DEPARTMENT OF EDUCATION

**NATIONAL CURRICULUM
STATEMENT GRADES 10-12
(GENERAL)**

ENGINEERING
GRAPHICS
AND DESIGN

DEPARTMENT OF EDUCATION

National Curriculum Statement
Grades 10 – 12
(General)

ENGINEERING GRAPHICS AND DESIGN

HOW TO USE THIS BOOK

This document is a policy document divided into four chapters. It is important for the reader to read and integrate information from the different sections in the document. The content of each chapter is described below.

■ ### Chapter 1 - Introducing the National Curriculum Statement

This chapter describes the principles and the design features of the National Curriculum Statement Grades 10 – 12 (General). It provides an introduction to the curriculum for the reader.

■ ### Chapter 2 - Introducing the Subject

This chapter describes the definition, purpose, scope, career links and Learning Outcomes of the subject. It provides an orientation to the Subject Statement.

■ ### Chapter 3 - Learning Outcomes, Assessment Standards, Content and Contexts

This chapter contains the Assessment Standards for each Learning Outcome, as well as content and contexts for the subject. The Assessment Standards are arranged to assist the reader to see the intended progression from Grade 10 to Grade12. The Assessment Standards are consequently laid out in double-page spreads. At the end of the chapter is the proposed content and contexts to teach, learn and attain Assessment Standards.

■ ### Chapter 4 – Assessment

This chapter deals with the generic approach to assessment being suggested by the National Curriculum Statement. At the end of the chapter is a table of subject-specific competence descriptions. Codes, scales and competence descriptions are provided for each grade. The competence descriptions are arranged to demonstrate progression from Grade 10 to Grade 12.

■ ### Symbols

The following symbols are used to identify Learning Outcomes, Assessment Standards, grades, codes, scales, competence description, and content and contexts.

LO	= Learning Outcome	**S**	= Scale
AS	= Assessment Standard	**Cd**	= Competence Description
G	= Grade	**C**	= Content and Contexts
C	= Code		

CONTENTS

ACRONYMS

AIDS	Acquired Immune Deficiency Syndrome
CADD	Computer-Aided Design and Draughting
CASS	Continuous Assessment
DO	Developmental Outcome
FET	Further Education and Training
GET	General Education and Training
HIV	Human Immunodeficiency Virus
IKS	Indigenous Knowledge Systems
NCS	National Curriculum Statement
NQF	National Qualifications Framework
OBE	Outcomes-Based Education
SABS	South African Bureau of Standards
SAQA	South African Qualifications Authority
SANS	South African National Standards

CHAPTER 1

INTRODUCING THE NATIONAL CURRICULUM STATEMENT

The adoption of the Constitution of the Republic of South Africa (Act 108 of 1996) provided a basis for curriculum transformation and development in South Africa. The Preamble 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.

The Constitution further states that 'everyone has the right … to further education which the State, through reasonable measures, must make progressively available and accessible'.

The National Curriculum Statement Grades 10 – 12 (General) lays a foundation for the achievement of these goals by stipulating Learning Outcomes and Assessment Standards, and by spelling out the key principles and values that underpin the curriculum.

PRINCIPLES

The National Curriculum Statement Grades 10 – 12 (General) is based on the following principles:

■ social transformation;
■ outcomes-based education;
■ high knowledge and high skills;
■ integration and applied competence;
■ progression;
■ articulation and portability;
■ human rights, inclusivity, environmental and social justice;
■ valuing indigenous knowledge systems; and
■ credibility, quality and efficiency.

Social transformation

The Constitution of the Republic of South Africa forms the basis for social transformation in our post-apartheid society. The imperative to transform South African society by making use of various transformative tools stems from a need to address the legacy of apartheid in all areas of human activity and in education in particular. Social transformation in education is aimed at ensuring that the educational imbalances of the past are redressed, and that equal educational opportunities are provided for all sections of our population. If social transformation is to be achieved, all South Africans have to be educationally affirmed through the recognition of their potential and the removal of artificial barriers to the attainment of qualifications.

Outcomes-based education

Outcomes-based education (OBE) forms the foundation for the curriculum in South Africa. It strives to enable all learners to reach their maximum learning potential by setting the Learning Outcomes to be achieved by the end of the education process. OBE encourages a learner-centred and activity-based approach to education. The National Curriculum Statement builds its Learning Outcomes for Grades 10 – 12 on the Critical and Developmental Outcomes that were inspired by the Constitution and developed through a democratic process.

The Critical Outcomes require learners to be able to:

- identify and solve problems and make decisions using critical and creative thinking;
- work effectively with others as members of a team, group, organisation and community;
- 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.

The Developmental Outcomes require learners to be able to:

- reflect on and explore a variety of strategies to learn more effectively;
- participate as responsible citizens in the life of local, national and global communities;
- be culturally and aesthetically sensitive across a range of social contexts;
- explore education and career opportunities; and
- develop entrepreneurial opportunities.

High knowledge and high skills

The National Curriculum Statement Grades 10 – 12 (General) aims to develop a high level of knowledge and skills in learners. It sets up high expectations of what all South African learners can achieve. Social justice requires the empowerment of those sections of the population previously disempowered by the lack of knowledge and skills. The National Curriculum Statement specifies the minimum standards of knowledge and skills to be achieved at each grade and sets high, achievable standards in all subjects.

Integration and applied competence

Integration is achieved within and across subjects and fields of learning. 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. Applied competence aims at integrating three discrete competences – namely, practical, foundational and reflective competences. In adopting integration and applied competence, the National Curriculum Statement Grades 10 – 12 (General) seeks to promote an integrated learning of theory, practice and reflection.

Progression

Progression refers to the process of developing more advanced and complex knowledge and skills. The Subject Statements show progression from one grade to another. Each Learning Outcome is followed by an explicit statement of what level of performance is expected for the outcome. Assessment Standards are arranged in a format that shows an increased level of expected performance per grade. The content and context of each grade will also show progression from simple to complex.

Articulation and portability

Articulation refers to the relationship between qualifications in different National Qualifications Framework levels or bands in ways that promote access from one qualification to another. This is especially important for qualifications falling within the same learning pathway. Given that the Further Education and Training band is nested between the General Education and Training and the Higher Education bands, it is vital that the Further Education and Training Certificate (General) articulates with the General Education and Training Certificate and with qualifications in similar learning pathways of Higher Education. In order to achieve this articulation, the development of each Subject Statement included a close scrutiny of the exit level expectations in the General Education and Training Learning Areas, and of the learning assumed to be in place at the entrance levels of cognate disciplines in Higher Education.

Portability refers to the extent to which parts of a qualification (subjects or unit standards) are transferable to another qualification in a different learning pathway of the same National Qualifications Framework band. For purposes of enhancing the portability of subjects obtained in Grades 10 – 12, various mechanisms have been explored, for example, regarding a subject as a 20-credit unit standard. Subjects contained in the National Curriculum Statement Grades 10 – 12 (General) compare with appropriate unit standards registered on the National Qualifications Framework.

Human rights, inclusivity, environmental and social justice

The National Curriculum Statement Grades 10 – 12 (General) seeks to promote human rights, inclusivity, environmental and social justice. All newly-developed Subject Statements are infused with the principles and practices of social and environmental justice and human rights as defined in the Constitution of the Republic of South Africa. In particular, 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.

The National Curriculum Statement Grades 10 – 12 (General) adopts an inclusive approach by specifying minimum requirements for all learners. It acknowledges that all learners should be able to develop to their full potential provided they receive the necessary support. The intellectual, social, emotional, spiritual and physical needs of learners will be addressed through the design and development of appropriate Learning Programmes and through the use of appropriate assessment instruments.

Valuing indigenous knowledge systems

In the 1960s, the theory of multiple-intelligences forced educationists to recognise that there were many ways of processing information to make sense of the world, and that, if one were to define intelligence anew, one would have to take these different approaches into account. Up until then the Western world had only valued logical, mathematical and specific linguistic abilities, and rated people as 'intelligent' only if they were adept in these ways. Now people recognise the wide diversity of knowledge systems through which people make sense of and attach meaning to the world in which they live. Indigenous knowledge systems in the South African context refer to a body of knowledge embedded in African philosophical thinking and social practices that have evolved over thousands of years. The National Curriculum Statement Grades 10 – 12 (General) has infused indigenous knowledge systems into the Subject Statements. It acknowledges the rich history and heritage of this country as important contributors to nurturing the values contained in the Constitution. As many different perspectives as possible have been included to assist problem solving in all fields.

Credibility, quality and efficiency

The National Curriculum Statement Grades 10 – 12 (General) aims to achieve credibility through pursuing a transformational agenda and through providing an education that is comparable in quality, breadth and depth to those of other countries. Quality assurance is to be regulated by the requirements of the South African Qualifications Authority Act (Act 58 of 1995), the Education and Training Quality Assurance Regulations, and the General and Further Education and Training Quality Assurance Act (Act 58 of 2001).

THE KIND OF LEARNER THAT IS ENVISAGED

Of vital importance to our development as people are the values that give meaning to our personal spiritual and intellectual journeys. *The Manifesto on Values, Education and Democracy* (Department of Education, 2001:9-10) states the following about education and values:

Values and morality give meaning to our individual and social relationships. They are the common currencies that help make life more meaningful than might otherwise have been. An education system does not exist to simply serve a market, important as that may be for economic growth and material prosperity. Its primary purpose must be to enrich the individual and, by extension, the broader society.

The kind of learner that is envisaged is one who will be imbued with the values and act in the interests of a society based on respect for democracy, equality, human dignity and social justice as promoted in the Constitution.

The learner emerging from the Further Education and Training band must also demonstrate achievement of the Critical and Developmental Outcomes listed earlier in this document. Subjects in the Fundamental Learning Component collectively promote the achievement of the Critical and Developmental Outcomes, while specific subjects in the Core and Elective Components individually promote the achievement of particular Critical and Developmental Outcomes.

In addition to the above, learners emerging from the Further Education and Training band must:

- 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 familiar to unfamiliar situations.

THE KIND OF TEACHER THAT IS ENVISAGED

All teachers and other educators are key contributors to the transformation of education in South Africa. The National Curriculum Statement Grades 10 – 12 (General) visualises teachers who are qualified, competent, dedicated and caring. They will be able to fulfil the various roles outlined in the Norms and Standards for Educators. These include being mediators of learning, interpreters and designers of Learning Programmes and materials, leaders, administrators and managers, scholars, researchers and lifelong learners, community members, citizens and pastors, assessors, and subject specialists.

STRUCTURE AND DESIGN FEATURES

Structure of the National Curriculum Statement

The National Curriculum Statement Grades 10 – 12 (General) consists of an Overview Document, the Qualifications and Assessment Policy Framework, and the Subject Statements.

The subjects in the National Curriculum Statement Grades 10 – 12 (General) are categorised into Learning Fields.

What is a Learning Field?

A Learning Field is a category that serves as a home for cognate subjects, and that facilitates the formulation of rules of combination for the Further Education and Training Certificate (General). The demarcations of the Learning Fields for Grades 10 – 12 took cognisance of articulation with the General Education and Training and Higher Education bands, as well as with classification schemes in other countries.

Although the development of the National Curriculum Statement Grades 10 – 12 (General) has taken the twelve National Qualifications Framework organising fields as its point of departure, it should be emphasised that those organising fields are not necessarily Learning Fields or 'knowledge' fields, but rather are linked to occupational categories.

The following subject groupings were demarcated into Learning Fields to help with learner subject combinations:

- Languages (Fundamentals);
- Arts and Culture;
- Business, Commerce, Management and Service Studies;
- Manufacturing, Engineering and Technology;
- Human and Social Sciences and Languages; and
- Physical, Mathematical, Computer, Life and Agricultural Sciences.

What is a subject?

Historically, a subject has been defined as a specific body of academic knowledge. This understanding of a subject laid emphasis on knowledge at the expense of skills, values and attitudes. Subjects were viewed by some as static and unchanging, with rigid boundaries. Very often, subjects mainly emphasised Western contributions to knowledge.

In an outcomes-based curriculum like the National Curriculum Statement Grades 10 – 12 (General), subject boundaries are blurred. Knowledge integrates theory, skills and values. Subjects are viewed as dynamic, always responding to new and diverse knowledge, including knowledge that traditionally has been excluded from the formal curriculum.

A subject in an outcomes-based curriculum is broadly defined by Learning Outcomes, and not only by its body of content. In the South African context, the Learning Outcomes should, by design, lead to the achievement of the Critical and Developmental Outcomes. Learning Outcomes are defined in broad terms and are flexible, making allowances for the inclusion of local inputs.

What is a Learning Outcome?

A Learning Outcome is a statement of an intended result of learning and teaching. It describes knowledge, skills and values that learners should acquire by the end of the Further Education and Training band.

What is an Assessment Standard?

Assessment Standards are criteria that collectively describe what a learner should know and be able to demonstrate at a specific grade. They embody the knowledge, skills and values required to achieve the Learning Outcomes. Assessment Standards within each Learning Outcome collectively show how conceptual progression occurs from grade to grade.

Contents of Subject Statements

Each Subject Statement consists of four chapters and a glossary:

- *Chapter 1, Introducing the National Curriculum Statement:* This generic chapter introduces the National Curriculum Statement Grades 10 – 12 (General).
- *Chapter 2, Introducing the Subject:* This chapter introduces the key features of the subject. It consists of a definition of the subject, its purpose, scope, educational and career links, and Learning Outcomes.
- *Chapter 3, Learning Outcomes, Assessment Standards, Content and Contexts:* This chapter contains Learning Outcomes with their associated Assessment Standards, as well as content and contexts for attaining the Assessment Standards.
- *Chapter 4, Assessment:* This chapter outlines principles for assessment and makes suggestions for recording and reporting on assessment. It also lists subject-specific competence descriptions.
- *Glossary:* Where appropriate, a list of selected general and subject-specific terms are briefly defined.

LEARNING PROGRAMME GUIDELINES

A Learning Programme specifies the scope of learning and assessment for the three grades in the Further Education and Training band. It is the plan that ensures that learners achieve the Learning Outcomes as prescribed by the Assessment Standards for a particular grade. The Learning Programme Guidelines assist teachers and other Learning Programme developers to plan and design quality learning, teaching and assessment programmes.

CHAPTER 2

ENGINEERING GRAPHICS AND DESIGN

DEFINITION

Engineering Graphics and Design integrates cognitive and manipulative skills to communicate graphically, using a combination of lines, symbols and signs in order to produce products, processes, services and systems which contribute towards economic growth and enhanced quality of life.

PURPOSE

Engineering Graphics and Design will contribute towards learners' technological literacy by giving them opportunities to:

- develop and apply specific skills to solve technological problems related to Engineering Graphics and Design;
- understand the concepts and knowledge used in Engineering Graphics and Design, and use them responsibly and purposefully; and
- appreciate the interaction between people's values and attitudes, technology, society, environment and human rights.

Engineering Graphics and Design will provide learners in Further Education and Training schools with an opportunity directly related to the attainment of the Critical Outcomes, which are embedded in the Learning Outcomes. They will learn how to:

- identify and solve design problems while making responsible decisions using critical and creative thinking when applied to Engineering Graphics and Design;
- work effectively with others as a member of a team, group, organisation or community using Engineering Graphics and Design to make models;
- organise and manage themselves and their activities responsibly and effectively when researching the idea, thinking about it and make drawings to develop more ideas;
- collect, analyse, organise and critically evaluate information before producing a working drawing;
- communicate effectively using visual, mathematical and/or language skills in oral and/or written modes when applied to Engineering Graphics and Design;
- use science and technology effectively and critically, showing responsibility towards the environment and towards the health of others when using and producing engineering graphics and designs;
- understand and implement the ethical provisioning of services; and
- demonstrate an understanding of the world as a set of related systems by recognising that problem contexts do not exist in isolation, with the application of Engineering Graphics and Design.

In order to contribute to the full personal development of each learner and to the social and economic development of society at large, Engineering Graphics and Design will make learners aware of the importance of:

■ reflecting on and exploring a variety of strategies to learn more effectively;
■ participating as responsible citizens in the life of local, national and global communities;
■ being culturally and aesthetically sensitive across a range of social contexts;
■ exploring education and career opportunities;
■ developing entrepreneurial opportunities; and
■ using technology-based tools when engaged in computer-aided design and draughting to communicate graphically.

SCOPE

Engineering Graphics and Design as a subject gives learners the opportunity to:

■ communicate ideas graphically by employing drawing instruments and computer-based tools;
■ learn by solving problems in creative ways;
■ carry out practical projects and tasks using the process skills of investigating by means of meaningful research, designing, making, evaluating and communicating;
■ learn by dealing directly with human rights and social and environmental issues in their project work;
■ use and engage with knowledge in a purposeful way; and
■ create more positive attitudes, perceptions and aspirations towards manufacturing, engineering and technology-based careers.

The two Learning Outcomes in Engineering Graphics and Design are interrelated, and are based on the following principles:

■ *physical products:* Learners will be able to demonstrate the ability to design, draw and communicate graphically. They will also demonstrate the potential to build a variety of objects using different types of tools and equipment and a wide range of natural and processed materials;
■ *human processes:* Learners will be able to demonstrate the ability to learn about and analyse a range of human production processes. They will undertake projects that require them to design, develop and use examples of such processes; and
■ *environmental systems:* Learners will be able to demonstrate the ability to analyse and learn about different environmental systems and the technologies that make it possible to use or modify those systems to suit our own purposes. They will examine the impact of technology on the natural environment, and learn about the beneficial and the harmful effects and the short-term consequences of various types of technological intervention. Engineering Graphics and Design also offers new scope and opportunities for people with disabilities to be economically independent.

The following concepts are included to prepare learners for career pathways and for Higher Education and

Training in architectural, civil, mechanical and electrical engineering:

- cognitive development (visualisation, insight and perception);
- free-hand, instrument and computer-aided design;
- 2-dimensional and 3-dimensional drawings;
- projection methods;
- spatial drawings; and
- sectioning (detail and assembly drawing).

Embedded in each of these concepts are the following technologies:

- mechanical technology;
- electrical technology;
- civil technology; and
- architectural technology.

Engineering Graphics and Design can open up a range of career opportunities to people with disabilities to ensure that they become economically independent.

EDUCATIONAL AND CAREER LINKS

In the General Education and Training band, the Technology Learning Area Statement is an integrated study covering a wide range of technological areas. The Technology Learning Area is organised around the following Learning Outcomes:

- technological processes and skills;
- technological knowledge and understanding; and
- technology, society and the environment.

The Technology Learning Area encourages learners to engage in investigating, designing, making, evaluating and communicating solutions. It equips learners with knowledge and skills that enable them to be competent and confident when operating within a manufacturing, engineering or technological environment.

In order to satisfy the requirements of mobility between National Qualifications Framework (NQF) levels, progression to Higher Education and other career pathways, Engineering Graphics and Design includes but is not limited to:

- applications of the principles of Mathematics, Physical Sciences, Computer Applications Technology and Life Sciences to manufacturing, engineering and technology problem solving;
- conceptual design, synthesis and graphics;
- conceptual knowledge, understanding and application of materials and processes in manufacturing and the built environment;

- architectural, mechanical, structural, electrical and civil engineering;
- communicating technical, supervisory and general management effectively, both orally and in writing, using appropriate language, structure, style and graphical support;
- application of codes of practice (standards and conventions) and legislation;
- mobilising indigenous knowledge so that learners can benefit from indigenous technologies and indigenous technological solutions; and
- enabling learners to consider a range of technological solutions to problems, particularly those that are more sustainable and ones that are not detrimental to human health, well-being and the environment.

LEARNIN OUTCOMES

Learning Outcome 1: Techniques, Skills and Technologies

The learner is able to understand and apply techniques, skills and technologies related to the production of engineering graphics by working across a range of design and engineering disciplines ethically and responsibly through free-hand drawing, instrument drawing and computer-aided design and draughting.

In this Learning Outcome, learners must demonstrate the ability to understand, analyse and competently apply the fundamental principles of Engineering Graphics and Design, which include free-hand drawing, instrument drawing and computer-aided design and draughting programmes, utilising the responsible application of ethics.

Learning Outcome 2: Graphical Communication

The learner is able to understand and apply knowledge of the principles of global graphical communication in solving technological and design problems in an aesthetically, ethically and responsible way.

In this Learning Outcome, learners must demonstrate the ability to apply problem-solving principles in respect of the identification, analysis and development of a wide and varied range of data and information related to Engineering Graphics and Design.

CHAPTER 3

LEARNING OUTCOMES, ASSESSMENT STANDARDS, CONTENT AND CONTEXTS

Grade 10

Learning Outcome 1

Techniques, Skills and Technologies

The learner is able to understand and apply techniques, skills and technologies related to the production of engineering graphics by working across a range of design and engineering disciplines ethically and responsibly through freehand drawing, instrument drawing and computer-aided design and draughting.

Assessment Standards

We know this when the learner is able to:

■ Demonstrate and understand the basic principles, techniques and skills as well as the SABS code of practice.

■ Apply Engineering Graphics and Design through drawing techniques in relation to freehand and instrument drawings.

■ Demonstrate an understanding of computer-aided design and draughting programmes in relation to elementary reproduction drawing problems.

■ Explain different cultures encountered in the manufacturing industry.

Grade 11

Assessment Standards

We know this when the learner is able to:

- Apply knowledge of the basic principles, techniques and skills as well as the SABS code of practice.

- Apply Engineering Graphics and Design drawing techniques using more complex exercises on visualisation, perception and cognitive problems.

- Demonstrate an understanding of and apply curves of interpenetration and development.

- Apply free-hand drawing.

- Apply methods of determining various types of loci.

- Apply computer-aided design and draughting programmes to simple reproduction drawing problems.

- Explain how change in electronic and computer technologies impacts on the social milieu (e.g. privacy, ethics, access to classified information, security, intelligence, crime, crime fighting and human rights).

Grade 12

Assessment Standards

We know this when the learner is able to:

- Analyse and apply knowledge of the basic principles, techniques and skills as well as the SABS code of practice.

- Apply Engineering Graphics and Design drawing techniques using advanced exercises on visualisation, perception and cognitive problems.

- Demonstrate an understanding of, analyse and apply curves of interpenetration and development.

- Apply free-hand drawing.

- Apply and draw mechanical systems.

- Use computer-aided design and draughting programmes for complex problems.

- Understand the entrepreneurial principles and opportunities related to Engineering Graphics and Design, and how this can enhance the economy.

Grade 10

Learning Outcome 2

Graphical Communication

The learner is able to understand and apply knowledge of the principles of global graphical communication in solving technological and design problems in an aesthetically, ethically and responsible way.

In this Learning Outcome, learners must demonstrate the ability to apply problem-solving principles in respect of the identification, analysis and development of a wide and varied range of data and information related to Engineering Graphics and Design.

Assessment Standards

We know this when the learner is able to:

■ Develop the visualisation, cognitive and perception skills necessary for the production of drawings.

■ Apply first-angle orthographic projection.

■ Produce elementary pictorial drawings.

■ Demonstrate an understanding of full-sectional and half-sectional views of castings.

Grade 11

Assessment Standards

We know this when the learner is able to:

- Develop the visualisation, cognitive and perception skills necessary for the interpretation of data and information to produce drawings.

- Apply first-angle and third-angle orthographic projection.

- Produce more complex pictorial drawings.

- Demonstrate an understanding of full-sectional and half-sectional views of detailed drawings.

- Apply the principles used in basic engineering design.

Grade 12

Assessment Standards

We know this when the learner is able to:

- Develop the visualisation, cognitive and perception skills necessary in order to investigate, understand and accurately interpret more complex data to produce drawings.

- Apply third-angle orthographic projection.

- Produce details of steel structures.

- Produce details of drawings used in civil technology.

- Produce drawings used in electrical technology.

- Produce advanced pictorial drawings.

- Demonstrate an understanding of full-sectional and half-sectional views of assembly drawings.

- Apply the principles used in more complex engineering design problems.

CONTENT AND CONTEXTS FOR THE ATTAINMENT OF ASSESSMENT STANDARDS

In this section, content and contexts are provided to support the attainment of the Assessment Standards. The content indicated needs to be dealt with in such a way as to assist learners to progress towards the achievement of the Learning Outcomes. Content must serve the Learning Outcomes and not be an end in itself. The contexts suggested will enable the content to be embedded in situations which are meaningful to learners and so assist learning and teaching. The teacher should be aware of and use local contexts, not necessarily indicated here, which could be more suited to the experiences of the learners. Content and context, when aligned to the attainment of the Assessment Standards, provide a framework for the development of Learning Programmes. The Engineering Graphics and Design Learning Programme Guidelines give more detail in this respect.

Grade 10

Learning Outcome 1

Techniques, Skills and Technologies

The learner is able to understand and apply techniques, skills and technologies related to the production of engineering graphics by working across a range of design and engineering disciplines ethically and responsibly through free-hand drawing, instrument drawing and computer-aided design and draughting.

Proposed content

- Understanding the basic principles, concepts, terminology, techniques and skills as well as the SABS code of practice as it relates to:
    - dimensioning;
    - free-hand printing;
    - constructions;
    - scale drawing;
    - projections; and
    - reproduction of drawings.

- Application of the principles and techniques of Engineering Graphics and Design to free-hand and instrument drawings.

Grade 11

Proposed content

■ Application of the basic principles, concepts, terminology, techniques and skills as well as the SABS code of practice.

■ Application of the principles and techniques of Engineering Graphics and Design to more complex examples using visualisation, perception and cognitive skills.

■ Understanding curves of interpenetration and developments.

■ Application of free-hand drawing as related to Engineering Graphics and Design.

Grade 12

Proposed content

■ Analysis and application of the basic principles, concepts, terminology, techniques and skills as well as the SABS code of practice.

■ Application of the principles and techniques of Engineering Graphics and Design to advanced exercises using visualisation, perception and cognitive skills.

■ Analysis and application of a variety of curves of interpenetration and developments.

■ Application of free-hand drawing in two-dimensional and three-dimensional drawings as related to Engineering Graphics and Design.

Grade 10

Learning Outcome 1 Continued

Techniques, Skills and Technologies

The learner is able to understand and apply techniques, skills and technologies related to the production of engineering graphics by working across a range of design and engineering disciplines ethically and responsibly through free-hand drawing, instrument drawing and computer-aided design and draughting.

Proposed content

■ Understanding the concepts and principles of computer-aided design and draughting.

■ Explanation of different cultures encountered in the manufacturing industry.

Grade 11

Proposed content

■ Application of various methods to determine different types of loci.

■ Application of the concepts and principles of computer-aided design and draughting to simple exercises.

■ Understanding the impact of electronic and computer technologies on the social milieu.

Grade 12

Proposed content

■ Application of drawing techniques to mechanical systems including cam profiles for knife and roller edge followers.

■ Application of computer-aided design and draughting in more complex exercises.

■ Understanding the entrepreneurial principles and opportunities relating to Engineering Graphics and Design to enhance the economy.

Grade 10

Learning Outcome 2

Graphical Communication

The learner is able to understand and apply knowledge of the principles of global graphical communication in solving technological and design problems in an aesthetically, ethically and responsible way.

Proposed content

- Development of the visualisation, cognitive and perception skills for the production of drawings.

- Understanding and application of the principles of first-angle orthographic projection.

- Production of elementary isometric and one-point perspective drawings.

- Understanding and application of the rules for sectioning of solids and machine parts from industry (castings).

Grade 11

Proposed content

- Development of the visualisation, cognitive and perception skills for interpretation of data and information to produce drawings.

- Understanding and application of the principles of first-angle and third-angle projection.

- Production of complex isometric (sections included) and two-point perspective drawings.

- Understanding and application of the rules for sectioning of composite solids and machine parts from industry (detail drawing).

- Application of basic calculations used in engineering design.

Grade 12

Proposed content

- Development of the visualisation, cognitive and perception skills in order to investigate, understand and accurately interpret more complex data to produce drawings.

- Understanding and application of the principles of third-angle orthographic projection.

- Application and production of basic steel structures.

- Identification, interpretation and production of working drawings for the built environment.

- Identification, interpretation and production of working drawings for electrical technology.

- Production of isometric drawings (sections included) for more complex examples.

- Understanding and application of the rules for sectioning of machine parts from industry (assembly).

- Application of advanced calculations used in engineering design.

CHAPTER 4

ASSESSMENT

INTRODUCTION

Assessment is a critical element of the National Curriculum Statement Grades 10 – 12 (General). It is a process of collecting and interpreting evidence in order to determine the learner's progress in learning and to make a judgement about a learner's performance. Evidence can be collected at different times and places, and with the use of various methods, instruments, modes and media.

To ensure that assessment results can be accessed and used for various purposes at a future date, the results have to be recorded. There are various approaches to recording learners' performances. Some of these are explored in this chapter. Others are dealt with in a more subject-specific manner in the Learning Programme Guidelines.

Many stakeholders have an interest in how learners perform in Grades 10 – 12. These include the learners themselves, parents, guardians, sponsors, provincial departments of education, the Department of Education, the Ministry of Education, employers, and higher education and training institutions. In order to facilitate access to learners' overall performances and to inferences on learners' competences, assessment results have to be reported. There are many ways of reporting. The Learning Programme Guidelines and the Assessment Guidelines discuss ways of recording and reporting on school-based and external assessment as well as giving guidance on assessment issues specific to the subject.

WHY ASSESS

Before a teacher assesses learners, it is crucial that the purposes of the assessment be clear and unambiguous. Understanding the purposes of assessment ensures that an appropriate match exists between the purposes and the methods of assessment. This, in turn, will help to ensure that decisions and conclusions based on the assessment are fair and appropriate for the particular purpose or purposes.

There are many reasons why learners' performance is assessed. These include monitoring progress and providing feedback, diagnosing or remediating barriers to learning, selection, guidance, supporting learning, certification and promotion.

In this curriculum, learning and assessment are very closely linked. Assessment helps learners to gauge the value of their learning. It gives them information about their own progress and enables them to take control of and to make decisions about their learning. In this sense, assessment provides information about whether teaching and learning is succeeding in getting closer to the specified Learning Outcomes. When assessment indicates lack of progress, teaching and learning plans should be changed accordingly.

TYPES OF ASSESSMENT

This section discusses the following types of assessment:

- baseline assessment;
- diagnostic assessment;
- formative assessment; and
- summative assessment.

Baseline assessment

Baseline assessment is important at the start of a grade, but can occur at the beginning of any learning cycle. It is used to establish what learners already know and can do. It helps in the planning of activities and in Learning Programme development. The recording of baseline assessment is usually informal.

Diagnostic assessment

Any assessment can be used for diagnostic purposes – that is, to discover the cause or causes of a learning barrier. Diagnostic assessment assists in deciding on support strategies or identifying the need for professional help or remediation. It acts as a checkpoint to help redefine the Learning Programme goals, or to discover what learning has not taken place so as to put intervention strategies in place.

Formative assessment

Any form of assessment that is used to give feedback to the learner is fulfilling a formative purpose. Formative assessment is a crucial element of teaching and learning. It monitors and supports the learning process. All stakeholders use this type of assessment to acquire information on the progress of learners. Constructive feedback is a vital component of assessment for formative purposes.

Summative assessment

When assessment is used to record a judgement of the competence or performance of the learner, it serves a summative purpose. Summative assessment gives a picture of a learner's competence or progress at any specific moment. It can occur at the end of a single learning activity, a unit, cycle, term, semester or year of learning. Summative assessment should be planned and a variety of assessment instruments and strategies should be used to enable learners to demonstrate competence.

WHAT SHOULD ASSESSMENT BE AND DO?

Assessment should:

- be understood by the learner and by the broader public;
- be clearly focused;
- be integrated with teaching and learning;
- be based on the pre-set criteria of the Assessment Standards;
- allow for expanded opportunities for learners;
- be learner-paced and fair; and
- be flexible;
- use a variety of instruments;
- use a variety of methods.

HOW TO ASSESS

Teachers' assessment of learners' performances must have a great degree of reliability. This means that teachers' judgements of learners' competences should be generalisable across different times, assessment items and markers. The judgements made through assessment should also show a great degree of validity; that is, they should be made on the aspects of learning that were assessed.

Because each assessment cannot be totally valid or reliable by itself, decisions on learner progress must be based on more than one assessment. This is the principle behind continuous assessment (CASS). Continuous assessment is a strategy that bases decisions about learning on a range of different assessment activities and events that happen at different times throughout the learning process. It involves assessment activities that are spread throughout the year, using various kinds of assessment instruments and methods such as tests, examinations, projects and assignments. Oral, written and performance assessments are included. The different pieces of evidence that learners produce as part of the continuous assessment process can be included in a portfolio. Different subjects have different requirements for what should be included in the portfolio. The Learning Programme Guidelines discuss these requirements further.

Continuous assessment is both classroom-based and school-based, and focuses on the ongoing manner in which assessment is integrated into the process of teaching and learning. Teachers get to know their learners through their day-to-day teaching, questioning, observation, and through interacting with the learners and watching them interact with one another.

Continuous assessment should be applied both to sections of the curriculum that are best assessed through written tests and assignments and those that are best assessed through other methods, such as by performance, using practical or spoken evidence of learning.

METHODS OF ASSESSMENT

Self-assessment

All Learning Outcomes and Assessment Standards are transparent. Learners know what is expected of them. Learners can, therefore, play an important part, through self-assessment, in 'pre-assessing' work before the teacher does the final assessment. Reflection on one's own learning is a vital component of learning.

Peer assessment

Peer assessment, using a checklist or rubric, helps both the learners whose work is being assessed and the learners who are doing the assessment. The sharing of the criteria for assessment empowers learners to evaluate their own and others' performances.

Group assessment

The ability to work effectively in groups is one of the Critical Outcomes. Assessing group work involves looking for evidence that the group of learners co-operate, assist one another, divide work, and combine individual contributions into a single composite assessable product. Group assessment looks at process as well as product. It involves assessing social skills, time management, resource management and group dynamics, as well as the output of the group.

METHODS OF COLLECTING ASSESSMENT EVIDENCE

There are various methods of collecting evidence. Some of these are discussed below.

Observation-based assessment

Observation-based assessment methods tend to be less structured and allow the development of a record of different kinds of evidence for different learners at different times. This kind of assessment is often based on tasks that require learners to interact with one another in pursuit of a common solution or product. Observation has to be intentional and should be conducted with the help of an appropriate observation instrument.

Test-based assessment

Test-based assessment is more structured, and enables teachers to gather the same evidence for all learners in

the same way and at the same time. This kind of assessment creates evidence of learning that is verified by a specific score. If used correctly, tests and examinations are an important part of the curriculum because they give good evidence of what has been learned.

Task-based assessment

Task-based or performance assessment methods aim to show whether learners can apply the skills and knowledge they have learned in unfamiliar contexts or in contexts outside of the classroom. Performance assessment also covers the practical components of subjects by determining how learners put theory into practice. The criteria, standards or rules by which the task will be assessed are described in rubrics or task checklists, and help the teacher to use professional judgement to assess each learner's performance.

RECORDING AND REPORTING

Recording and reporting involves the capturing of data collected during assessment so that it can be logically analysed and published in an accurate and understandable way.

Methods of recording

There are different methods of recording. It is often difficult to separate methods of recording from methods of evaluating learners' performances.

The following are examples of different types of recording instruments:

- ■ rating scales;
- ■ task lists or checklists; and
- ■ rubrics.

Each is discussed below.

Rating scales

Rating scales are any marking system where a symbol (such as A or B) or a mark (such as 5/10 or 50%) is defined in detail to link the coded score to a description of the competences that are required to achieve that score. The detail is more important than the coded score in the process of teaching and learning, as it gives learners a much clearer idea of what has been achieved and where and why their learning has fallen short of the target. Traditional marking tended to use rating scales without the descriptive details, making it difficult to have a sense of the learners' strengths and weaknesses in terms of intended outcomes. A six-point scale of achievement is used in the National Curriculum Statement Grades 10 – 12 (General).

Task lists or checklists

Task lists or checklists consist of discrete statements describing the expected performance in a particular task. When a particular statement (criterion) on the checklist can be observed as having been satisfied by a learner during a performance, the statement is ticked off. All the statements that have been ticked off on the list (as criteria that have been met) describe the learner's performance. These checklists are very useful in peer or group assessment activities.

Rubrics

Rubrics are a combination of rating codes and descriptions of standards. They consist of a hierarchy of standards with benchmarks that describe the range of acceptable performance in each code band. Rubrics require teachers to know exactly what is required by the outcome. Rubrics can be holistic, giving a global picture of the standard required, or analytic, giving a clear picture of the distinct features that make up the criteria, or can combine both. The Learning Programme Guidelines give examples of subject-specific rubrics.

To design a rubric, a teacher has to decide the following:

- Which outcomes are being targeted?
- Which Assessment Standards are targeted by the task?
- What kind of evidence should be collected?
- What are the different parts of the performance that will be assessed?
- What different assessment instruments best suit each part of the task (such as the process and the product)?
- What knowledge should be evident?
- What skills should be applied or actions taken?
- What opportunities for expressing personal opinions, values or attitudes arise in the task and which of these should be assessed and how?
- Should one rubric target all the Learning Outcomes and Assessment Standards of the task or does the task need several rubrics?
- How many rubrics are, in fact, needed for the task?

It is crucial that a teacher shares the rubric or rubrics for the task with the learners before they do the required task. The rubric clarifies what both the learning and the performance should focus on. It becomes a powerful tool for self-assessment.

Reporting performance and achievement

Reporting performance and achievement informs all those involved with or interested in the learner's progress. Once the evidence has been collected and interpreted, teachers need to record a learner's achievements. Sufficient summative assessments need to be made so that a report can make a statement about the standard achieved by the learner.

The National Curriculum Statement Grades 10 – 12 (General) adopts a six-point scale of achievement. The scale is shown in Table 4.1.

Table 4.1   Scale of achievement for the National Curriculum Statement Grades 10 – 12 (General)

Rating Code	Description of Competence	Marks (%)
6	Outstanding	80-100
5	Meritorious	60-79
4	Satisfactory	50-59
3	Adequate	40-49
2	Partial	30-39
1	Inadequate	0-29

SUBJECT COMPETENCE DESCRIPTIONS

To assist with benchmarking the achievement of Learning Outcomes in Grades 10 – 12, subject competences have been described to distinguish the grade expectations of what learners must know and be able to achieve. Six levels of competence have been described for each subject for each grade. These descriptions will assist teachers to assess learners and place them in the correct rating. The descriptions summarise the Learning Outcomes and the Assessment Standards, and give the distinguishing features that fix the achievement for a particular rating. The various achievement levels and their corresponding percentage bands are as shown in Table 4.1.

In line with the principles and practice of outcomes-based assessment, all assessment – both school-based and external – should primarily be criterion-referenced. Marks could be used in evaluating specific assessment tasks, but the tasks should be assessed against rubrics instead of simply ticking correct answers and awarding marks in terms of the number of ticks. The statements of competence for a subject describe the minimum skills, knowledge, attitudes and values that a learner should demonstrate for achievement on each level of the rating scale.

When teachers/assessors prepare an assessment task or question, they must ensure that the task or question addresses an aspect of a particular outcome. The relevant Assessment Standard or Standards must be used when creating the rubric for assessing the task or question. The descriptions clearly indicate the minimum level of attainment for each category on the rating scale.

The competence descriptions for this subject appear at the end of this chapter.

PROMOTION

Promotion at Grade 10 and Grade 11 level will be based on internal assessment only, but must be based on the same conditions as those for the Further Education and Training Certificate. The requirements, conditions, and rules of combination and condonation are spelled out in the *Qualifications and Assessment Policy Framework for the Grades 10 – 12 (General)*.

WHAT REPORT CARDS SHOULD LOOK LIKE

There are many ways to structure a report card, but the simpler the report card the better, provided that all important information is included. Report cards should include information about a learner's overall progress, including the following:

- the learning achievement against outcomes;
- the learner's strengths;
- the support needed or provided where relevant;
- constructive feedback commenting on the performance in relation to the learner's previous performance and the requirements of the subject; and
- the learner's developmental progress in learning how to learn.

In addition, report cards should include the following:

- name of school;
- name of learner;
- learner's grade;
- year and term;
- space for signature of parent or guardian;
- signature of teacher and of principal;
- date;
- dates of closing and re-opening of school;
- school stamp; and
- school attendance profile of learner.

ASSESSMENT OF LEARNERS WHO EXPERIENCE BARRIERS TO LEARNING

The assessment of learners who experience any barriers to learning will be conducted in accordance with the recommended alternative and/or adaptive methods as stipulated in the *Qualifications and Assessment Policy Framework for Grades 10 – 12 (General)* as it relates to learners who experience barriers to learning. *Refer to White Paper 6 on Special Needs Education: Building an Inclusive Education and Training System.*

Grade 10

C Code   **S** Scale

Cd Competence Descriptions

6

80%-100%
Outstanding

By the end of Grade 10 the learner with outstanding achievement can:

■ independently demonstrate an in-depth understanding of concepts, terminologies, functions, principles and theories by applying correct scientific and technological knowledge, drawing techniques and skills in generating descriptive geometry drawings and elementary reproduction drawings using a computer-aided design and draughting programme as well as freehand drawings with clear line distinction, precision and clarity of presentation aesthetically, ethically and in a responsible way.

Grade 11

Cd Competence Descriptions

By the end of Grade 11 the learner with outstanding achievement can:

- independently demonstrate an in-depth understanding of concepts, terminologies, functions, principles and theories by applying correct scientific and technological knowledge, drawing techniques and skills in generating construction methods, projections, engineering designs and complex reproduction drawings using a computer-aided design and draughting programme as well as free-hand drawings aesthetically, ethically and in a responsible way.

Grade 12

Cd Competence Descriptions

By the end of Grade 12 the learner with outstanding achievement can:

- independently demonstrate an in-depth understanding of concepts, terminologies, functions, principles and theories by applying correct scientific and technological knowledge, drawing techniques and skills in generating detail drawings of steel structures, drawings of electrical and electronic symbols and circuits, drawings used in the built environment, construction methods, projections and more complex reproduction drawings using a computer-aided design and draughting programme as well as free-hand drawings aesthetically, ethically and in a responsible way.

Grade 10

C Code   S Scale

5

60%-79%
Meritorious

Cd Competence Descriptions

By the end of Grade 10 the learner with meritorious achievement can:

- demonstrate a comprehensive understanding of concepts, terminologies, functions, principles and theories by applying correct scientific and technological knowledge, drawing techniques and skills in generating descriptive geometric drawings and elementary reproduction drawings using a computer-aided design and draughting programme as well as free-hand drawing with clear line distinction, precision and clarity of presentation aesthetically, ethically and in a responsible way.

Grade 11

Cd Competence Descriptions

By the end of Grade 11 the learner with meritorious achievement can:

- demonstrate a comprehensive understanding of concepts, terminologies, functions, principles and theories by applying correct scientific and technological knowledge, drawing techniques and skills in generating construction methods, projections, engineering designs and complex reproduction drawings using a computer-aided design and draughting programme as well as free-hand drawings aesthetically, ethically and in a responsible way.

Grade 12

Cd Competence Descriptions

By the end of Grade 12 the learner with meritorious achievement can:

- demonstrate a comprehensive understanding of concepts, terminologies, functions, principles and theories by applying correct scientific and technological knowledge, drawing techniques and skills in generating detail drawings of steel structures, drawings of electrical and electronic symbols and circuits, drawings used in the built environment, construction methods, projections, free-hand drawings and more complex reproduction drawings using a computer-aided design and draughting programme as well as freehand drawings aesthetically, ethically and in a responsible way.

Grade 10

C Code   **S** Scale

4   **50%-59%**
Satisfactory

Cd Competence Descriptions

By the end of Grade 10 the learner with satisfactory achievement can:

■ demonstrate a clear understanding of concepts, terminologies, functions, principles and theories by applying correct scientific and technological knowledge, drawing techniques and skills in generating descriptive geometry drawings and elementary reproduction drawings using a computer-aided design and draughting programme as well as free-hand drawings with clear line distinction, precision and clarity of presentation aesthetically, ethically and in a responsible way.

Grade 11

Cd Competence Descriptions

By the end of Grade 11 the learner with satisfactory achievement can:

- demonstrate a clear understanding of concepts, terminologies, functions, principles and theories by applying correct scientific and technological knowledge, drawing techniques and skills in generating construction methods, projections, free-hand drawings, engineering designs and complex reproduction drawings using a computer-aided design and draughting programme as well as free-hand drawings aesthetically, ethically and in a responsible way.

Grade 12

Cd Competence Descriptions

By the end of Grade 12 the learner with satisfactory achievement can:

- demonstrate a clear understanding of concepts, terminologies, functions, principles and theories by applying correct scientific and technological knowledge, drawing techniques and skills in generating detail drawings of steel structures, drawings of electrical and electronic symbols and circuits, drawings used in the built environment, construction methods, projections, freehand drawings and more complex reproduction drawings using a computer-aided design and draughting programme as well as free-hand drawings aesthetically, ethically and in a responsible way.

Grade 10

C Code   **S** Scale

Cd Competence Descriptions

3

40%-49%
Adequate

By the end of Grade 10 the learner with adequate achievement can:

- demonstrate with minimum guidance the application of basic scientific and technological knowledge, drawing techniques and skills in generating free-hand drawings, instrument drawings, elementary scale drawings using a computer-aided design and draughting programme as well as free-hand drawings with clear line distinction, precision and clarity of presentation aesthetically, ethically and in a responsible way.

Grade 11

Cd Competence Descriptions

By the end of Grade 11 the learner with adequate achievement can:

- demonstrate with minimum guidance the application of basic scientific knowledge and drawing techniques and skills to generate construction methods, projections, engineering designs and complex reproduction drawings using a computer-aided design and draughting programme as well as free-hand drawings aesthetically, ethically and in a responsible way.

Grade 12

Cd Competence Descriptions

By the end of Grade 12 the learner with adequate achievement can:

- demonstrate with minimum guidance the application of basic scientific knowledge and drawing techniques and skills to generate detail drawings of steel structures, drawings of electrical and electronic symbols and circuits, drawings used in the built environment, construction methods, projections and more complex reproduction drawings using a computer-aided design and draughting programme as well as free-hand drawings aesthetically, ethically and in a responsible way.

Grade 10

C Code   **S** Scale

2   **30%-39%**
Partial

Cd Competence Descriptions

By the end of Grade 10 the learner with partial achievement can:

- experience difficulty in demonstrating and applying basic scientific and technological knowledge, drawing techniques and skills in generating instrument drawings and elementary scale drawings using a computer-aided design and draughting programme as well as free-hand drawings with clear line distinction, precision and clarity of presentation aesthetically, ethically and in a responsible way.

Grade 11

Cd Competence Descriptions

By the end of Grade 11 the learner with partial achievement can:

- experience difficulty in demonstrating the application of basic scientific and technological knowledge, drawing techniques and skills in generating construction methods, projections, engineering designs and complex reproduction drawings using a computer-aided design and draughting programme as well as free-hand drawings aesthetically, ethically and in a responsible way.

Grade 12

Cd Competence Descriptions

By the end of Grade 12 the learner with partial achievement can:

- experience difficulty in demonstrating the application of basic scientific and technological knowledge, drawing techniques and skills in generating detail drawings of steel structures, drawings of electrical and electronic symbols and circuits, drawings used in the built environment, construction methods, projections and more complex reproduction drawings using a computer-aided design and draughting programme as well as free-hand drawings aesthetically, ethically and in a responsible way.

Grade 10

C Code   **S** Scale

Cd Competence Descriptions

1

0%-29%
Inadequate

By the end of Grade 10 the learner with inadequate achievement can:

■ describe and identify basic scientific and technological knowledge, drawing techniques and skills in generating instrument drawings and elementary scale drawings using a computer-aided design and draughting programme as well as freehand drawings with clear line distinction, precision and clarity of presentation aesthetically, ethically and in a responsible way.

Grade 11

Cd Competence Descriptions

By the end of Grade 11 the learner with inadequate achievement can:

- describe and identify basic scientific and technological knowledge, drawing techniques and skills in generating construction methods, projections, engineering designs and complex reproduction drawings using a computer-aided design and draughting programme as well as free-hand drawings aesthetically, ethically and in a responsible way.

Grade 12

Cd Competence Descriptions

By the end of Grade 12 the learner with inadequate achievement can:

- describe and identify basic scientific and technological knowledge, drawing techniques and skills in generating detail drawings of steel structures, drawings of electrical and electronic symbols and circuits, drawings used in the built environment, construction methods, projections, and more complex reproduction drawings using a computer-aided design and draughting programme as well as free-hand drawings aesthetically, ethically and in a responsible way.

GLOSSARY

aesthetics – characteristics of a product or system that make it look beautiful and attractive

architectural engineering – the various fields in architectural engineering industries that are related to services

architectural technology – focuses on the built environment from a point of view of changing the landscape to erect building or structures

built environment – civil and architectural engineering industries and related services

cam – a machine part fixed to a shaft rotating with constant velocity; transmits reciprocal movement to a linear movement

civil engineering – focuses on the construction of bridges, roads, etc., that are used in the built environment

civil technology – focuses on the technological processes from conceptual design to practical problem solving by the application of scientific principles. The subject provides scope for the improvement of the different processes, systems and services used in the built environment.

cognitive skills – thinking and problem-solving skills applied to drawing

communicate graphically – communicate by using a combination of lines, symbols, drawings and signs

composite solids – a combination of solids forged together as a casting

computer-aided design and draughting (CADD) – computer software used as a drawing tool to assist in the application and execution of a design

computer-based tools – software and hardware components that are utilised to communicate ideas graphically

conceptual – ideas transformed into visual drawing applications

data – facts and figures that can be processed into information

design – the plan, sketch, model or drawing that outlines or shows intention of the proposed solution

design problem – a short and clear statement that gives the general outline of the problem to be solved, as well as the purpose of the proposed solution

dimensions – the measurements that indicate the actual size of an object

drawing – a means of conveying ideas to others using lines, symbols and signs

drawing instruments – equipment that a draughtsman uses to generate a drawing

electrical technology – focuses on the understanding and application of electrical and electronic principles and the technological processes inherent in the production of products, services and systems in order to improve the quality of life

engineering design – application of calculations with relation to forces, stresses, etc. used in Engineering design.

ethics – high standard of moral values applied to the designing and manufacturing processes

free-hand drawing – generating a drawing using only a pencil and eraser

free-hand printing – printing dimensions and other information between guidelines using only a pencil and eraser

first-angle and third-angle orthographic projection – the method of representing the exact shape of the object by dropping perpendiculars from two or more sides of the object to planes

global graphical communication – internationally-recognised drawing language comprising a combination of lines, symbols and signs

indigenous knowledge – the knowledge located naturally within the community

indigenous technological solutions – problem solving by making use of knowledge, technologies and resources located naturally within the community

indigenous technologies – the technologies located naturally within the community

insight – understanding concepts that influence design or drawing

instrument drawing – using conventional or computer-based tools to generate drawings based on drawing principles and techniques

interpenetration – when two geometrical solids are adapted to each other a curve of interpenetration is formed

isometric – a three-dimensional drawing where the lines of sight are set at 30 degreesto be horizontal plane

knife and roller edge followers – type of cam followers that move at uniform velocity around the cam in the opposite direction to that in which the cam is actually moving

locus (pl. **loci**) **–** the path generated by the movement of a point subjected to certain conditions

manipulative skills – motor skills that are applied to produce a drawing

material – physical substance used in technology (e.g. wood, textiles, plastics, fabric)

mechanical system – a combination of mechanisms that function as a whole

mechanical technology – focuses on technological processes from conceptual design to practical problem solving to the application of scientific principles. It provides scope for the improvement of the different processes, systems and services used in the production and manufacturing of the goods and products used to enhance the quality of life of both the individual and society.

orthographic – a type of two-dimensional drawing, usually showing three separate views of the same object (e.g. front, top, left)

perception – visual insight of two-dimensional and three-dimensional applications

perspective – a three-dimensional drawing in which the lines of sight converge on the horizon

pictorial drawing – showing an object the way it would appear in a photograph

problem – a situation that leads to a need or want and that can give rise to an opportunity

process – the part of a system that combines resources to produce an output in response to input

product – the physical or tangible artefact that results from a process

projection method – a method of representing a new figure on a plane by means of straight lines through a focal point in such a way that each point of the new figure corresponds to a point of the original figure in accordance with a definite rule

scale drawing – a drawing made with a proper, systematic code-system, so that cross-referencing is established to generate drawings that fit on standard-size paper to simplify copying and storing

section – a representation of an object where an imaginary cut has been made to show how the internal components are assembled

spatial drawing – projection of orthographic views of points and lines suspended in space

synthesis – putting together the known into something new; the combining of components to form a connected whole

system – something that is made up of interlinked parts that function together as a whole to accomplish a goal

techniques, tools and technologies – applications of conventional use of instruments and computer-based or computer-aided drawing tools with the applicable software

technological literacy – the ability to use, understand, manage and assess technology

technological processes – creative human activities to develop technological solutions in order to satisfy human needs and wants

technological solution – a successful outcome that is achieved by using a systematic problem-solving process

two-dimensional drawing – orthographic projection of two-dimensional plane figures

visualisation – making visible to one's mind; a mental picture or envisioned solution

ENGINEERING GRAPHICS AND DESIGN

DEPARTMENT OF EDUCATION

Working together to build an education and
training system for the 21st century

HIV/AIDS is everybody's concern