. **Note:** Clean workshop on a weekly basis

GRADE 10: TERM 1 – AUTOMOTIVE

WEEK	TOPIC	CONTENT
4 - 5 **8 hours**	**TOOLS (Generic)**	Basic tools and equipment: • Spanners: ring-, flat- and combination- • Sockets and accessories • Pliers: combination, circlip, diagonal, long nose and water pump pliers, vice grip • Hammers: ball peen, soft face, cross pane, mallet • Chisels, hacksaws, scribers, punches • Screwdrivers: flat, Phillips/star and off set • Allen keys • Files, smooth; second cut and bastard: flat-, square-, triangle-, round and half round shapes • Stocks and dies Identify and explain the functions of the THREE types of drilling machines, namely sensitive (pedestal and pillar types), radial and portable drills. Application of measuring and marking-off instruments: • Steel Rule • Square • Scriber • Tape measure • Combination set • Punches **Practical:** Use the marking-off instruments to mark-off a plate (at least 5mm thick) with 5 holes.

GRADE 10: TERM 1 – AUTOMOTIVE

WEEK	TOPIC	CONTENT
6 - 7 **8 hours**	**ENGINES (Generic)**	Operating principles of 2 and 4 stroke internal combustion engines. (Single cylinder spark ignition engines only): • Stroke • Dead centre • Cycle **Practical:** Demonstrate knowledge of the operating principles of the 2 and 4 stroke internal combustion spark ignition engines
8 - 9 **8 hours**	**ENGINES (Specific)**	**Identification and function of engine components**: Pistons, piston rings, crankshaft, connecting rod, bearings, gudgeon pin, camshaft, cam and crank gears, valves, valve springs, lifters, flywheel, cylinder head, engine block, oil pump, manifolds, carburettor, water pump, gaskets and seals. **Practical:** • Identify and describe functions of various engine components of a 2 and 4 stroke single cylinder spark ignition engine. (Use actual engines) • Do a comparison between 2 and 4 stroke SI engines regarding operating cycle and construction **Conventional layouts:** • Engine in front with front- and rear-wheel drives • Engine at rear with rear-wheel drive • Advantages and disadvantages of each position
10	**REVISION**	
11	**CONTROL TEST**	

GRADE 10: TERM 2 – AUTOMOTIVE

WEEK	TOPIC	CONTENT
1 - 2 **8 hours**	**JOINING METHODS (Generic)**	Calculations on the size of drills and key dimensions: • Drill sizes for screw cutting • Width, thickness and length of keys **Practical:** Apply hand threading with the aid of a the tap and die set Semi-permanent joining methods: • Bolts • Studs • Locking devices • Nuts • Split pins • Rivets • Keys – Identification, fitting and uses of the following types: • Parallel key • Taper key, • Gib-head key • Woodruff key **Practical:** Produce semi-permanent joints using any two of the following methods: bolts and nuts, rivets, studs and split pins on flat bar or sheet metal.

GRADE 10: TERM 2 – AUTOMOTIVE

WEEK	TOPIC	CONTENT
3 - 6 **16 hours**	**FORCES (Generic)**	**Forces:** Different types of forces found in engineering components: • Pulling force (Tensile) • Compressive force • Shearing force Components of forces: • Triangle and parallelogram of forces – resultant of two forces only • Graphical and mathematical solution of the horizontal and vertical component of a single force acting at an angle **Moments:** Moments found in engineering components (basic calculations): Definition: Moment = force x perpendicular distance (Spanner used to tighten a nut or bolt) **Stress (Basic calculations on):** • Square bar • Round bar **Practical:** Use basic calculations to determine forces, moments and stress

GRADE 10: TERM 2 – AUTOMOTIVE

WEEK	TOPIC	CONTENT
7 - 8 **8 hours**	**MAINTENANCE (Generic)**	Properties of lubricants: • Viscosity • Pour point • Flash point Grading of oil according to viscosity: (SAE standards) • Transmission oil • Engine oil • Differential oil • Cutting fluid • Grease Friction: • Characteristics • Application Define the following types of maintenance: • Preventive • Predictive • Reliability centred maintenance Lack of maintenance on equipment • Excessive wear • Overheating/seizing; and distortion (lack of cooling and lubrication) • Failure e.g. hydraulics/pneumatics, controls and cables **Practical:** Analyse and predict the outcome of the lack of maintenance on equipment used in the workshop.
9 - 11	**MID-YEAR EXAMINATION**	

GRADE 10: TERM 3 – AUTOMOTIVE

WEEK	TOPIC	PRESCRIBED CONTENT
1 **4 hours**	**MATERIALS (Generic)**	Characteristics, composition and use of: • Ferrous metals and alloys: ➢ Low carbon steel ➢ Medium carbon steel ➢ High carbon steel ➢ Cast iron: • Grey cast iron • White cast iron ➢ Stainless steel (manganese, chrome, vanadium, titanium, tungsten, molybdenum and cobalt) • Non-ferrous elements: ➢ Copper, tin, lead, zinc, aluminium, nickel • Non-ferrous alloys: ➢ Brass, bronze, phosphor bronze, white metal, duralumin and solder **Practical:** • Collect a sample of 5 non-ferrous elements and 5 non-ferrous alloys • Give 2 uses for each sample collected

GRADE 10: TERM 3 – AUTOMOTIVE

WEEK	TOPIC	PRESCRIBED CONTENT
2 - 4 **12 hours**	**TERMINOLOGY (Specific)** **(DRIVE TRAINS)**	**Function, construction and operation of the single-plate clutch assembly:** • Flywheel • Diaphragm pressure plate • Clutch Plate (spring and solid disc) • Clutch Couplings: Mechanical; Cables, Linkages and Levers • Hydraulic; Master and Slave Cylinders, pipes • Fault finding **Identify and investigate the various components of the constant mesh manual gearbox and define the construction, function, operation and power flow of:** • Gears • Shafts • Seals and gaskets • Synchronising unit • Selector Mechanism **Practical:** Demonstrate knowledge of the working principle of a multi-speed manual gearbox including condition report. **Function, construction and operation of drive shafts:** • The Slip Joint • Universal Joint • Constant Velocity Joint • Flexible coupling

GRADE 10: TERM 3 – AUTOMOTIVE

WEEK	TOPIC	PRESCRIBED CONTENT
5 - 7 **12 hours**	**MAINTENANCE (Specific)**	**Lubrication Systems:** • Splash feed, Pressure Feed and Full pressure feed **Oil:** • Oil purity, oil dilution, Crankcase ventilation • Oil Filtration systems: Full-flow and by-pass systems **Temperature Control:** • Factors generating heat **Cooling systems:** • Direct air • Indirect air cooling **Components:** • Radiators, Radiator pressure cap, Water pumps, thermostat, by-pass system • Diagnose causes of overheating • Pressure test • Visual inspection **Practical:** • Do a visual inspection on a cooling system • Do a pressure test **Check and maintain all fluid levels:** • Water • Oil • Brake fluid
8 - 9 **8 hours**	**SYSTEMS AND CONTROL (Specific)**	**Basic carburetion:** • Function of a carburettor • Basic principle of operation • Idle & choke and high speed circuits **Air filters:** Purpose and types. **Hydraulic brake system** (Layout, function, construction and operation): • Master Cylinder (function) • Wheel Cylinders • Disc brake assembly • Brake shoe assembly • Hand brake assembly **Practical:** Replace front brake pads
10	**REVISION**	
11	**CONTROL TEST**	

GRADE 10: TERM 4 – AUTOMOTIVE

WEEK	TOPIC	PRESCRIBED CONTENT
1 - 2 **8 hours**	**SYSTEMS AND CONTROL (Specific)**	**Electricity:** • Electron theory – basic electrical principles: ➢ Electron movement ➢ Electrons and conductors ➢ Pulse with modulation ➢ Digital and analogue signal ➢ Effects of electricity • Characteristics of magnetism • Electromagnets • Ohm's Law • Electrical units and measurements: ➢ Volts ➢ Amps ➢ Ohms • Use of the Multi-meter • Basics series and parallel circuits • Battery – lead acid type **Practical:** Demonstrate: • Competence in the use of the multi-meter • Taking of basic measurements.
3	**REVISION**	
4 - 9	**EXAMINATIONS**	

3.2.2 Automotive: Grade 11

MECHANICAL TECHNOLOGY – AUTOMOTIVE

GRADE 11: TERM 1 – AUTOMOTIVE

WEEK	TOPIC	CONTENT
1 - 3 **12 hours**	**SAFETY (Generic)**	**First Aid:** • HIV/AIDS Awareness • Knowledge of basic First Aid measures **OHS Act:** Analyse the OHS Act and regulations where applicable. Machine-specific safety measures when dealing with: • Grinding machines (portable, bench and surface) • Cutting machines (drilling machines, power saw, band saw) • Press machines • Joining equipment (arc, gas) • Handling and storage of gas cylinders • Hydraulic operated equipment – hydraulic press **Practical:** Perform a first aid exercise to demonstrate action to be taken when a fellow learner hurts him/herself in the workshop.
4 - 5 **8 hours**	**TOOLS (Generic)**	The principles and functions of the following purpose-made tooling and equipment: • Stocks and dies (characteristics and drill sizes) • Grinding machines (portable, bench) • Cutting machines (drilling machines, power saw, horizontal band saw) • Guillotine machine (manual and power driven) • Press machines **Practical:** Explain the safety precautions to be followed when using the various cutting and grinding machines.

GRADE 11: TERM 1 – AUTOMOTIVE

WEEK	TOPIC	CONTENT
6 **4 hours**	**TOOLS** **(Specific)**	The principles and functions of the following purpose-made tooling and equipment: • Dial indicators • Telescopic gauges • Torque wrenches • Outside, Inside micrometres and vernier calliper (simple readings from the instruments, use of attachments) **Practical:** • Demonstrate the competent use of the specific tools above with the measuring of various engine components to determine wear etc. (e.g. bore, piston and crankshaft) • Tighten bolts to the correct torque in the correct sequence (cylinder head)
7 - 9 **12 hours**	**ENGINES** **(Specific)**	**C.I. Engines:** Combustion chamber designs for direct and indirect injection **Injector:** Function, construction, operation and types of nozzles **Valve assemblies:** • Identify various overhead valve arrangements • Identify various camshafts arrangements: SOHC (single) and DOHC (double) • Cam followers – mechanical and hydraulic • Valve timing diagram – necessity for lead, lag and overlap • Continuously variable valve timing (CVVT) system • Purpose and importance of valve clearance • Timing gears, chains, belt drives and tensioners **Practical:** • Research the CVVT systems used by any 4 various manufacturers of motor vehicles • Use a practical method and determine the valve timing of a four cylinder four stroke engine (with or without marks). Record findings
10	**REVISION**	
11	**TEST**	

GRADE 11: TERM 2 - AUTOMOTIVE

WEEK	TOPIC	CONTENT
1 - 4 **16 hours**	**MATERIALS (Generic)**	Function and operation of the following equipment used during the manufacturing of steel: • Blast furnace • Open-hearth furnace • Bessemer converter • Electric arc furnace • Rotor plant Distinguish between the following properties of engineering materials: • Hardness • Plasticity • Elasticity • Ductility • Malleability • Brittleness • Toughness

GRADE 11: TERM 2 – AUTOMOTIVE

WEEK	TOPIC	CONTENT
5 - 8 **16 hours**	**SYSTEMS AND CONTROL (Specific)**	**Basic function, construction and operation of final drives:** • Spiral bevel type • Hypoid type • Conventional differential • Limited slip differential **Practical:** • Use an actual differential in the workshop and explain the power flow under different simulated conditions and record findings **Identify the layout and purpose of different drive systems:** • Four-wheel drive • All-wheel drive **Hydraulic brakes:** • Master Cylinder (Parts & Operation) • Vacuum servo unit (purpose and operation) • ABS braking system (basic lay-out and operation) **Practical:** • Investigate a master cylinder and compile condition report
9 - 11	**EXAMINATION**	

WEEK	TOPIC	CONTENT
1 - 5 **20 hours**	**SYSTEM AND CONTROL (Specific)**	**Define the difference in construction between:** • Front axles • Rear axles: ➢ Semi-floating and, ➢ Full-floating **Steering systems, layout and operation:** • Types of steering boxes (Rack and pinion gearing and worm gearing) • Power steering • Electric power steering **Identify and state the function and purpose of the following steering control components:** • Drag links • Tie rod ends • Ball joints **Suspension layout and operation:** • Define sprung and un-sprung mass • Semi-elliptic leaf springs • Coil springs • Torsion bars • Control ➢ Telescopic shock absorbers (gas and hydraulic) ➢ Anti-roll bars ➢ Stabilisers **ELECTRICITY** **Identify the functions and describe the operation of the conventional ignition system with reference to:** • Firing order • Ignition timing • Spark plugs • Purpose of mechanical and vacuum regulators **Starting circuit:** Show an understanding of the basic starting circuit **Supplemental systems (purpose and operation):** • Traction control • Air bag control

GRADE 11: TERM 3 – AUTOMOTIVE

WEEK	TOPIC	PRESCRIBED CONTENT
6 **4 hours**	**MAINTENANCE (Generic)**	Identify causes of malfunction of pedestal drill, power saw and pedestal grinder: • Lack of lubrication or incorrect lubrication • Overloading • Friction **Practical:** Analyse and predict the outcome of the lack of maintenance on equipment used in the workshop.
7 **4 hours**	**MAINTENANCE (Specific)**	**ENGINE LUBRICATION** **Oil pumps (purpose and operation):** • Gear • Vane • Rotor **Demonstrate an understanding of oil control methods referring to:** • Oil filtration systems • Pressure relief valve • Seals **Servicing of vehicles:** • Importance of regular servicing **Practical:** • Describe the basic process to follow when performing a major service
8 - 9 **8 hours**	**FORCES (Specific)**	**Automotive calculations and application:** • Work • Power • Torque • Compression Ratio **Practical:** Use basic specifications from a given engine to determine the theoretical power (IP) and compression ratio (CR)
10	**Revision**	
11	**Control Test**	

GRADE 11: TERM 4 – AUTOMOTIVE

WEEK	TOPIC	CONTENT
1 - 2 **8 hours**	**TERMINOLOGY (Specific)**	• Workshop administration: ➢ Read and interpret job instructions ➢ Read, interpret and adhere to Manufacturers' Specifications
3 - 4	**REVISION**	
5 - 9	**EXAMINATIONS**	

3.2.3 Automotive: Grade 12

MECHANICAL TECHNOLOGY – AUTOMOTIVE

GRADE 12 – TERM 1

WEEK	TOPIC	CONTENT
1 - 3 **12 hours**	**SAFETY (Generic)**	HIV/AIDS Awareness Knowledge of basic First Aid measures Analyse the OHS Act and regulations where applicable to the following machines: • Grinding machines (portable, bench and surface) • Cutting (drilling machines, power saw, band saw) • Shearing machines (manual and power driven) • Press machines • Joining (arc, gas) • Handling and usage of gas cylinders Knowledge and application of basic workshop layouts: • Process layout • Product layout Referring to the OHS Act analyse the responsibilities of the: • Employer • Employee **Practical:** Compare the process and product layout of TWO different manufacturing or maintenance workshops

GRADE 12: TERM 1 – AUTOMOTIVE

WEEK	TOPIC	CONTENT
4 - 6 **12 hours**	**TOOLS (Specific)**	**Identification and application of diagnostic equipment:** • Compression tester • Cylinder leakage tester • Gas analyser (all crankcase gases) • Computerised diagnostic scanner • Wheel balancer • Wheel alignment equipment (bubble gauge and turn tables) **Practical:** Use any 2 of the diagnostic equipment mentioned above to simulate a real-life situation
7 - 9 **12 hours**	**ENGINES (Specific)**	**Crankshafts:** • Balancing of crankshafts • Vibration damper (function and assembly) • Cylinder layouts • Crank arrangements • Firing orders **Describe the operating principles and construction of:** • Turbochargers • Super chargers **Practical:** Compare and identify different crankshafts layouts and match to the different cylinder blocks
10	**REVISION**	
11	**CONTROL TEST**	

GRADE 12: TERM 2 – AUTOMOTIVE

WEEK	TOPIC	CONTENT
1 - 2 **8 hours**	**MATERIALS (Generic)**	**Identify materials by:** • Sound test • Bending test • Filing test • Machining test **Methods of enhancing the properties of steel (only heated temperature and cooling apply):** • Tempering • Case hardening • Hardening • Annealing • Normalising **Practical:** Test TWO different materials using the: • Sound test • Bending test • Filing test • Machining test
3 - 4 **8 hours**	**FORCES (Specific)**	**Application of the following automotive calculations:** • Work, Power, Torque, Compression Ratio • Indicated Power, Brake Power, Mechanical Efficiency **Practical:** • Measure stroke • Measure cylinder bore • Measure combustion chamber volume Use specifications and measurements obtained from a given engine and calculate the Indicated power

GRADE 12: TERM 2 – AUTOMOTIVE

WEEK	TOPIC	CONTENT
5 - 6 **8 hours**	**MAINTENANCE (Specific)**	**Diagnose faults by using and reading test equipment:** • Gas analysing • Compression test • Cylinder leakage • Pressure test **Practical:** Use abovementioned equipment to diagnose faults on an engine
7 - 8 **8 hours**	**SYSTEMS AND CONTROL (Specific)** **(DRIVE TRAINS)**	**Describe the operational purpose and functions of the automatic gearbox:** • Torque converters • Epicyclical gear trains • Brake bands/locking devices • Control body (purpose only) • Gear Ratios **Practical:** • Explain the power flow through the torque convertor • Identify various main components of the automatic gearbox
9 - 11	**EXAMINATION**	

GRADE 12: TERM 3 – AUTOMOTIVE

WEEK	TOPIC	PRESCRIBED CONTENT
1 - 6 **24 hours**	**SYSTEM AND CONTROL (Specific)**	**Steering Geometry:** • Alignment to manufacturers specifications • Toe-in and toe-out • Castor and camber • Kingpin inclination • Ackermann principle (toe-out on turns) **Practical:** Use testing equipment and demonstrate competency to test and adjust various wheel alignment angles to specifications: • Toe-in and toe-out • Castor and camber **Application of wheel balancing:** • Static • Dynamic **Practical:** Use a wheel balancer and demonstrate competency to balance a wheel **ELECTRICITY:** Purpose and operation of engine management: • Petrol • Diesel • Catalytic converter • Speed Control systems (Theory only) • Charging systems (Alternator) **Practical:** Use a diagnostic scanner on an engine to test various systems **Electrical fuel pump (Theory):** • Purpose and operation • Pressure control (basic) **Practical:** Test fuel pump pressure
7 - 11	**EXAMINATIONS**	

GRADE 12: TERM 4 – AUTOMOTIVE

WEEK	TOPIC	PRESCRIBED CONTENT
1 - 3	REVISION	
4 - 9	EXAMINATIONS	

WELDING AND METALWORK PROGRESSION

	GRADE 10	GRADE 11	GRADE 12
GENERIC	• **Safety** (HIV/Aids Awareness) • **Tools** Hand tools Measuring tools • **Materials** Characteristics and uses • **Forces** Types of forces Basic calculations • **Maintenance** Properties of lubricants Friction Lack of maintenance • **Joining Methods** Calculations on drill and key sizes Semi-permanent joining methods • **Engines** Operating principles of 2 and 4 stroke internal combustion engines	• **Safety** Basic first Aid HIV/Aids Awareness OHS act Machine-specific safety measures • **Tools** Purpose made tooling and equipment • **Materials** Equipment used during manufacturing of steel Properties of engineering materials • **Maintenance** Malfunction of power tools due to lack of maintenance	• **Safety** First Aid HIV/Aids Awareness OHS act Machine-specific safety measures • **Materials** Properties and Uses Methods of enhancing the properties of steel
SPECIALISATION	• **Terminology** Welding terms Welding symbols Welding joints Developments Templates Principles and functions of welding machines Electrical aspects regarding arc welding and gas welding	• **Tools** Purpose-made tooling and equipment • **Terminology** Use of templates Roof trusses Terms and definitions Welding symbols Developments Steel sections • **Forces** Effects of forces moments and torques System of forces Moments, Stress and strain • **Maintenance** Malfunction of power tools • **Joining Methods** Joining processes, gas arc and MIG Spot welding Welding defects, causes and remedies Heat treatment of steel	• **Tools** Purpose-made tooling and equipment • **Terminology** Templates Calculations sheet metal Welding symbols application Developments • **Forces** Forces and moments Steel frameworks Stress and strain • **Maintenance** Maintenance on various operating systems • **Joining Methods** Inspection of welds Destructive tests Non-destructive tests Distortion and stresses Effect of temperature

3.3 Content outline per term: Welding and Metalwork

3.3.1 Welding and Metalwork: Grade 10

MECHANICAL TECHNOLOGY: WELDING AND METALWORK

GRADE 10: TERM 1 – WELDING AND METALWORK

WEEK	TOPIC	CONTENT
1 - 3 **12 hours**	**SAFETY (Generic)**	Organise and manage activities responsibly and effectively, including self-management and HIV/Aids awareness. Safety precautions taken into account during performance-based activities in order to avoid injuries or incidents. Explain his/her rights, human rights, contributions and responsibilities. **Understanding of the OHS Act** Learners must be fully aware of all the safety precautions to be taken during performance-based activities, in order to avoid injuries or incidents. Refer specifically to the following tools/machines/equipment: • Hand tools • Pedestal drill • Bench grinder • Lathe • Milling machine • Guillotine • Compressors • Fire extinguishing apparatus • Bending machine • Power saws • Two and/or four post lift, trolley jack and trestles **Practical:** Identify safe and hazardous acts and conditions (e.g. speed of emery wheels, Maximum lift on hydraulic equipment, etc.) Apply personal hygiene measures. **Note:** Clean workshop on a weekly basis.

GRADE 10: TERM 1 – WELDING AND METALWORK

<table>
<tr><th>WEEK</th><th>TOPIC</th><th colspan="2">CONTENT</th></tr>
<tr><td rowspan="4">4 - 6
12 hours</td><td rowspan="4">TERMINOLOGY
(Specific)</td><td colspan="2">WELDING TERMS
Explain the following terms with the aid of sketches:</td></tr>
<tr><td>• Arc
• Arc length
• Leg length
• Included angle
• Parent metal
• Penetration
• Reinforcement
• Root
• Root face
• Root run
• Run</td><td>• Tack welding
• Throat thickness
• Toe of weld
• Weld face
• Weld junction
• Weld bead
• Weld decay
• Welding voltage
• Welding current
• Welding heat</td></tr>
<tr><td colspan="2">Practical:
Explain the welding terms by means of sketches</td></tr>
<tr><td colspan="2">TEMPLATES

• Materials used for template: wood, cardboard, steel and hardboard
• Principle of simple setting-out of the right angle and the application of Pythagoras’ theory</td></tr>
<tr><td colspan="2">Practical:
Do calculations on the theorem of Pythagoras and apply the principle by setting a right angled project.</td></tr>
</table>

GRADE 10: TERM 1 – WELDING AND METALWORK

<table>
<tr><th>WEEK</th><th>TOPIC</th><th colspan="2">CONTENT</th></tr>
<tr><td rowspan="3">4 - 6
12 hours</td><td rowspan="3">TERMINOLOGY
(Specific)</td><td colspan="2">PRINCIPLES AND FUNCTIONS OF

• Arc welding machines such as AC and DC
• Arc welding accessories

ELECTRICAL ASPECTS REGARDING ARC WELDING

Explain the following:</td></tr>
<tr><td>• Volts
• Current (Ampere)
• Resistance
• Polarity
• Arc voltage
• Direct current</td><td>• Alternating current
• Earthing
• Single phase
• Three phase
• Voltage drop</td></tr>
</table>

WEEK	TOPIC	CONTENT
4 - 6 **12 hours**	**TERMINOLOGY (Specific)**	**PRINCIPLES AND FUNCTIONS OF** • Gas welding (oxy-acetylene) • Oxy-acetylene welding accessories • Assembly of oxy-acetylene equipment • Setting of flames **Practical:** Demonstrate an understanding of oxy-acetylene equipment by assembling the equipment in the correct sequence. Demonstrate an understanding of different types of flames by setting flames for heating, cutting and welding.

GRADE 10: TERM 1 – WELDING AND METALWORK

8 - 9 **8 hours**	**TOOLS (Generic)**	Basic tools and equipment: • Spanners: ring-, flat- and combination- • Sockets and accessories • Pliers: combination, circlip, diagonal, long nose and water pump pliers, vice grip • Hammers: ball peen, soft face, cross pane, mallet • Chisels, hacksaws, scribers, punches • Screwdrivers: flat, Phillips/star and offset • Allen keys • Files, smooth; second cut and bastard: flat-, square-, triangle-, round and half round shapes • Stocks and dies Identify and explain the functions of the THREE types of drilling machines, namely sensitive (pedestal and pillar types), radial and portable drills Application of measuring and marking-off instruments: • Steel Rule • Square • Scriber • Tape measure • Combination set • Punches **Practical:** Use the marking-off instruments to mark-off a plate (at least 5mm thick) with 5 holes.
10 **4 hours**	**REVISION**	
11 **4 hours**	**CONTROL TEST**	

GRADE 10: TERM 2 – WELDING AND METALWORK

WEEK	TOPIC	CONTENT
1 - 2 **8 hours**	**JOINING METHODS (Generic)**	Basic calculations on the size of drills and keyway sizes: • Drill sizes for screw cutting • Width, thickness of keyways Application of hand threading with the aid of the tap and die set Semi-permanent joining methods: • Bolts • Studs • Locking devices • Nuts • Split pins • Rivets Keyway identification, fitting and uses of: • Parallel keys • Taper keys • Gib head keys • Woodruff keys **Practical:** Use the marking-off plate from Topic "Tools" and drill and tap two (2) holes.

GRADE 10: TERM 2 – WELDING AND METALWORK

WEEK	TOPIC	CONTENT
3 - 6 **16 hours**	**FORCES (Generic)**	**Forces:** Different types of forces found in engineering components: • Pulling force (Tensile) • Compressive force • Shearing force Components of forces: • Triangle and parallelogram of forces – resultant of two forces only • Graphical and mathematical solution of the horizontal and vertical component of a single force acting at an angle **Moments:** Moments found in engineering components (basic calculations): Definition: Moment = force x perpendicular distance (Spanner used to tighten a nut or bolt) **Stress (Basic calculations on):** • Square bar • Round bar **Practical:** Use basic calculations to determine forces, moments and stress.

GRADE 10: TERM 2 – WELDING AND METALWORK

WEEK	TOPIC	CONTENT
7 - 8 **8 hours**	**MAINTENANCE (Generic)**	Properties of lubricants: • Viscosity • Pour point • Flash point Grading of oil according to viscosity: (SAE standards) • Transmission oil • Engine oil • Differential oil • Cutting fluid • Grease Friction: • Characteristics • Application Define the following types of maintenance: • Preventive • Predictive • Reliability centred maintenance Identify the outcome of the lack of maintenance on equipment used in the workshop: • Excessive wear • Overheating/seizing; and distortion (lack of cooling and lubrication) • Failure e.g. hydraulics/pneumatics, controls and cables Disadvantages of an unbalanced work piece or machine part **Practical:** Analyse and predict the outcome of the lack of maintenance on equipment used in the workshop
9 - 11	**MID-YEAR EXAMINATION**	

GRADE 10: TERM 3 – WELDING AND METALWORK

WEEK	TOPIC	CONTENT
1 - 5 **20 hours**	**TERMINOLOGY** **WELDING SYMBOLS AND JOINTS (Specific)**	**Identifying the different WELDING SYMBOLS:** • Elements of welding symbols **Theory and Application of PERMANENT JOINTS (Arc welding):** • Lap joint • Butt joint • T-joint • Edge • Corner **Practical:** Apply the identified welding symbols by welding different types of joints using oxy-acetylene and arc-welding. **Theory and Application of PERMANENT JOINTS (Oxy-acetylene):** • Edge • Corner

GRADE 10: TERM 3 – WELDING AND METALWORK

WEEK	TOPIC	CONTENT
6 - 9 **16 hours**	**TERMINOLOGY** **DEVELOPMENTS (Specific)**	**Development of:** • Elbows with one joint only • Right angled and oblique T pieces of equal and unequal diameter pipes, including shapes of holes. All branches to be on centre of the main pipe • Right cones with top and base parallel to the horizontal plane **Practical:** Demonstrate an understanding of developments by developing/ producing models from the drawings of right angled and oblique T-pieces of equal and unequal diameters, and the right cones with the top and base parallel to the horizontal
10	**REVISION**	
11	**TEST**	

GRADE 10: TERM 4 – WELDING AND METALWORK

WEEK	TOPIC	CONTENT

1 - 2
8 hours
	MATERIALS (Generic)	Characteristics, composition and use of:
		• Ferrous metals and alloys:
		  • Low, medium and high carbon steel
		  • Cast iron, grey cast iron, white cast iron
		  ➢ Stainless steel (manganese, chrome, vanadium, titanium, tungsten, molybdenum and cobalt)
		• Non-ferrous elements:
		  ➢ Copper, tin, lead, zinc, aluminium, nickel
		• Non-ferrous alloys:
		  ➢ Brass, bronze, phosphor bronze, white metal, duralumin and solder
		Practical:
		  • Collect a sample of 5 non-ferrous elements and 5 non-ferrous alloys
		  • Give 2 uses for each sample collected

3 - 4 **8 hours**	**ENGINES (Generic)**	Operating principles of 2 and 4 stroke internal combustion engines. (Single cylinder spark ignition engines only): • Stroke • Dead centre • Cycle **Practical:** Demonstrate knowledge of the operating principles of the 2 and 4 stroke internal combustion spark ignition engines
5	**REVISION**	
6 - 9	**FINAL EXAMINATION**	

3.3.2 Welding and Metalwork: Grade 11

WELDING AND METALWORK

GRADE 11: TERM 1 – WELDING AND METALWORK

WEEK	TOPIC	CONTENT
1 - 3 **12 hours**	**SAFETY (Generic)**	HIV/AIDS Awareness Knowledge of basic First Aid measures Analyse the OHS Act and regulations where applicable Machine-specific safety measures when dealing with: • Grinding machines (portable, bench and surface) • Cutting machines (drilling machines, power saw, band saw) • Press machines • Joining equipment (arc, gas) • Handling and storage of gas cylinders • Hydraulic operated equipment – hydraulic press

GRADE 11: TERM 1 – WELDING AND METALWORK

WEEK	TOPIC	CONTENT
- 6 **12 hours**	**TERMINOLOGY (Specific)**	**The use of TEMPLATES:** • Materials used for templates: wood, cardboard, steel plate and hardboard • Principle of simple setting out of the right angle and the application of Pythagoras' theorem, the ratio of 45° and 60° right angled triangles. Use principles 3, 4 and 5 • Standard cross centres and benchmarks • Transference of floor diagrams to templates • Use of strip, flange and web templates for steel sections. Ordinary and bushed steel templates • Use of coloured and lettered holes, instructions and conventional marks on templates **The application of ROOF TRUSSES:** Calculations of: • Rise • Slope • Pitch The layout of roof trusses, details of purlins, truss shoes, wall plates, expansion and footing. **Practical:** Develop a roof truss using the given instructions and templates and by applying the theorem of Pythagoras. **CALCULATION OF COSTS:** • Quantification from drawings • Compiling of cutting lists • Calculation of cost of roof trusses and lattice beams **EXPLAIN THE FOLLOWING TERMS:** • Deposited metal • Fusion zone • Gap • Heat effected zone • Kerf • Spatter • Weld metal • Weld pool • Welding sequence **WELDING SYMBOLS:** • Fusion weld symbols • Supplementary symbols

GRADE 11: TERM 1 – WELDING AND METALWORK

WEEK	TOPIC	CONTENT
7 - 9 **12 hours**	**TOOLS** **(Specific)**	The principles and functions of the following purpose-made tooling and equipment: • Stocks and dies (characteristics and drill sizes) • Grinding machines (portable, bench) • Cutting machines (drilling machines, power saw, horizontal band saw) • Guillotine machine (manual and power driven) • Press machines • Joining equipment (arc, spot, gas) • Rolling machine • Punch and cropper machine • Plasma cutter • Cut-off machine **Practical:** Demonstrate the use and care of purpose-made tooling and equipment when producing a product and when doing maintenance.
10	**REVISION**	
11	**CONTROL TEST**	

GRADE 11: TERM 2 – WELDING AND METALWORK

WEEK	TOPIC	CONTENT
1 - 3 **12 hours**	**FORCES** **(Specific)**	**FORCES:** Effects of forces, moments and torques on engineering components applying design principles. Forces found in engineering components. Determine graphically. **SYSTEM OF FORCES (Bow's notation)** • Triangle of forces • Polygon of forces • Resultant and equilibrant **Practical:** Determine graphically the magnitude of forces found in engineering components using triangle of forces, polygon of forces and resultant forces. **Moments:** Moments found in engineering components. (By calculation only): Law of moments: Sum of LHM = Sum of RHM A supported beam with two vertical point loads acting on the beam with two supports. The calculation of shear force and bending moment diagram and graphically illustrated. **Practical:** Do calculations on moments of forces found in engineering components. **STRESS AND STRAIN (Calculation of):** • Stress and strain (Hooke's law) • Compressive/tensile stresses • Young's modulus of elasticity *(ignore factor of safety)* • Determine change in length (Δl) • Stress/strain diagram **Practical:** Do calculations on stress and strain as indicated.

GRADE 11: TERM 2 – WELDING AND METALWORK

WEEK	TOPIC	CONTENT
4 **4 hours**	**MAINTENANCE** **(Generic)**	Identify causes of malfunction of pedestal drill, power saw and pedestal grinder: • Lack of lubrication or incorrect lubrication • Overloading • Friction **Practical:** Analyse and predict the outcome of the lack of maintenance on equipment used in the workshop.

5 **4 hours**	**MAINTENANCE (Specific)**	Refer to manufacturers' manual. Identify causes of malfunction of guillotine, roller, punch and shearing machine: • Lack of lubrication or incorrect lubrication • Overloading • Friction **Practical:** Identify causes of malfunctioning of guillotines, roller, punch and shearing machines and demonstrate sufficient knowledge to apply the necessary preventive measures.

GRADE 11: TERM 2 – WELDING AND METALWORK

WEEK	TOPIC	CONTENT
6 - 8 **12 hours**	**JOINING METHODS (Specific)**	**Identify the applications and uses of the following processes:** • Gas welding (oxy-acetylene) • Arc welding • MIG welding **Practical:** Apply the theoretical knowledge in performing welding processes to produce a project using oxy-acetylene, arc-welding and MIG/MAGS welding **Apply the welding process to CARBON STEEL:** • The heating and cooling cycle • To control the hardness • Preheating and tempering • Factors reducing hardness • Factors increasing hardness **ARC WELDING:** • Sequence and direction of welding • Pre-setting to control warping and distortion, its causes and prevention • Shrinkage in welded joints and the influence of the welding order on shrinkage and stress in welds in order to prevent distortion **The use and application of SPOT (Resistance) WELDING:** • Description of process • Current • Electrodes • Size of tips • Time cycle • Maintenance and care of electrodes tips **Practical:** Produce a project using spot welding, taking into consideration the size of the plate thickness, size of tips and maintenance of tips. **Identify defects in welds, the causes and remedies for**: • Blowholes • Porosity • Incomplete penetration • Undercutting • Weld craters • Restarts • Slag inclusion • Cracks **Practical:** Identify defects from different welds, the causes and remedies.

GRADE 11: TERM 2 – WELDING AND METALWORK

5 - 8 **16 hours**	**JOINING METHODS (Specific)**	**HEAT TREATMENT OF STEEL:** • The change in the structure of carbon steel during heating and cooling processes • The iron – carbon equilibrium diagram: ➢ The temperature range of 500 - 900 ˚C ➢ Carbon content between 0% and 1.4% • Description of the purpose and methods for the following: ➢ Annealing ➢ Normalizing ➢ Hardening ➢ Tempering ➢ Case hardening **Practical:** • Apply knowledge of heat treatment in performing tempering process on a cutting tool. • Apply knowledge of heat treatment in performing normalising process on a tempered cutting tool.
9 - 11	**MID-YEAR EXAMINATION**	

GRADE 11: TERM 3 – WELDING AND METALWORK

WEEK	TOPIC	CONTENT
1 - 4 **16 hours**	**MATERIALS (Generic)**	Describe the use of the following plants in the manufacturing of steel: • Blast furnace • Open-hearth furnace • Bessemer converter • Electric arc furnace • Rotor plant Identify the following properties of engineering materials: • Hardness • Plasticity • Elasticity • Ductility • Malleability • Brittleness • Toughness

GRADE 11: TERM 3 – WELDING AND METALWORK

WEEK	TOPIC	CONTENT
5 - 9 **20 hours**	**TERMINOLOGY** **DEVELOPMENTS (Specific)**	**Development of:** • Transformations between parallel horizontal planes: ➢ square to square ➢ square to round ➢ rectangular to round ➢ cones on and off centres • Oblique cones with top and base parallel to the horizontal plane • Right cylindrical Y-connections **Practical:** Apply the knowledge gained on developments to produce TWO transformations between parallel horizontal planes and a right cylindrical Y-connection.
10	**REVISION**	
11	**CONTROL TEST**	

GRADE 11: TERM 4 – WELDING AND METALWORK

WEEK	TOPIC	CONTENT
1 - 3 **12 hours**	**TERMINOLOGY** **Sections (Specific)**	**Knowledge of steel sections such as:** • Angle sections • Channel sections • I-beam sections **Referring to:** • Identification of the profile of the sections • Uses of different sections • Joining of the different sections **Practical:** Identify different types of steel sections as used in steel structures around the school or nearby buildings
4 - 5	**REVISION**	
6 - 11	**EXAMINATION**	

3.3.3 Welding and Metalwork: Grade 12

WELDING AND METALWORK

GRADE 12: TERM 1 – WELDING AND METALWORK

WEEK	TOPIC	CONTENT
1 - 3 **12 hours**	**SAFETY (Generic)**	HIV/AIDS Awareness Knowledge of basic First Aid measures Analyse the OHS Act and regulations where applicable to the following machines: • Grinding machines (portable, bench and surface) • Cutting (drilling machines, power saw, band saw) • Shearing machines (manual and power driven) • Press machines • Joining (arc, gas) • Handling and usage of gas cylinders Knowledge and application of basic workshop layouts: • Process layout • Product layout Referring to the OHS Act analyse the responsibilities of the: • Employer • Employee **Practical:** Compare the process and product layout of TWO different manufacturing or maintenance workshops

GRADE 12: TERM 1 – WELDING AND METALWORK

WEEK	TOPIC	CONTENT
3 - 5 **12 hours**	**TERMINOLOGY (Specific)**	**Templates:** • Marking off templates, full or part • Sets of roof trusses, beams, lattice girders and plate girders • Method of obtaining and transferring dimensions **Calculations of sheet metal for rolling and bending:** • Rolled plate • Rectangular and square plate **Practical:** Do calculations on rolling and bending plates. **Application of WELDING SYMBOLS:** All the welding symbols according to the Code of Practice for welding – SANS **Practical:** Apply the welding symbols as indicated on a given sketch according to SANS to produce a project from a template.

WEEK	TOPIC	CONTENT
6 - 7 **8 hours**	**TOOLS (Specific)**	The principles and functions of the following purpose-made tooling and equipment: • Stocks and dies (characteristics and drill sizes) • Grinding machines (portable, bench) • Cutting machines (drilling machines, power saw, horizontal band saw) • Guillotine machine (manual and power driven) • Press machines • Joining equipment (arc, spot, gas) • Rolling machine • Punch and cropper machine • Plasma cutter • Brinell and Rockwell hardness testers • Moments and forces testers • Tensile testers • MIG/MAG welders **Practical:** Display an understanding of the use and care of purpose-made tooling and equipment when producing a product and doing maintenance.

GRADE 12: TERM 1 – WELDING AND METALWORK

WEEK	TOPIC	CONTENT
8 - 9 **8 hours**	**MATERIALS (Generic)**	**Identify materials by:** • Sound test • Bending test • Filing test and • Machining test **Practical:** Identify material types by using sound, bending, filing and machining tests. **Methods of enhancing the properties of steel (only heated temperature and cooling apply):** • Tempering • Case hardening • Hardening • Annealing • Normalising **Practical:** Do enhancement on materials by applying tempering on cutting tools and hardening soft carbon steel.
10	**REVISION**	
11	**CONTROL TEST**	

GRADE 12: TERM 2 – WELDING AND METALWORK

WEEK	TOPIC	CONTENT
1 - 4 **16 hours**	**FORCES** **(Specific)**	**FORCES AND MOMENTS:** Effects of forces and moments on engineering components applying design principles: **STEEL FRAMEWORKS:** Determine graphically the magnitude and nature of forces on the members of frameworks with a maximum of 11 (eleven) parts. (Only parallel and vertical loads.) Calculate the reactions. **Basic calculations on:** • Moments found in engineering components: (By calculation only) • A simply supported beam with two vertical point loads and one uniformly distributed load (UDL) acting on the beam (including reactions at the supports) • A simply supported beam with THREE vertical point loads and without uniformly distributed load (UDL) acting on the beam • Calculate the reactions at the supports • Calculate the bending moments at each and shear forces between points **Draw the following diagrams to scale:** • Space diagram • Bending moment diagram • Shear force diagram **Practical:** Do calculations of moments and, using a bending moment tester, perform a bending moment test on a beam. **STRESS AND STRAIN (Calculation of):** • Stress and strain (Hooke's law) • Compressive/tensile stresses • Young's modulus of elasticity (*include the factor of safety*) • Determine change in length (Δl) • Stress/strain diagram **Practical:** Do calculations on stress and strain whilst taking into consideration Young's modulus for each material.

GRADE 12: TERM 2 – WELDING AND METALWORK

WEEK	TOPIC	CONTENT
5 - 8 **16 hours**	**JOINING METHODS (Specific)**	**INSPECTION OF WELDS (Inspection during and after completion of oxy-acetylene and arc welding):** • Clean bead • Constant width and height of bead • Fusion and penetration • Presence of pits • Undercutting • Distortion • Cracks • Spatter • Slag inclusion • Start and termination of weld • Correct flame • Pressure • Current **Application of destructive tests on welded joints:** • Nick break • Nick bend • Machinability tests **Practical:** Perform destructive tests on a welded joint using nick break, nick bend and machinability test to identify defects. **Describe and compare the following non-destructive tests:** • Visual inspection • X-rays • Dye penetration • Ultrasonic test **Practical:** Perform the above non-destructive tests on a welded joint to identify defects.

	JOINING METHODS (Specific)	**Stresses and distortion in welding and stress relieving:** • Shrinkage Of Welded Joint: ➢ Definition of shrinkage ➢ Transverse shrinkage causing distortion ➢ Longitudinal shrinkage causing distortion ➢ Thickness shrinkage causing distortion ➢ The effect of the type of electrode with which it is welded ➢ The effect of the size of the welding current ➢ The effect of speed with which it is welded ➢ The effect of the rate of cooling while welding and after welding • Identify the factors affecting distortion and residual stress • • Methods to prevent or reduce distortion and stress • • **Identify and apply *stress relieving* heat treatment processes** • • Describe the effect of change in temperature on steel: ➢ The effect of cold and hot working on the crystal structure ➢ The application of the iron-carbon equilibrium diagram on steel in respect of heat treatment and welding ➢ The effect of fast cooling on the structure and properties of steel **Practical:** Identify the factors that lead to distortion and residual stresses within a welded joint.
9 - 11	**MID-YEAR EXAMINATION**	

GRADE 12: TERM 3 – WELDING AND METALWORK

WEEK	TOPIC	CONTENT
1 - 2 **8 hours**	**MAINTENANCE** **(Specific)** Refer to manufacturers' manual. Suitable preventative maintenance in operating systems for guillotine, pedestal drill, power saw, roller, punch and shearing machine and pedestal grinder. Identify causes of malfunction of: • Lack of lubrication or incorrect lubrication • Overloading • Friction **Practical:** Perform periodic maintenance as prescribed by manufacturers on specific machines.	
3 - 8 **24 hours**	**TERMINOLOGY** **DEVELOPMENTS** **(Specific)**	**Development of:** Marking-off templates, by calculation only, of the following between horizontal parallel planes: • A cone frustum of slight taper • Square to round transformers (on centre only) • Hoppers with square or rectangular openings (on and off centre) **Practical:** Do calculations on cone frustum, square to round transition and hoppers.
9 - 11	**TRIAL EXAMINATION**	

GRADE 12: TERM 4 – WELDING AND METALWORK

WEEK	TOPIC	CONTENT
1 - 3	**REVISION**	
4 - 9	**EXAMINATION**	

SECTION 4

ASSESSMENT

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' achievements 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	0

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)

4.3.1 Formal assessment requirements

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 Mechanical 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.
- **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 learners' abilities 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 Mechanical 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 given criteria)
- 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 (PAT) Phase 1 – Phase 4	☑ Phase 1 (skills task) Plan for phase 4	☑ Phase 2 (skills task) Phase 4 under construction (project)	☑ Phase 3 (skills task) Phase 4 completed (project)		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 marks for Grades 10 and 11.

DESCRIPTION	TIME FRAME	WEIGHTING OF FINAL MARK	MARK ALLOCATION
Control test 1	**Term 1** January – April	5%	50
Mid-year examination	**Term 2** Mid-year	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) Phase 1 – Phase 4	☑ Phase 1 (skills task) Plan for phase 4	☑ Phase 2 (skills task) Phase 4 under construction (project)	☑ Phase 3 (skills task) Phase 4 completed (project)		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 Grade 12.

DESCRIPTION	TIME FRAME	WEIGHTING OF FINAL 25%	MARKS
Control test	Term 1	5%	50
Mid-year examination	Terms 1 & 2	10%	200
Preparatory examination	Term 3	10%	200
Total		25%	450

4.5.2 Tests

A test for formal assessment should not consist of a series of small tests, but should cover a substantial amount of content and the duration should be at least 60 minutes and a minimum of 50 marks (allocate one 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 intended 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 Mechanical Technology comprises 50% of a learner's total mark (200 marks). 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 Mechanical Technology curriculum advisor/facilitator for the district. 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.

Grades 10 and 11 Examination Paper

Question	Content covered	Marks
1	Multiple-choice questions	20
2	Safety	10
3	Tools and equipment	12
4	Materials	13
5	Terminology (manufacturing process)	30
6	Joining methods	25
7	Forces	30
8	Maintenance	15
9	Systems and control ***(only Fitting and Turning and Automotive)***	25
10	Engines, pumps and turbines ***(only Fitting and Turning and Automotive)***	20
TOTAL		200

Grade 12 Examination paper

Question	Content covered	Marks
1	Multiple-choice questions	20
2	Safety	10
3	Tools and equipment	12
4	Materials	13
5	Terminology (manufacturing process)	30
6	Joining methods	25
7	Forces	30
8	Maintenance	15
9	Systems and control ***(only Fitting and Machining and Automotive)***	25
10	Engines, pumps and turbines ***(only Fitting and Machining and Automotive)***	20
TOTAL		200

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 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 including 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 and simulation marks to show how the learner is progressing.

The weighting of the term mark will be done in accordance with the table in paragraph 4.5.1 above.

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. phase 1 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 moderation learners may be selected at random to demonstrate the different skills developed during the PAT. All phases will be moderated.
- Learners being moderated will have access to their completed project during moderation and may refer to the phases they completed earlier in the year.
- Learners may not seek 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 of 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 facilitator or a peer teacher. Grade 10 and 11 tasks are internally moderated except for the PAT that is externally moderated. The curriculum/subject advisor 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 must comply 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 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 / district facilitator.

(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 PAT 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 and schools may not use the tasks of the previous years.
- Providing the resources for the Practical Assessment Task is the responsibility of the school; the school should ensure that adequate time and funding is allocated for the completion of the Practical Assessment Task.

Practical sessions must 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 needed for the learner to hone the necessary skills.

FOUR hours of contact time is prescribed per week, of which TWO hours is intended for theory and TWO hours for the completion of practical work and the PAT (ONE double period – at least one hour continuous – is required for practical work).

It is essential that at least a ONE hour continuous time period be allocated for practical sessions.

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 needed for the learner to hone the necessary skills. A guideline of 2 hours per week is given for Grades 10 – 11.

In cases where Grades 10 – 11 PAT tasks and topics are set by the teacher internally, the head of department at the school and the Mechanical 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. However, the PAT may not contradict the design principles outlined in the Grade 12 PAT.

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

Description	Time Frame	Weighting of Final 25%	Marks
• Phase 1 Terminology / Manufacturing • Plan and prepare for PAT phase 4 task	January – March	5%	50
• Phase 2 Joining • PAT final task phase 4 under construction	April – June	5%	50
• **Phase 3 Maintenance / Experimentation / Simulation task** • **Completion of phase 4**	July – September	5%	50
• Phase 4 Final Product • Moderation of PAT	July – September	10%	100
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 Mechanical Technology.

4.11 General

This document should be read in conjunction with:

4.11.1 National policy pertaining to the program and promotion requirements of the National Curriculum Statement Grades R – 12

4.11.2 Policy Document, National Protocol for Assessment Grade R – 12