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REPUBLIC OF SOUTH AFRICA

NATIONAL CURRICULUM STATEMENT GRADES 10-12 (GENERAL)

LEARNING PROGRAMME GUIDELINES

MECHANICAL TECHNOLOGY

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SECTION 1

INTRODUCTION

1.1 INTRODUCING THE NATIONAL CURRICULUM STATEMENT

1.1.1 BACKGROUND

In 1995 the South African government began the process of developing a new curriculum for the school system. There were two imperatives for this. First, the scale of change in the world, the growth and development of knowledge and technology and the demands of the 21st Century required learners to be exposed to different and higher level skills and knowledge than those required by the existing South African curricula. Second, South Africa had changed. The curricula for schools therefore required revision to reflect new values and principles, especially those of the Constitution of South Africa.

The first version of the new curriculum for the General Education Band, known as Curriculum 2005, was introduced into the Foundation Phase in 1997. While there was much to commend the curriculum, the concerns of teachers led to a review of the Curriculum in 1999. The review of Curriculum 2005 provides the basis for the development of the National Curriculum Statement for General Education and Training (Grades R-9) and the National Curriculum Statement for Grades 10-12.

1.1.2 THE NATIONAL CURRICULUM STATEMENT

The National Curriculum Statement consists of 29 subjects. Subject specialists developed the Subject Statements, which make up the National Curriculum Statement. The draft versions of the Subject Statements were published for comment in 2001 and then re-worked to take account of the comments received. In 2002 twenty-four subject statements and an overview document were declared policy through Government Gazette. In 2004 five subjects were added to the National Curriculum Statement. The National Curriculum Statement now consists of the Subject Statements for the following subjects:

- Languages – 11 official languages (each counted as three subjects to cater for the three levels Home Language, First Additional Language and Second Additional Language); 13 non-official languages
- Mathematics; Mathematical Literacy; Physical Sciences; Life Sciences; Computer Applications Technology; Information Technology
- Accounting; Business Studies; Economics
- Geography; History; Life Orientation; Religion Studies
- Consumer Studies; Hospitality Studies; Tourism
- Dramatic Arts; Dance Studies; Design; Music; Visual Arts
- Agricultural Sciences, Agricultural Management Practices, Agricultural Technology

- Civil Technology; Mechanical Technology; Electrical Technology; Engineering Graphics and Design

1.1.3 NATIONAL SENIOR CERTIFICATE

The *National Senior Certificate: A Qualification on Level 4 of the National Qualifications Framework (NQF)* provides the requirements for promotion at the end of Grades 10 and 11 and the awarding of the National Senior Certificate at the end of Grade 12. This document replaces two of the original National Curriculum Statement documents: the *Overview* and the *Qualifications and Assessment Policy Framework*.

1.1.4 SUBJECT ASSESSMENT GUIDELINES

The Subject Assessment Guidelines set out the internal or school-based assessment requirements for each subject and the external assessment requirements. In addition, the *National Protocol for Recording and Reporting (Grades R-12)* (an addendum to the policy, *The National Senior Certificate*) has been developed to standardise the recording and reporting procedures for Grades R to 12. This protocol came into effect on 1 January 2007.

1.2 INTRODUCING THE LEARNING PROGRAMME GUIDELINES

1.2.1 PURPOSE AND CONTENT OF THE LEARNING PROGRAMME GUIDELINES

The Learning Programme Guidelines aim to assist teachers and schools in their planning for the introduction of the National Curriculum Statement. The Learning Programme Guidelines should be read in conjunction with the National Senior Certificate policy and the National Curriculum Statement Subject Statements.

Section 2 of the Learning Programme Guidelines suggests how teaching the particular subject may be informed by the principles which underpin the National Curriculum Statement.

Section 3 suggests how schools and teachers might plan for the introduction of the National Curriculum Statement. The Department of Education encourages careful planning to ensure that the high skills, high knowledge goals of the National Curriculum Statement are attained.

The Learning Programme Guidelines do not include sections on assessment. The assessment requirements for each subject are provided in the Subject Assessment Guidelines which come into effect on 1 January 2008.

1.2.2 WHAT IS A LEARNING PROGRAMME

INTRODUCTION

A Learning Programme assists teachers to plan for sequenced learning, teaching and assessment in Grades 10 to 12 so that all Learning Outcomes in a subject are achieved in a progressive manner. The following three phases of planning are recommended:

- Phase 1 – develop a *Subject Framework* for grades 10 to 12
- Phase 2 – develop a *Work Schedule* for each grade
- Phase 3 – develop *Lesson Plans*

It is recommended that the teachers of a subject at a school or cluster of schools first put together a broad subject outline (Subject Framework) for the three grades to arrive at an understanding of the content of the subject and the progression which needs to take place across the grades (see Section 3.3.1). This will assist with the demarcation of content for each grade. Thereafter, teachers of the subject teaching the same grade need to work together to develop a year long Work Schedule. The Work Schedule should indicate the sequence in which the content and context will be presented for the subject in that particular grade (see Section 3.3.2). Finally, individual teachers should design Lesson Plans using the grade-specific Work Schedule as the starting point. The Lesson Plans should include learning, teaching and assessment activities that reflect the Learning Outcomes and Assessment Standards set out in the Subject Statements (see Section 3.3.3). Learning Programmes should accommodate diversity in schools and classrooms but reflect the core content of the national curriculum.

An outline of the process involved in the design of a Learning Programme is provided on page 6.

DESIGNING A LEARNING PROGRAMME

A detailed description of the process involved in the design of a Learning Programme is provided in Sections 3.3.1 – 3.3.3 of the Learning Programme Guidelines. The first stage, the development of a Subject Framework does not require a written document but teachers are strongly advised to spend time with subject experts in developing a deep understanding of the skills, knowledge and values set out in the Subject Statements. The quality and rigour of this engagement will determine the quality of teaching and learning in the classroom.

Once the Subject Framework has been completed, teachers should develop Work Schedules and Lesson Plans. Examples of Work Schedules and Lesson Plans are provided in the Learning Programme Guidelines. Teachers are encouraged to critically engage with these formats and develop their own.

Developing a Subject Framework (Grades 10-12)

Planning for the teaching of subjects in Grades 10 to 12 should begin with a detailed examination of the scope of the subject as set out in the Subject Statement. No particular format or template is recommended for this first phase of planning but the steps recommended should be used as a checklist.

Although no prescribed document is required for this stage of planning, school-wide planning (timetables, requisitioning, teacher development, classroom allocation) as well as the development of grade-specific work schedules would benefit from short documents which spell out:

- The scope of the subject – the knowledge, skills and values; the content; the contexts or themes and electives to be covered in the three grades for each subject
- A three-year assessment plan for the subject
- The list of LTSM required for the subject

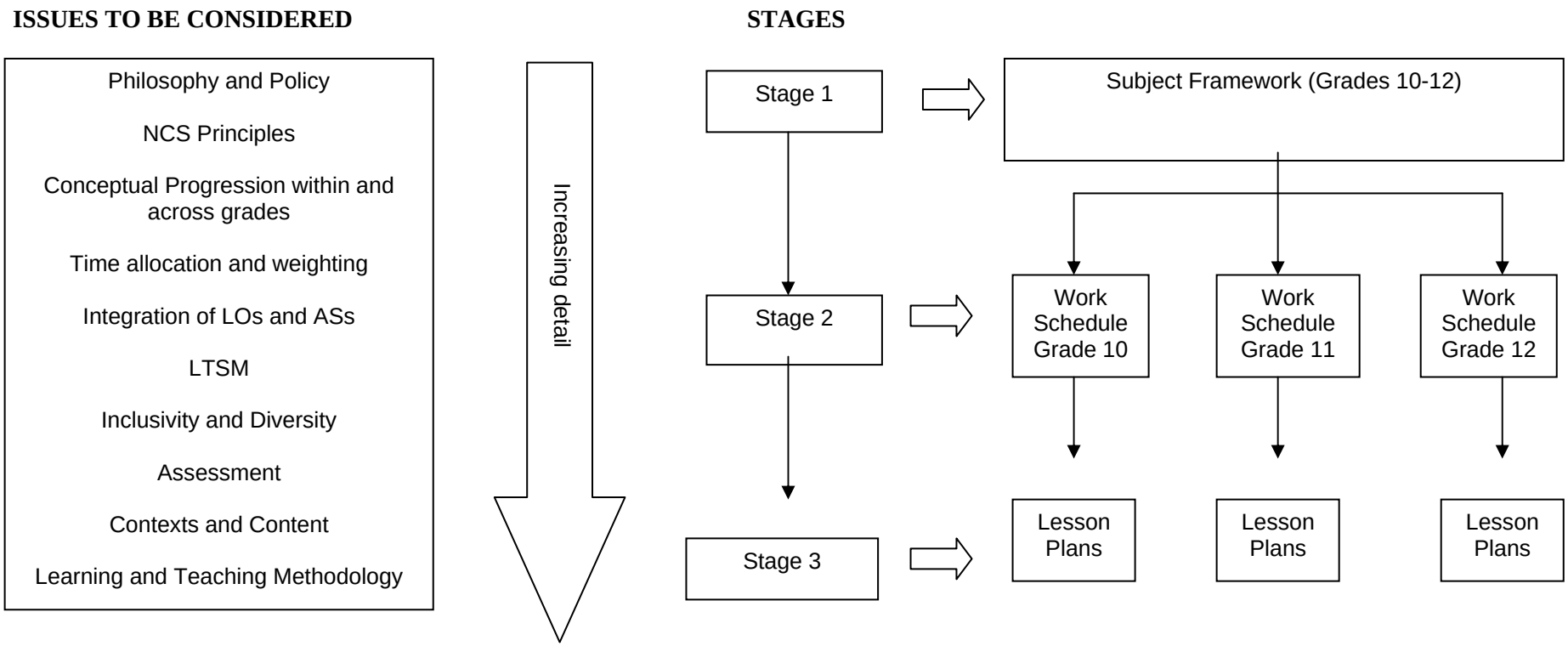
Designing Work Schedules

This is the second phase in the design of a Learning Programme. In this phase teachers develop Work Schedules for each grade. The Work Schedules are informed by the planning undertaken for the Subject Framework. The Work Schedules should be carefully prepared documents that reflect what teaching and assessment will take place in the 36-40 weeks of the school year.

Designing Lesson Plans

Each grade-specific Work Schedule must be divided into units of deliverable learning experiences, that is, Lesson Plans. Lesson Plans are not equivalent to periods in the school timetable. Each Lesson Plan should contain a coherent series of teaching, learning and assessment activities. A Lesson Plan adds to the level of detail for each issue addressed in the Work Schedule. It also indicates other relevant issues to be considered when teaching and assessing a subject.

FIGURE 1: RELATIONSHIP BETWEEN THE 3 STAGES OF PLANNING WHEN DEVELOPING A LEARNING PROGRAMME



SECTION 2

INTRODUCING MECHANICAL TECHNOLOGY

2.1 WHAT IS MECHANICAL TECHNOLOGY?

Mechanical Technology focuses on technological processes from conceptual design to practical problem solving and the application of scientific principles. The subject provides scope for learning about the different processes, services and systems used in the production, manufacturing and maintenance of goods and products.

Mechanical Technology draws from the following knowledge fields:

▪ Mechanical Engineering	▪ Environmental Engineering	▪ Metallurgic Engineering
▪ Automotive engineering	▪ Designing	▪ Maintenance Management
▪ Boilermaking	▪ Welding	▪ Aircraft / space technology
▪ Machining and fitting in the metal engineering industry	▪ Earth-moving and mining industry	

The emphasis in Mechanical Technology is on the Technological Process. The subject builds on technological literacy which was gained in Grades R-9. Technical skills are acquired in the process of developing or making a particular artefact. The concept and development of the artefact should solve an identified challenge and show responsibility towards the environment and the health of others.

The focus of the subject Mechanical Technology is the integration of high knowledge and high skills, concentrating on the principles and concepts embedded in Mechanical Technology. The Technological Process (identify and investigate, design, make, evaluate and communicate) is the rationale and driving force behind this subject. Creativity, innovation and ingenuity play a major role in developing the learners' full potential in this subject.

2.2 WHAT IS THE PURPOSE OF MECHANICAL TECHNOLOGY

Mechanical Technology aims to equip learners with knowledge, skills, values and attitudes that will enable them to adapt, participate and succeed in an economically complex society. The subject also aims to promote productivity, social justice and environmental sustainability. Therefore, these learners will be provided with the opportunity to:

- reinforce the principle of Mechanical Technology methodology and problem solving as a lifelong learning skill;
- develop practical skills and different modes of thinking;
- promote a sense of self – discipline by emphasising the need for effective time management in the meeting of deadlines which is an essential part of professional practice;
- relate Mechanical Technology skills and knowledge to real situations by ensuring a balance between theory and practice;
- recognise how systems and products relate to environmental, social, political, historical and cultural contexts;

- enable the learner to practice Mechanical Technology as an enjoyable and fulfilling life experience;
- understand the social contribution of Mechanical Technology with regard to economic growth, entrepreneurship and sustainability;
- affirm the cultural heritage of South Africa through a focus on indigenous knowledge in ways that are accessible to all learners in all communities;
- develop an awareness of career opportunities in Mechanical Technology thereby creating a credible route to higher education and the world of work; and
- develop the creative potential of the learner.

2.3 WHAT IS THE RELATIONSHIP BETWEEN MECHANICAL TECHNOLOGY AND THE NATIONAL CURICULUM STATEMENT PRINCIPLES?

The Constitution of the Republic of South Africa (Act 108 of 1996) provides the basis for curriculum transformation and development in South Africa. The National Curriculum Statement Grades 10-12 (General) lays the foundation for the achievement of these goals by stipulating Learning Outcomes (LO) and Assessment Standards (AS), and by spelling out the key principles and values that underpin the Curriculum.

The National Curriculum Statement is based on the following principles:

2.3.1 Social transformation

Mechanical Technology may be seen as a vehicle for social change by improving the quality of life and providing solutions that are responsive to individual and community needs.

2.3.2 Outcomes-Based Education

Mechanical Technology makes use of learning outcomes and assessment standards to describe what a learner should know and be able to demonstrate i.e. the skills, knowledge, and values that are the results of learning. Mechanical Technology encourages learners to develop inquiring and problem solving skills which support the practical application of knowledge in technology and involves active and high level teaching, learning and assessment.

2.3.3 High knowledge and high skills

The NCS aims at developing a high level of **knowledge and skills** in Mechanical Technology learners. It sets high expectations of what all South African learners can achieve. The Mechanical Technology curriculum specifies the minimum standards of knowledge and skills to be achieved. Mechanical Technology promotes creative thinking, innovation and ingenuity during the Technological Process.

2.3.4 Integration and applied competence

The four Learning Outcomes in Mechanical Technology are integrated and not presented in any specific order. They should not be considered sequential as each one supports and underpins the other. The integration of knowledge and skills across subjects and terrains of practice is crucial for achieving applied competence as defined in the National Qualifications Framework (NQF). **Applied competence** aims at **integrating** three discrete competences namely, practical, foundational and reflective competencies. In adopting integration and applied competence Mechanical Technology seeks to promote integrated learning of theory, practice and reflection.

2.3.5 Progression

Progression in Mechanical Technology refers to the process of developing more advanced and complex knowledge and skills. The subject statement for Mechanical Technology shows progression from one grade to another. Each LO is followed by an explicit statement of what level of performance is expected for the outcome per grade. The content and context of each grade will show **progression** from simple to complex.

2.3.6 Articulation and Portability

Articulation in Mechanical Technology refers to the relationship between qualifications at different NQF levels or bands in ways that promote access from one qualification to another. This is especially important for qualifications falling within the same learning field (Manufacturing, Engineering and Technology).

2.3.7 Human rights, exclusivity, environmental and social justice

The NCS is sensitive to issues of diversity such as poverty, inequality, race, gender, language, age, disability, environmental issues and other factors. The subject Mechanical Technology is infused with these principles and practices. All Mechanical Technology learners should be able to develop to their full potential through the development of appropriate Mechanical Technology learning programmes and choice of appropriate assessment instruments.

2.3.8 Valuing Indigenous Knowledge Systems

The Mechanical Technology Subject Statement has infused **Indigenous Knowledge and Skills** (IKS) to acknowledge the richness of the history and heritage of this country and its constitution. IKS, from whatever context, should not be seen as static but dynamic and responsive to change from influences that may be local, national, continental or global.

2.3.9 Credibility, quality and efficiency

Mechanical Technology aims to achieve **credibility, quality and efficiency** through pursuing a transformational agenda and through providing an education that is comparable in quality, breadth and depth to those of other countries.

2.4 PROFILE OF A MECHANICAL TECHNOLOGY LEARNER

The learner entering Grade 10 would have successfully completed Grade 9. As illustrated in table 2.1 below, all four Learning Outcomes of Mechanical Technology have strong links with the Learning Areas of the NCS Grades R-9.

Table 2.1 Interrelationship between the Learning Outcomes in the NCS Grades R-9 and the Mechanical Technology Learning Outcomes in the NCS Grades 10-12

NCS Grades R-9 Learning Areas	NCS Grades R-9 LOs	NCS Grades 10-12 Mechanical Technology LOs
Technology	1,2 and 3	1, 2, 3 and 4
Economic and Management Sciences	3	2 and 3
Mathematics	4 and 5	2 and 3
Languages	1,2,3,4, 5 and 6	1, 2, 3 and 4
Life Orientation	1,2,3,4 and 5	1
Natural Sciences	1,2 and 3	1, 2 and 3
Arts and Culture	1 and 4	2 and 3
Social Sciences	3	1, 2 and 3

In Grades 10-12 learners should be provided with opportunities to acquire, develop and apply a range of more advanced knowledge, understanding and skills. Breadth, depth and access are particularly important to ensure that learners are given a sound basis from which choices can be made. Learners should have sufficient knowledge to make informed decisions about their future career choice.

The learner emerging from Grades 10-12 should:

- value, have access to, and succeed in lifelong education and training of good quality;
- demonstrate an ability to think logically and analytically as well as holistically and laterally; and
- be able to transfer skills from one context to another.

2.5 RELATIONSHIP BETWEEN THE MECHANICAL TECHNOLOGY LEARNING OUTCOMES AND THE CRITICAL AND THE DEVELOPMENTAL OUTCOMES

The Critical Outcomes (COs) and Developmental Outcomes (DOs) are fundamental to Mechanical Technology. These outcomes enable learners to become culturally and aesthetically sensitive, to embrace the spiritual, material, intellectual and emotional aspects of human endeavour.

Table 2.2 and Table 2.3 show the relationship between the Mechanical Technology Learning Outcomes and the Critical and Developmental Outcomes respectively, and possible application in developing Mechanical Technology skills, knowledge and values.

Table 2.2: Relationship between the Critical Outcomes and the Mechanical Technology Learning Outcomes

Critical Outcomes	Application in Mechanical Technology	Mechanical Technology LOs
Identify and **solve problems** and make decisions using critical and creative thinking	Engage in creative and innovative thinking by following the Technology Process in solving problems, when conceptualising and realising a solution.	**2**
Work effectively with others as members of a team, group or organisation and community	The Technological Process often requires participants to work together which involves sharing of ideas, developing interviewing skills, democratic practices and ethical responsibilities.	**2**
Organise and manage themselves and their activities responsibly and effectively	Mechanical Technology encourages learners to be self disciplined, to plan, organise and manage their work, to keep to time schedules, to be committed to the task and to take responsibility for their actions.	**1, 2, 3 and 4**
Collect, analyse, organise and **critically evaluate** information	Mechanical Technology encourages learners to observe and record data in a variety of ways so that they are able to analyse, interpret and critically evaluate information and apply it in theory and practice.	**1, 2, 3 and 4**
Communicate effectively using visual, symbolic and/or language skills in various modes	Mechanical Technology requires learners to communicate through verbal, non-verbal and symbolic language forms that characterise the Technological Processes.	**1, 2, 3 and 4**
Use science and technology effectively and critically, **showing responsibility** towards the environment and the health of others	Mechanical Technology concepts and end products should develop effective social, ethical and environmental responsibility.	**1, 2, 3 and 4**
Demonstrate an understanding of the world as a set of related systems by recognizing that **problem solving contexts do not exist in isolation**	The Technological Process involves learners in understanding how their own problem solving activities are influenced by, or may impact on, local, national and global contexts.	**1, 2, 3 and 4**

Table 2.3: Relationship between the Developmental Outcomes and the Mechanical Technology Learning Outcomes

Developmental Outcome	Application in Mechanical Technology	Mechanical Technology LOs
Reflecting on and **exploring** a variety of strategies to learn more effectively	Mechanical Technology combines theory with practice in an ongoing process which enables learners continually to evaluate their knowledge and skills while at the same time supporting and enhancing teaching and learning.	**1, 2, 3 and 4**
Participating as **responsible citizens** in the life of local, national and global communities	Mechanical Technology ensures that learners develop responsibility towards their communities, both locally and nationally and understand the contribution of Mechanical Technology towards the development of vibrant local, national and international industries.	**1, 2, 3 and 4**
Being **culturally and aesthetically sensitive** across a range of social contexts	Mechanical Technology can influence or be influenced by other cultures and has the potential to be a powerful agent for change, transformation and affirmation.	**1 and 2**
Exploring education and career opportunities	The Mechanical Technology field offers a varied range of professional and vocational opportunities, which can enable learners to make a significant economic contribution to self and society.	**1, 2, 3 and 4**
Developing **entrepreneurial** opportunities	The Mechanical Technology field offers a varied range of professional and vocational opportunities through commitment of best practice and the ability to initiate, market and manage skills, processes and end products.	**1, 2, 3 and 4**

2.6 WAYS TO ACHIEVE MECHANICAL TECHNOLOGY LEARNING OUTCOMES

Approach to Mechanical Technology

The NCS approach to Mechanical Technology encourages active learning, problem solving, lateral thinking, critical reflection, decision-making, and working in groups or independently.

Achievement of Learning Outcomes

It is important to note that the Learning Outcomes for Mechanical Technology are the same for all grades. Each Learning Outcome has its own number of Assessment Standards, which give detail to content and context, and the application of such content. The Assessment Standards describe ways of achieving the Learning Outcomes. They have been formulated in such a way that there is progression in the development of skills, processes, concepts, content knowledge, values and attitudes within, and across grades. The performance of learners in the Learning Outcomes is measured against the Assessment Standards. Each grade builds on the competencies developed in the previous grade.

Interrelationship of Learning Outcomes

All the Learning Outcomes are of equal importance but not all have the same weighting in the allocation of time and resources. Learning Outcome 3 reflects knowledge and understanding, whilst Learning Outcome 4 deals with the application of this knowledge. These two Learning Outcomes are underpinned by Learning Outcome 1, which reflects the interrelationship of technology, society and the environment and Learning Outcome 2, which outlines the technological process that is used as the organising concept.

The four Learning Outcomes are integrated and not presented in any specific order. They should not be considered sequential as each one supports and underpins each other. This approach supports and expands learners' opportunities to attain skills, acquire knowledge and develop appropriate attitudes and values.

Resource materials

Textbooks should not be considered as the only source of content. Other relevant resources such as catalogues, user manuals, magazines, journal articles, radio and television, local experts, electronic media and internet sites need to be incorporated into the content.

Learners must be encouraged to use their own initiative. Project-based learning, collaborative learning and groupwork should to be encouraged. Content needs to be selected in such way that it encourages the development of creativity, critical thinking, research skills, reading proficiency and interpretation skills.

Bloom's Taxonomy

The Learning Outcomes are formulated in a manner that specifies the broad context in which content has to be dealt with. Context in this sense refers to *cognitive* context. For example, knowledge, understanding, application, analysis and evaluation are all contexts specified in the four Learning Outcomes to deal with content. Assessment Standards give more detail.

The following words are commonly used in explaining the levels of complexity:

Knowledge - memorises and recalls information: arrange, define, label, list, outline, and repeat order, select, recognise, name, state, identify.

Comprehension (understanding) - interpret information in one's own words: describe, indicate, restate, review, summarise, classify, predict, and distinguish.

Applications - apply knowledge to new situations: apply, calculate, draw, explain, identify, illustrate, prepare, operate, practice, solve, sketch, use, show, modify, classify, produce, use and sketch.

Analysis - breakdown knowledge into parts and show relationship among parts: analyse, categorize, compare, distinguish, discuss, examine, investigate, test, classify, survey, differentiate, select.

Synthesis - brings together parts of knowledge to form a whole; build relationships for new situation: arrange, compose, formulate, organize, plan, assemble, construct, create, develop, produce and design.

Evaluation - makes judgments on basis of criteria: appraise, assess, comment on, critically analyse, evaluate, conclude, interrogate, judge, predict, compare, score, judge, relate, summarise, recommend, criticize, support.

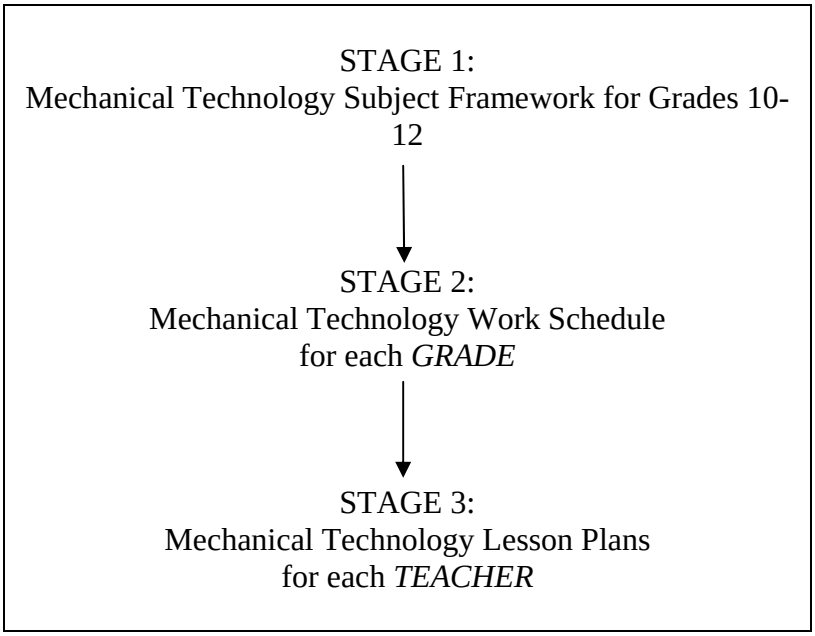
SECTION 3

DESIGNING A LEARNING PROGRAMME FOR MECHANICAL TECHNOLOGY

3.1 INTRODUCTION

A Learning Programme is a tool to plan for sequenced learning, teaching and assessment across Grades 10-12 so that all four Learning Outcomes in Mechanical Technology are achieved in a progressive manner. It is recommended that the Mechanical Technology teachers at a school first put together a broad subject outline (i.e. Subject Framework) for Grades 10-12 to arrive at an understanding of the progression which needs to take place across the grades (see Section 3.3.1). This will assist with the demarcation of content for each grade. Thereafter, Mechanical Technology teachers teaching the same grade need to work together and draw from the content and context identified for their grade in the Subject Framework, to develop a Work Schedule in which they indicate the sequence in which the content and context will be presented for Mechanical Technology in that particular grade (see Section 3.3.2). Finally, the individual Mechanical Technology teacher should design Lesson Plans using the grade-specific Work Schedule as the starting point. The Lesson Plans should include learning, teaching and assessment activities (see Section 3.3.3).

An outline of the process involved in the design of a Learning Programme for Mechanical Technology is provided in the diagram below:



The process to be followed in the development of a Learning Programme is not a neatly packaged sequence of numbered steps that follow one another in a particular order. Teachers may find themselves moving back and forth in the process as they plan and critically reflect on decisions taken before moving on to the next decision in the process. The process is therefore not strictly linear and is reflective in nature. For this reason the steps provided in this Section are a guide and should be used as a checklist in the planning process.

3.2 ISSUES TO ADDRESS WHEN DESIGNING A LEARNING PROGRAMME

The issues to be addressed in the development of a Mechanical Technology Learning Programme are presented in a tabular format to indicate the implications of each issue at each of the three stages of the development of a Learning Programme:

- Stage 1 – Subject Framework
- Stage 2 – Work Schedule
- Stage 3 – Lesson Plan

3.2.1 Policies and Principles

STAGE 1 **Subject Framework** **STAGE 2** **Work Schedule** **STAGE 3** **Lesson Plan**	The various Policies that impact on curriculum implementation should be considered throughout the planning process. *NCS:* • Principles: Refer to Section 2.3 to see how Mechanical Technology supports the application of the nine principles of the NCS • Critical and Developmental Outcomes: Refer to Section 2.5 to see how Mechanical Technology supports the application of the Critical and Developmental Outcomes *Other Policies and Legislation:* • White Paper 6, Language in Education Policy, Religion and Education Policy, HIV/AIDS Policy– all have implications for LTSM and teaching methods in Mechanical Technology • White Paper 7 – gives an indication on the use of computers in the classroom and therefore has implications for LTSM and teaching methods in Mechanical Technology

3.2.2 Content

In the NCS Grades 10-12 content means the combination of knowledge, skills and values.

STAGE 1 **Subject Framework**	The content is provided by the ASs. These give an indication of the knowledge, skills and values (KSVs) to be covered in each of the three grades. The Subject Framework sets out the content for the three years (i.e. Grades 10, 11 and 12).
STAGE 2 **Work Schedule**	The Work Schedule sets out the content for one year. Here the focus falls on the grade-specific KSVs required by the NCS.
STAGE 3 **Lesson Plan**	The Lesson Plans set out the content to be covered in each coherent series of learning, teaching and assessment activities. Each Lesson Plan can be one or more weeks in duration.

3.2.3 Integration

Integration involves the grouping of Assessment Standards according to natural and authentic links.

STAGE 1 **Subject Framework**	Integration within the subject should be considered in broad terms during discussions at this stage. All Grade 10-12 teachers should consider integration of ASs within and across the grades.

STAGE 2 **Work Schedule**	The integration and sequencing of the ASs is undertaken in the Work Schedule to ensure that all ASs for a particular grade are covered in the 40-week contact period.
STAGE 3 **Lesson Plan**	The same groupings of LOs and ASs as arrived at in the Work Schedule should be used to develop a coherent series of learning, teaching and assessment activities for each Lesson Plan.

3.2.4 Conceptual Progression

STAGE 1 **Subject Framework**	The Subject Framework should indicate the increasing depth of difficulty across Grades 10-12. Progression across the three grades is shown in the ASs per Learning Outcome.
STAGE 2 **Work Schedule**	Progression in a grade is evident in the increasing depth of difficulty in that particular grade. Grade-specific progression is achieved by appropriately sequencing the groupings of integrated LOs and AS in the Work Schedule.
STAGE 3 **Lesson Plan**	In the individual Mechanical Technology classroom increasing depth of difficulty is shown in the activities and Lesson Plans. Progression is achieved by appropriately sequencing the activities contained within each Lesson Plan and in the series of Lesson Plans.

3.2.5 Time Allocation and Weighting

The three stages of developing a Learning Programme give guidance of how to manage time effectively during the year. It is very important that the different activities be selected according to ability of the learners and time available. As soon as learners have mastered a skill learners must be exposed to a different type of activity. The nature of Mechanical Technology is that the majority of activities are completed practically by learners by applying the principles imbedded in Mechanical Technology. The mastering of the theory component is a prerequisite as the different LOs are integrated and can not stand alone.

STAGE 1 **Subject Framework**	4 hours per week is allocated to Mechanical Technology in the NCS. This is approximately 160 hours per year. The teachers of the subject should plan how this time will be used for the teaching of Mechanical Technology in the three grades. The suggested weighting of the four Learning Outcome for Mechanical Technology in the FET Band is as follows: LO1: 10 %, LO2: 10 %, LO3: 30 % and LO4: 50 %.
STAGE 2 **Work Schedule**	The groupings of ASs as arrived at in the integration process should be paced across the 40 weeks of the school year to ensure coverage of the curriculum.
STAGE 3 **Lesson Plan**	The amount of time to be spent on activities should be indicated in the Lesson Plans.

3.2.6 LTSM

LTSM refers to any materials that facilitate learning and teaching. LTSM need to be chosen judiciously because they have cost implications for the school and the learner. The NCS provides scope for the use of a variety of resources. All teachers and learners must have a textbook. However, teachers are required to go beyond the textbook. They do not necessarily need exotic, specialised materials. Rather common and readily available items can be used.

STAGE 1 **Subject Framework**	Compile a list of general LTSM (text books and other resources) that will be necessary and useful in the teaching, learning and assessment of the content. This assists with the requisition and availability of LTSM at a school.
STAGE 2 **Work Schedule**	List grade-specific LTSM (resources) required in the learning, teaching and assessment process for the grade.
STAGE 3 **Lesson Plan**	Identify specific resources related to the individual activities contained within a Lesson Plan.

3.2.7 Assessment

All Grade 10, 11 and 12 learners are expected to complete seven internal tasks for Mechanical Technology. Of the seven tasks, two must be tests, two must be examinations and the remaining three tasks can take any form suitable to the teaching and assessment of Mechanical Technology. In addition, Grade 12 learners are expected to complete an external examination. See Section 3 of the Subject Assessment Guidelines for Mechanical Technology for further information.

In order to administer effective assessment one must have a clearly defined purpose. It is important that all the tasks are well covered as spelt out in the Subject Assessment Guideline document. By answering the following questions the teacher can decide what assessment activity is most appropriate:

- What concept, skill or knowledge needs to be assessed?
- What should the learners know?
- At what level should the learners be performing?
- What type of knowledge is being assessed: reasoning, memory or process?

Observation-based assessment requires that learner performance be assessed while the learner is actually performing a skill in the classroom as there will be no concrete product for the teacher to assess after the performance. Not all observations need culminate in a formally recorded assessment of learner performance. **Performance-based** assessment relies on the availability of a product as evidence of learner performance that can be assessed by the teacher after the completion of the performance. **Test-based** assessment focuses on assessing the presentation and application of knowledge.

STAGE 1 **Subject Framework**	Develop a three-year assessment plan using the Subject Assessment Guidelines for Mechanical Technology. This should ensure the use of a variety of assessment forms relevant to the subject and progression across the three grades.
STAGE 2 **Work Schedule**	Use the Subject Assessment Guidelines for Mechanical Technology to develop a grade-specific assessment plan. The forms of assessment listed must facilitate the achievement of the particular LOs and ASs in each grouping.
STAGE 3 **Lesson Plan**	Indicate more classroom-specific assessment strategies, by mentioning the methods, forms and tools that will be used to assess learner performance in each activity. HINT: Not all activities need to be assessed – some may just be introductory in nature or for enrichment. The choice of an assessment strategy is determined by the LOs and ASs that have been grouped together for a particular Lesson Plan. The assessment strategy chosen must facilitate the achievement of these particular LOs and ASs in the classroom.

3.2.8 Inclusivity and Diversity

The following steps can be taken to effectively address diversity in the classroom when planning Mechanical Technology teaching activities:

- consider individual past experiences, learning styles and preferences;
- develop questions and activities that are aimed at different levels of ability;
- provide opportunity for a variety of participation levels such as individual, pairs and small group activities;
- consider the value of individual methods ; and
- assess learners based on individual progress.

STAGE 1 **Subject Framework** **STAGE 2** **Work Schedule**	Teachers should be sensitive to inclusivity and diversity when identifying content, teaching styles and methods, forms of assessment and LTSM (Resources). Diversity should be accommodated in the following areas: • Learning styles: provide optional activities / different ways of doing same activity • Pace of learning: provide for both slower and faster learners by providing optional extra activities, reading or research, as well as multiple assessment opportunities • Differences in levels of achievement: provide optional extra activities, challenges and materials that cater for these differences between learners. • Gender diversity: ensure that teachers do not inadvertently allow or contribute towards discrimination against boys or girls in the classroom on the basis of gender. • Cultural diversity: recognise, celebrate and be sensitive when choosing content, assessment tasks and LTSM.
STAGE 3 **Lesson Plan**	This is catered for as EXPANDED OPPORTUNITIES in the Lesson Plan. Enrichment is provided for high achievers and remediation or other relevant opportunities for learners requiring additional support. It is not necessary to develop an activity to cater for each type of diversity which arises in the classroom. Teachers may find it possible to cater for different diversities within one activity with effective planning.

3.2.9 Learning and Teaching Methodology

STAGE 1 **Subject Framework**	It is not necessary to record Teaching Methods for either of these stages.
STAGE 2 Work Schedule	
STAGE 3 **Lesson Plan**	This is catered for as TEACHING METHOD in the Lesson Plan. It provides an indication of how teaching and learning will take place, that is, how each activity will be presented in the classroom.

3.3 DESIGNING A LEARNING PROGRAMME

A detailed description of the process involved in the design of a Learning Programme for Mechanical Technology is provided in this section (see Sections 3.3.1 – 3.3.3). The process presented here is a suggestion of how to go about designing a Learning Programme.

3.3.1 Subject Framework (Grades 10-12) for Mechanical Technology

Planning for the teaching of Mechanical Technology in Grades 10 to 12 should begin with a detailed examination of the scope of the subject as set out in the Subject Statement. No particular format or template is recommended for this first phase of planning but the five steps below should be used as a checklist.

Although no prescribed document is required for this stage of planning, school-wide planning (timetables, ordering, teacher development, classroom allocation) as well as the development of grade-specific work schedules would benefit from short documents which spell out:

- The scope of the subject – the knowledge, skills and values; the content; the contexts or themes and electives to be covered in the three grades (see Appendix A)
- A three-year assessment plan
- The list of LTSM required

❶ Clarify the Learning Outcomes and Assessment Standards.

The essential question for Mechanical Technology is: What Learning Outcomes do learners have to master by the end of Grade 12 and what Assessment Standards should they achieve to show that they are on their way to mastering these outcomes?

All learning, teaching and assessment opportunities must be designed down from what learners should know, do and produce by the end of Grade 12. The Learning Outcomes and Assessment Standards that learners should master by the end of Grade 12 are specified in the Mechanical Technology Subject Statement.

❷ **Study the conceptual progression across the three grades.**

Study the Assessment Standards for Mechanical Technology across the three grades. Progression should be clearly evident across the grades.

❸ **Identify the content to be taught.**

Analyse the Assessment Standards to identify the skills, knowledge, attitudes and values to be addressed in each grade. Also consider the content and context in which they will be taught.

❹ **Identify three-year plan of assessment.**

Use the Subject Assessment Guidelines to guide the three-year assessment plan. Consider what forms of assessment will be best suited to each of the Learning Outcomes and Assessment Standards. This ensures that assessment remains an integral part of the learning and teaching process in Mechanical Technology and that learners participate in a range of assessment activities.

❺ **Identify possible LTSM (resources).**

Consider which LTSM will be best suited to the learning, teaching and assessment of each Learning Outcome in the three grades using the Assessment Standards as guidance.

3.3.2 Designing Work Schedules for Mechanical Technology

This is the second phase in the design of a Learning Programme. In this phase teachers develop Work Schedules for each grade. The Work Schedules are informed by the planning undertaken for the Subject Framework. The Work Schedules should be carefully prepared documents that reflect what teaching and assessment will take place in the 40 weeks of the school year. See Appendix B for examples of Work Schedules for Grades 10, 11 and 12.

The following steps provide guidelines on how to approach the design of a Work Schedule per grade for Mechanical Technology:

❶ **Package the content.**

Study the Learning Outcomes and Assessment Standards prescribed for the particular grade in Mechanical Technology and group these according to natural and authentic links.

❷ **Sequence the content.**

Determine the order in which the groupings of Learning Outcomes and Assessment Standards will be presented in the particular grade in Mechanical Technology. Besides the conceptual progression in the Assessment Standards for Mechanical Technology, context can also be used to sequence groupings in Mechanical Technology.

❸ **Pace the content.**

Determine how much time in the school year will be spent on each grouping of Learning Outcomes and Assessment Standards in the particular grade.

❹ **Review forms of assessment.**

Revisit the forms of assessment listed for the particular grade in the Subject Assessment Guidelines, and refine them to address each grouping of Learning Outcomes and Assessment Standards as developed in Step 1.

❺ **Review LTSM.**

Revisit the LTSM (resources) listed for the particular grade in the Subject Framework, and refine them to address each grouping of Learning Outcomes and Assessment Standards as developed in Step 1.

3.3.3 Designing Lesson Plans for Mechanical Technology

Each grade-specific Work Schedule for MECHANICAL TECHNOLOGY must be divided into units of deliverable learning experiences, that is, Lesson Plans. A Lesson Plan adds to the level of detail in the Work Schedule. It also indicates other relevant issues to be considered when teaching and assessing Mechanical Technology.

A Lesson Plan is not equivalent to a subject period in the school timetable. Its duration is dictated by how long it takes to complete the coherent series of activities contained in it.

❶ **Indicate the content, context, Learning Outcomes and Assessment Standards.**

Copy this information from the Work Schedule for the particular grade.

❷ **Develop activities and select teaching method.**

Decide how to teach the Learning Outcomes and Assessment Standards indicated in Step 1 and develop the activity or activities that will facilitate the development of the skills, knowledge, attitudes and values in the particular grouping. Thereafter, determine the most suitable teaching method(s) for the activities and provide a description of how the learners will engage in each activity.

❸ **Consider diversity.**

Explore the various options available within each activity that will allow expanded opportunities to those learners that require individual support. The support provided must ultimately guide learners to develop the skills, knowledge, attitudes and values indicated in the grouping of Learning Outcomes and Assessment Standards.

❹ **Review assessment and LTSM.**

Indicate the details of the assessment strategy and LTSM to be used in each activity.

❺ **Allocate time.**

Give an indication of how much time will be spent on each activity in the Lesson Plan.

3.3.4 Reflection and review of the Mechanical Technology Learning Programme

After the Learning Programme has been delivered by means of Lesson Plans in the classroom, the teacher should reflect on what worked, how well it worked and what could be improved. Teachers need to note these while the experience is still fresh in their minds, so that if necessary, they can adapt and change the affected part of the Mechanical Technology Learning Programme for future implementation. It is advisable to record this reflection on the Lesson Plan planning sheets.

APPENDIX A:
CONTENT FRAMEWORK FOR MECHANICAL TECHNOLOGY

Note:

- See the Defining Content and Context document for Mechanical Technology (Department of Education, 2006) for further guidance on the content to be addressed in Mechanical Technology.

UNPACKING THE ASSESSMENT STANDARDS IN LEARNING OUTCOMES 3 AND 4

LEARNING OUTCOMES 3 & 4 GRADE 10 ASSESSMENT STANDARDS	**POSSIBLE CONTENT FOR THE ASSESSMENT STANDARD**
SAFETY 10.3.1 demonstrate an understanding of the Occupational Health and Safety (OHS) Act where applicable	**General unsafe actions, dangerous practices and unsafe conditions** • Learners must be fully aware of all the safety precautions to be taken during performance-based activities in order to avoid injuries or incidents.
10.4.1 apply all relevant safety measures	**Identify and prevent hazardous conditions by taking precautions to avoid injuries and accidents in terms of:** • Good housekeeping, machine guards, covering of transmission belts, protruding shaft ends and sharp edges; • No adjustment or maintenance on running machines; • Proper and safe stacking of objects; • Proper lighting; • Clean and dry workplace, floor space, condition of floors; • Working at safe speed; • Safe electrical extensions; • Using tools within capacity limits; • Safe practices and good personal habits, protective equipment and clothing; • Safety switches, colour coding and signs; and • Machines with moving/rotating parts such as emery wheels, cutting discs, grinding equipment, pedestal drilling machines and lathes.
TOOLS AND EQUIPMENT 10.3.2 describe the principles and functions of appropriate basic tools and equipment	**Basic tools and equipment such as:** • Spanners: ring-, flat - and combination; • Sockets and accessories; • Pliers: combination, circlip, diagonal, long nose and water pump; • Chisels, hammers, hacksaws, scribers, punches, steel rulers, engineering squares and measuring tapes; • Screwdrivers: flat- Phillips / star and off set; and • Files, smooth and bastard: flat -, square-, triangle – round and half round shapes.
10.4.2 select, use and care for appropriate basic tools and equipment	**Measuring instruments such as:** • steel rulers, engineering squares, combination set, measuring tapes; and • verniers, callipers and outside micrometers.

LEARNING OUTCOMES 3 & 4 GRADE 10 ASSESSMENT STANDARDS	POSSIBLE CONTENT FOR THE ASSESSMENT STANDARD
ENGINEERING MATERIALS 10.3.3 explain the reason for using certain engineering materials by taking environmental aspects into consideration	***Ferrous metals:*** • Cast iron, grey cast iron, white cast iron; and • Steel, chrome - nickel, vanadium, manganese, nickel, spring steel, wolfram.` ***Non ferrous metals:*** • Copper, tin, lead, zinc and aluminium. ***Non ferrous alloys:*** • Yellow copper, bronze, phosphor bronze, white metal, duralumin, solder and silver solder. ***Composites:*** • Nylon, Teflon, Carbon and Glass Fibre and Polly Vinyl Composite (PVC), Vesconite.
ENGINEERING MATERIALS 10.4.3 distinguish between materials according to their properties	**Tests to distinguish between materials, tests such as:** • Visual inspection of general appearance like colour, texture and density (weight); • Sound test; • Filing test; • Spark test; and • Break test.
TERMINOLOGY 10.3.4 demonstrate an understanding of appropriate terminology and procedures used in the subject including but not limited to lathes and milling machines	• South African National Standards (SANS) as applicable to Mechanical Technology, but not only limited to SANS; and • Cutting procedures including, but not limited to, lathes, milling, drilling, machines and power saws
TERMINOLOGY 10.4.4 use instructions or basic drawings and apply different cutting methods to make an artefact	**Interpretation of terminology:** • Demonstrate the correct interpretation of terminology by using the given criteria; and • Apply different cutting methods on a lathe to make a basic artefact
JOINING METHODS 10.3.5 explain the uses of semi-permanent joining applications	**Semi-permanent joining applications:** • Bolts, studs, locking devices, nuts, split pins, rivets, and keys.
JOINING METHODS 10.4.5 use working instructions and apply basic relevant joining methods	**Apply semi-permanent joining applications:** • Demonstrate the correct interpretation of terminology by using the given criteria; and then make a lap joint by using a variety of jointing techniques which include rivets, bolts, nuts and other locking devices
FORCES 10.3.6 distinguish between different types of forces found in engineering components by graphically determining the nature of these forces	**Graphically determine the magnitude and nature of these forces by:** • Constructing a triangle or polygon of vectors to determine the resultant and equilibrant (balancing on the lathe).
FORCES 10.4.6 perform basic tests on various mechanical principles	**Testing of concepts such as:** • Forces, pressure and torque using gauges, meters and instruments.
MAINTENANCE 10.3.7 explain the effect of a lack of maintenance on operating systems	**Effects of lack of maintenance and lubrication such as:** • Excessive wear • Overheating / ceasing; and distortion; and • Failure e.g. hydraulics/ pneumatics, controls and cables

LEARNING OUTCOMES 3 & 4 GRADE 10 ASSESSMENT STANDARDS	POSSIBLE CONTENT FOR THE ASSESSMENT STANDARD
MAINTENANCE 10.4.7 identify signs of wear on components of mechanical systems	**Identifying:** • Excessive wear, overheating, ceasing and distortion on different components; and • Perform basic routine maintenance
SYSTEMS AND CONTROL 10.3.8 describe the functions of components applicable to different operating systems and the control thereof, such as mechanical, hydraulics and pneumatic systems	**Mechanical:** • Gears, pulleys, belts, chains, cables, threads and linkages, wheels and axles, clutches, levers and cams. **Hydraulics / Pneumatics** • Valves, pipes, pressure gauges, pistons and reservoirs, vessels under pressure. **Electrical/Electronic control** • Warning lights, sender units and gauges.
SYSTEMS AND CONTROL 10.4.8 demonstrate competency on basic systems and control	**Mechanical:** • Experiment with equipment (kits) containing levers, linkages and gear- and pulley ratios as found in practice on electrical press drills, lathes and other manual gearboxes; • Investigate examples of components such as oil pumps, fuel pumps and valves; and • Investigate examples driven by cams (timing and synchronising), wheels, axles and differentials. **Hydraulics and Pneumatics:** • Experiment with hydraulic and pneumatic equipment (kits) to demonstrate how Mechanical Advantage can be achieved. Automatic gearboxes, torque converters, power steering, brake systems are practical applications of these principles. **Electrical / Electronic control:** • Experiment with warning light circuits, sender units and gauges.
HEAT ENGINES 10.3.9 describe the operating principles of heat engines	**Internal combustion engine:** • Four-stroke and two-stroke petrol engines; and • Four and two stroke diesel engines. **External combustion engine:** • Reciprocating steam engine.
HEAT ENGINES 10.4.9 demonstrate understanding of the main functions of the components required for internal combustion engines	**Identify the main components such as:** • Pistons, rings, crankshaft, connecting rod, gudgeon pin, camshaft, cam and crank gears, valves, bearings, spark plug versus injector, carburettor versus fuel injection pump, that is found in the two stroke and four stroke spark ignition (petrol) and compression ignition (diesel) engines.

LEARNING OUTCOMES 3 & 4 GRADE 11 ASSESSMENT STANDARDS	POSSIBLE CONTENT FOR THE ASSESSMENT STANDARD
SAFETY 11.3.1 analyse the OHS Act and regulations where applicable 11.4 1 apply all relevant safety measures	**Machine specific safety measures when dealing with:** • Grinding machines (portable, bench and surface); • Cutting machines (drilling machines, power saw, lathes and milling); • Shearing machines (manual and power driven); • Press machines; • Joining equipment (arc, spot, gas); and • Handling gas bottles.
TOOLS AND EQUIPMENT 11.3.2 explain the principles and functions of purpose made tooling and equipment	**Purpose made tooling and equipment such as:** • Dial indicators; and • Verniers, callipers, inside and outside micrometers, torque wrenches, stocks and dies, Johannson gauge blocks, sine bars, toolmakers buttons.
TOOLS AND EQUIPMENT 11.4.2 demonstrate the care and use of hand and power tools	**Use with care purpose-made tooling and equipment such as:** • Grinding machines (portable, bench and surface); • Cutting machines (drilling machines, power saw, lathes and milling machines); • Shearing machines (manual and power driven); • Press machines; • Joining equipment (arc, spot, gas); • Dial indicator; and • Verniers, callipers, inside and outside micrometers, torque wrenches, Johannson gauge blocks, sine bars, and toolmakers buttons.
ENGINEERING MATERIALS 11.3.3 describe the ways of enhancing the properties of engineering materials by taking environmental aspects such as waste management into consideration	**Methods of enhancing the properties of steel such as:** • Tempering; • Case hardening • Hardening; • Annealing; and • Normalising.
ENGINEERING MATERIALS 11.4.3 apply measures to effect changes to the properties of materials so as to enhance their suitability	**Apply relevant measures to demonstrate competency in the following heat treatment processes:** • Tempering; and • Case hardening **Tasks on the following optional**: • Hardening; • Annealing; and • Normalising
TERMINOLOGY 11.3.4 describe applicable terminology encountered in the subject	• South African National Standards (SANS) as applicable to Mechanical Technology, but not only limited to SANS; and • Systéme International (SI) units and symbols.
TERMINOLOGY 11.4.4 use intermediate instructions and drawings and apply different cutting methods to make an artefact	**Interpretation of terminology:** • Demonstrate the correct interpretation of terminology by using the given criteria; and • Apply different cutting methods on a lathe to make an artefact.
JOINING METHODS 11.3.5 explain the uses of permanent joining applications	**Permanent joining applications such as:** • Soft and hard soldering; • Gas welding (oxy-acetylene); • Arc welding; and • Spot-welding.

LEARNING OUTCOMES 3 & 4 GRADE 11 ASSESSMENT STANDARDS	POSSIBLE CONTENT FOR THE ASSESSMENT STANDARD
JOINING METHODS 11.4.5 use working instructions and apply complex but relevant joining methods	**Applying permanent joining applications**: • Demonstrate the correct interpretation of terminology by using the given criteria; and • Make joints using a variety of jointing techniques which include soft and hard soldering, gas welding (oxy-acetylene), arc and spot welding
FORCES 11.3.6 demonstrate an understanding of the effects of forces, moments and torques on engineering components applying design principles	**Basic calculations on:** • Moments, forces and torques and the units thereof: e.g. F = m x a units Newton; e.g. Torque = Force x Radius.
FORCES 11.4.6 perform intermediate tests on various mechanical principles	**Testing of concepts such as:** • Bend moments and stresses, struts and tie using gauges and meters.
MAINTENANCE 11.3.7 analyse the causes of malfunction of operating systems	**Causes of malfunction of operating systems is:** • Lack of lubrication or incorrect lubrication • Overloading, friction, Balancing and • Alignment.
MAINTENANCE 11.4.7 evaluate and report on the deterioration of various mechanical components	Monitor the conditions of components in various mechanical systems and perform fault finding procedures on fuel systems, ignition circuits, timing. **Tasks on the following are optional:** • Overloading; • Balancing, and • Alignment.
SYSTEMS AND CONTROL 11.3.8 analyse the operation of components applicable to systems and the control thereof	**Mechanical:** • Gears, pulleys, belts, chains, cables, threads and linkages, wheels and axles, clutches, levers and cams, . **Hydraulics / Pneumatics** • Valves, pipes, pressure gauges, pistons and reservoirs. **Electrical / Electronic control** • ABS brakes, traction control, air bag control, fuel injection, ignition timing.
SYSTEMS AND CONTROL 11.4.8 demonstrate competency on intermediate systems and the control thereof	Examine mechanical, hydraulic- (brakes), fuel and pneumatic systems as found on equipment and vehicles
PUMPS 11.3.9 describe the operating principles of pumps	**Principles of pumps such as:** • Mono pumps; • Centrifugal pumps; • Reciprocating pumps; • Gear pumps; • Vane pumps; and • Rotor pumps.
PUMPS 11.4.9 demonstrate understanding of the operating principles of pumps	• Present models of different types of pumps as a project e.g. gear pump made out of foamalite; and • Read pressures of different pumps and compare with specifications

LEARNING OUTCOMES 3 & 4 GRADE 12 ASSESSMENT STANDARDS	POSSIBLE CONTENT FOR THE ASSESSMENT STANDARD
SAFETY 12.3.1 apply the OHS Act and regulations where applicable 12.4.1 apply all relevant safety measures	**Specific safety measures when dealing with the following machines and equipment:** • Metal Arc Gas-shielded welders (CO^2 and Argon); • Hardness testers (Brinnel and/or Rockwell); • Tensile testers • Torsion testers, • Moments and forces testers; • Beam bending tester; • Cylinder leakage and pressure testers; • Spring compressors and testers (valve and coil); • Gas analysers; • Multimeters; • Lathes and milling machines; and • Bearing and gear pullers.
TOOLS AND EQUIPMENT 12.3.2 describe the principles and functions of advanced engineering equipment 12.4.2 apply care and use of appropriate specialised mechanical equipment	**Advanced engineering equipment such as:** • Gas analysers; • Brinnel harden testers; • Multimeters; • Pressure testers; • Spring testers; • Cylinder leakage testers; • Torsion testers; • Moments and forces testers; • Beam bending testers; • Tensile testers; • Metal Arc Gas-shielded welders (CO^2 and Argon); and • Computerised Numerical Control (CNC, 3 axles) that are used on lathes and milling machines. **Use with care all the above.**
ENGINEERING MATERIALS 12.3.3 classify the enhanced materials according to their properties, uses and environmental aspects	**Non ferrous alloys*:*** • Yellow copper, bronze, phosphor bronze, white metal, duralumin, solder and silver solder. **Composites:** • Nylon, Teflon, carbon fibre and Polly Vinyl Composite (PVC). **Ferrous Alloys:** • Low-, medium- and high-carbon steels and stainless steel (chromium), manganese, vanadium, titanium and tungsten.
ENGINEERING MATERIALS 12.4.3 select materials suitable for their application	• Identify uses of materials with enhanced properties (tempering and case hardening) in practical applications (e.g. crankshafts, camshafts and piston rings).
TERMINOLOGY 12.3.4 apply correct terminology in the proper context	• South African National Standards (SANS) as applicable to Mechanical Technology, but not only limited to SANS; and • Systéme International (SI) units and symbols.

LEARNING OUTCOMES 3 & 4 GRADE 11 ASSESSMENT STANDARDS	POSSIBLE CONTENT FOR THE ASSESSMENT STANDARD
TERMINOLOGY 12.4.4 use advanced instructions and / or drawing and apply different cutting methods to make an artefact	**Interpretation of terminology:** • Demonstrate the correct interpretation of terminology by using working instructions; and • Apply different cutting methods on a milling machine to make an artefact.
JOINING METHODS 12.3.5 analyse the incorrect application of joining methods	**Possible defects by visual inspection:** • Porosity; • Slag inclusion; • Welding craters; • Incomplete penetration; • Undercutting; • Chamfering; • Faulty restart; and • Incorrect settings. **Destructive tests:** • Nick break; and • Nick bend. **Non-destructive tests:** • X – rays; • Dye penetration; and • Ultrasonic tests.
JOINING METHODS 12.4.5 use working instructions and apply advanced but relevant joining methods	**Applying advanced permanent joining applications:** • Demonstrate the correct interpretation of terminology by using given criteria; • Make joints by using a variety of jointing techniques which includes Gas Metal Arc Welding; and • Visual inspections of welded joints.
FORCES 12.3.6 demonstrate an understanding of the concepts of stress, strain and modules of elasticity	**Calculation of:** • Stress and strain; • Compressive / tensile stresses; and • Young's model of elasticity.
FORCES 12.4.6 perform advanced tests on various mechanical principles	**Testing of complex concepts such as:** • Advanced bending moments, shear forces, stresses, strains and elasticity using gauges and meters.
MAINTENANCE 12.3.7 identify the most suitable preventative maintenance in operating systems	**Before lubricant loses its properties like viscosity it must be replaced, for example:** • Transmission oil; • Engine oil; • Differential oil; • Cutting fluid; • Lubrication on bearings and linkages; and • Replacement of belt and chain drives, clutches.
MAINTENANCE 12.4.7 suggest applicable repair methods and adjustments to various systems	Apply various methods of repairing of, and adjustment to, mechanical systems

LEARNING OUTCOMES 3 & 4 GRADE 11 ASSESSMENT STANDARDS	POSSIBLE CONTENT FOR THE ASSESSMENT STANDARD
SYSTEMS AND CONTROL 12.3.8 use calculations to demonstrate understanding of systems and control explain fault finding techniques on operating systems	**Use of simple calculations related to power transmission systems on the following:** • Belt, gears, pulleys, cams, levers, threads and linkages, wheels and axles, hydraulic and pneumatic, clutches (friction). • Check the following: o Ignition (spark), fuel, the machine must rotate, power supply (battery); o Hydraulics: fluid, pressure, and relief valves, pistons, seals, pipe connections e.g. brakes; and o Pneumatics: vacuum, pressure, valves, pistons, diaphragms, vacuum meters, as found in the motor industry and food industry; • Electrical / Electronic control
SYSTEMS AND CONTROL 12.4.8 demonstrate competency on advanced systems and control	**Apply relevant methods of repairing to:** • Integrated electrical / mechanical systems e.g. electronic ignition, Anti-lock Braking System (ABS); • ignition (spark), fuel, the machine must rotate (rotor/valves), power supply (battery); • hydraulics: fluid, pressure, relief valves, pistons, seals, pipe connections, that are used in brakes, hydraulic presses and jacks; and • pneumatics: vacuum, pressure, valves, pistons, diaphragms, vacuum meters used in motor vehicles and industry.
TURBINES 12.3.9 describe the operating principles of turbines	**Principles of turbines such as:** • Steam turbines; • Gas turbines; **Operation of Turbo – and super chargers** including • vane compressors; • root blowers; and • centrifugal blowers.
12.4.9 demonstrate an understanding of the operating principles of turbines.	• Identify different types of turbines, turbo- and super chargers, their components. Demonstrate their working operation e.g. by simulations.

APPENDIX B: EXAMPLES OF WORK SCHEDULES FOR MECHANICAL TECHNOLOGY

GRADE 10 WORK SCHEDULE FOR MECHANICAL TECHNOLOGY				
▫ **Key to code used in table e.g. 10.1.1** ▫ **The grade is indicated with the first number, the second number indicates the LO, while the last number indicates the AS.**				
Wk	**LOs ASs**	**DESCRIPTION**	**ACTIVITIES**	**ASSESSMENT STRATEGIES**
1	10.1.1 & 10.2.1-5	**Introduce** the new subject and the technological process.	Presentation Video Criteria for assignment	Peer & group
2 3 4	10.1.3 & 10.3.1 & 10.4.1	• OHS Act dealing with unsafe actions, dangerous practices as well as hazardous conditions (proper housekeeping) in the working environment as to avoid injuries or dangerous incidents occurring; • Respond to basic medical emergency situations showing compassion towards health issues	Case studies and/or sketch scenarios Assignments Research tasks Role play	Group Task based Teacher Peer & group
5	10.3.2 & 10.4.2	Describe and select basic tools and equipment according to their functions and uses	Project	Teacher Peer Task based
6 7 8 9	10.3.4 10.3.5 10.1.3	Interpret symbols, units, terminology and procedures to apply different manufacturing methods such as drilling, cutting, filing, squaring and turning to make a basic artefact	Assignment	Task based
10		Summative Assessment and RECORDING of 1st Quarter Continuous Assessment (CASS)	Worksheets	Tests and examinations
11 12 13 14	10.3.4 10.3.5 10.1.3	Justify the use of different types of semi-permanent joining applications. Use a variety of jointing techniques which include rivets, bolts and nuts, and other locking devices	Assignment Experiments Performance tasks	Teacher Peer Task based
15 16 17	10.3.6 10.4.6 & 10.1.4	• Distinguish between different types of forces found in engineering components such as triangle and polygon of forces to determine the resultant and equilibrant, and addition	Exercises Assignment Experiments	Teacher Task based

18 19		of vectors; • Perform basic tests to verify various mechanical principles such as forces, pressure and torque using gauges, meters and relevant equipment		
20		Summative Assessment and RECORDING of 2nd Quarter Continuous Assessment (CASS)	Worksheets	Tests and examinations
21 22 23 24 	10.1.4 & 10.3.3 & 10.4.3	• Describe the properties of the various engineering materials and identification thereof (cast iron, mild steel, spring steel, aluminium, lead, copper, tungsten, chrome, white metal, and phosphor bronze; • Consider indigenous knowledge systems and environmental issues such as pollution and waste management	Assignment Experiments	Teacher Self Peer Task based
25 26 27 28 29	10.3.8 & 10.4.8	• Describe the functions of components used in different operating systems and the control thereof, such as mechanical, hydraulic and pneumatic systems; • Experiment with mechanical and laboratory equipment and kits containing levers, linkages, gear- and pulley ratios as encountered in practice on drills and gear boxes; • Experiment with hydraulic and pneumatic equipment and kits to demonstrate mechanical advantage; • Experiment with warning light circuits, sender units and gauges	Case Studies Experiments Applied theory project	Task based
30		Summative Assessment and RECORDING of 3rd Quarter Continuous Assessment (CASS)	Worksheets	Tests and examinations
31 32 33 34	10.3.7 & 10.4.7	Identify signs of wear on components of mechanical systems due to friction and deduct the importance of maintenance on operating systems	Research Videos and/or real life examples Assignment	Task based
35 36 37 38	10.3.9 10.4.9 & 10.1.1	Describe the operating principles of heat engines and demonstrate an understanding of the function of the main components required for the internal combustion engine (reciprocating steam-, and 2- and 4-stroke petrol and diesel engines)	Assignment Video Experiments Demonstrations	Teacher Task based

39 40		Summative Assessment and Consolidation of yearly Continuous Assessment (CASS)	Worksheets Question papers	Tests and examinations

GRADE 11 WORK SCHEDULE FOR MECHANICAL TECHNOLOGY				
❑ **Key to code used in table e.g. 11.1.1** ❑ **The grade is indicated with the first number, the second number indicates the LO, while the last number indicates the AS.**				
Wk	**LOs ASs**	**DESCRIPTION**	**ACTIVITIES**	**ASSESSMENT STRATEGIES**
1	11.2.1-5	**Revise** the technological process.	Video Criteria for assignment	Peer
2 3 4	11.1.3 & 11.3.1 & 11.4.1	• OHS Act dealing with basic and machine specific safety measures when dealing with grinding-, shearing-, cutting- and joining machines such as welders	Assignment Research Case studies Scenarios Role play	Peer Task based
5	11.3.2 & 11.4.2	Describe and select purpose-made tooling and equipment according to their functions and uses	Project	Teacher Peer Task based
6 7 8 9	11.3.4 11.3.5 11.1.3	Interpret symbols, units and terminology to make an artefact while applying different cutting procedures including lathes, drilling machines and power saws	Assignment	Task based
10		Summative Assessment and RECORDING of 1st Quarter Continuous Assessment (CASS)	Worksheets	Tests and examinations
11 12 13 14	11.3.4 11.3.5 11.1.3	Justify the use of different types of permanent joining applications and jointing techniques which include soft- and hard soldering, gas or oxy-acetylene welding, arc welding and spot welding to make an artefact	Assignment Experiments Performance task	Teacher Peer Task based
15 16 17 18 19	11.3.6 11.4.6 & 11.1.4	• Distinguish between different types of forces found in components such as force, moments and torque and identifying struts and ties; • Perform basic tests to verify various mechanical principles such as bending moments and stresses	Exercises Assignment Experiments	Teacher Task based
20		Summative Assessment and RECORDING of 2nd Quarter Continuous Assessment (CASS)	Worksheets	Tests and examinations
21 22	11.1.4 & 11.3.3 &	• Describe ways of enhancing the	Assignment Experiments	Teacher Self

23 24	11.4.3	properties of steel such as heat treatment and surface protection; • Temper and case-harden a piece of steel to make a chisel and punch		Peer Task based
25 26 27 28 29	11.3.8 & 11.4.8	• Describe the functions of components used in different operating systems and the control thereof, such as mechanical, hydraulic and pneumatic systems; • Examine mechanical and hydraulic brakes, fuel- and pneumatic systems found on mechanical equipment and vehicles; • Electronic control, including ABS, traction- and air bag control, fuel injection and ignition timing	Case Studies Experiments Applied theory project	Task based
30		Summative Assessment and RECORDING of 3rd Quarter Continuous Assessment (CASS)	Worksheets Question papers	Tests and examinations
31 32 33 34 35	11.3.7 & 11.4.7	• Analyse the causes of malfunction of operating systems; • Perform fault finding procedures on fuel systems, ignition and various gear timing; • Evaluate and report on the deterioration of various mechanical components	Research Videos and/or real life examples Assignment	Task based
36 37 38 39	11.3.9 11.4.9 & 11.1.1	Describe the operating principles of pumps and demonstrate an understanding of the function of the main components thereof	Assignment Video Experiments Demonstrations	Teacher Task based
40		Summative Assessment and Consolidation of yearly Continuous Assessment (CASS)	Worksheets Question papers	Tests and examinations

GRADE 12 WORK SCHEDULE FOR MECHANICAL TECHNOLOGY				
❑ **Key to code used in table e.g. 12.1.1** ❑ **The grade is indicated with the first number, the second number indicates the LO, while the last number indicates the AS.**				
Wk	**LOs ASs**	**DESCRIPTION**	**ACTIVITIES**	**ASSESSMENT STRATEGIES**
1	12.1.1 & 12.2.1-5	**Revise** the technological process	Video Criteria for assignment	Peer
2 3 4	12.1.3 & 12.3.1 & 12.4.1	• OHS Act dealing with basic and machine specific safety measures when dealing with advanced engineering equipment	Assignment Research tasks Case studies Scenarios Role play	Peer Task based
5	12.3.2 & 12.4.2	Describe and select advanced engineering equipment according to their functions and uses including milling machines	Project	Teacher Peer Task based
6 7 8 9	12.3.4 12.4.4 12.1.3	Interpret symbols, units and terminology to make an artefact while concentrating on cutting procedures including speed, feed, cutting depth, roughness values, limits and fits	Assignment	Task based
10		Summative Assessment and RECORDING of 2nd Quarter Continuous Assessment (CASS)	Worksheets	Tests and examinations
11 12 13 14	12.3.5 12.4.5 12.1.3	• Identify defects of welded joints by visual inspection, destructive and none destructive tests; • Apply jointing techniques which include gas metal arc welding to make an artefact	Assignment Experiments Performance task	Teacher Peer Task based
15 16 17 18 19	12.3.6 12.4.6 & 12.1.4	• Calculate stress and strain, compressive and tensile stress; and Young's Modules of Elasticity (E); • Perform basic tests to verify various complex concepts such as bending moments, shear forces, stress, strain and elasticity using gauges and meters,	Exercises Assignment Experiments	Teacher Task based
20		Summative Assessment and RECORDING of 2nd Quarter Continuous Assessment (CASS)	Worksheets	Tests and examinations

21 22 23 24	12.1.4 & 12.3.3 & 12.4.3	• Classify enhanced materials like alloys and composites according to their properties, uses and environmental aspects; • Identify metals by performing tests: sound, machining, filing, spark and break tests; • Identify uses of materials with enhanced properties (tempering and case hardening) in practical applications (e.g. crankshafts, camshafts and piston rings)		
25 26 27 28 29	12.3.7 & 12.4.7	• Identify the most suitable preventative maintenance in operating systems; • Perform fault finding procedures on fuel systems, ignition and various gear timing; • Suggest applicable repair methods and adjustment to various systems	Worksheets Question papers Research Videos and/or real life examples Assignment	Tests and examinations Task based
30		Summative Assessment and RECORDING of 3rd Quarter Continuous Assessment (CASS)		
31 32 33 34	12.3.8 & 12.4.8	• Use calculations to solve problems concerning systems and the control thereof, such as mechanical, hydraulic and pneumatic systems; • Indicate how one system is controlled by another system; • Integrated electrical/ electronic/ mechanical control systems including ABS, Computerised Numerical Control (CNC) on milling machines	Case Studies Experiments Applied theory project	Task based
35 36 37	12.3.9 & 12.4.9	Describe the operating principles of turbines and demonstrate an understanding of the function of the main components thereof	Assignment Video Experiments Demonstrations	Teacher Task based
38		Summative Assessment and Consolidation of yearly Continuous Assessment (CASS)	Worksheets Question papers	Tests and examinations