Technology and Industrial Arts

Construction Technology

Senior High

Grade 11

Teacher Guide

Standards-Based

Department of Education

'FREE ISSUE
NOT FOR SALE'

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Construction Technology

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Papua New Guinea
Department of Education

Issued free to schools by the Department of Education

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Acronyms

AAL	Assessment as Learning
ARS	Audience Response System.
AFL	Assessment for Learning
AOL	Assessment of Learning
BoS	Board of Studies
CDD	Curriculum Development Division
CP	Curriculum Panel
DA	Diagnostic Assessment
IHD	Integral Human Development
GoPNG	Government of Papua New Guinea
KSVA	Knowledge Skills Values and Attitudes
MTDG	Medium Term Development Goals
NDoE	National Department of Education
OBC	Outcomes-Based Curriculum
OBE	Outcomes-Based Education
PNG	Papua New Guinea
SAC	Subject Advisory Committee
SBC	Standards-Based Assessment
SBC	Standards-Based Curriculum
SBE	Standards-Based Education
SCG	Subject Curriculum Group
STEAM	Science, Technology, Engineering, Arts and Mathematics
SRS	Student Response System
UOW	Unit of Work
TIA	Technology and Industrial Arts

Secretary's Message

The ultimate aim of Standards-Based Education in Papua New Guinea (PNG) is to prepare students for careers, higher education, and citizenship. This means that education should focus on developing and equipping students with essential knowledge, skills, values, and attitudes that they can use in all aspects of their lives. Education must also aim to motivate and prepare students to pursue Science, Technology, Engineering, Arts, and Mathematics (STEAM) courses in higher education institutions and pursue careers in STEAM related fields.

The Construction Technology in grade 11 stands as a subject and has 5 units with its own time allocation. Construction Technology is a significant curriculum to develop in students' proficiency and competency in the engineering applications, methodology and processes of structures that encompass building, electrical, plumbing and welding. Thus enabling students' knowledge and skills in building through opportunities to design and build various construction projects. However, it is equally important for students to understand technology, its impacts and implications and make decisive and collaborative decisions that will enable themselves to utilise technology more to their advantage.

Construction Technology as a strand is envisioned to benefit students in enabling them to utilise technology knowledge, skills, values and attitudes, and systems and processes to solve problems using the design process in a methodical and precise manner to innovate and invent design solutions. The integration of STEAM in the teaching and learning of Construction Technology will instill in students the abilities and capabilities to be highly proficient and competent end users and possibly creators of technology in innovative problem-solving as STEAM is an integral component of the core curriculum.

Teachers are encouraged to read this teacher guide carefully to become familiar with the content so that they can be confident to use the new concepts and strategies as well as teach the content well. They can also adjust to suit the needs of the students.

I commend and approve this Grade 11 Technology and Industrial Arts: Construction Technology Teacher Guide to be used in all senior high schools throughout Papua New Guinea.

.....

UKE W KOMBRA, PhD
Secretary for Education

Introduction

The strand Construction Technology in the Technology and Industrial Arts (TIA) subject aims to help students become competent and confident in construction technology, who can make efficient, effective and creative use of building, electrical, plumbing, welding skills in their everyday activities. It further encourages them to individually and collaboratively apply processes, systems, techniques and materials to create, monitor, analyse, predict and shape the interactions within and between construction structures and the impact of on individuals, societies, economies and environments. It embraces the development in technology and emerging technologies using software and applications, safely, ethically and with greater responsibility.

The study of Construction Technology will enhance the students' knowledge to create and read technical drawings; become familiar with construction materials, components, processes and perform a variety of building operations using engineering skills and procedures of design. Thus understanding the importance of occupational health and safety, building codes and standards and regulations and further identify the impacts of construction technology in society. It also aims to provide lifelong skills and opportunities for students to live a productive life as well as a career or pursuing further learning. In the 21st Century, it is important to recognise that technology has become part of the educational process for all age levels and should be viewed and taught as a tool for problem solving and decision- making. Students should be encouraged to analyse, synthesise and evaluate situations at home, and school, thereby, apply technology to complete tasks efficiently and effectively and be prepared for the future in the face of a changing construction landscape.

Students' employability will be enhanced through the study and application of STEAM principles. STEAM is an integral component of the core curriculum. It is envisioned that the study of STEAM will motivate students to take up academic programs and careers in STEAM related fields. STEAM has been embedded in the Technology and Industrial Arts: Construction Technology curriculum.

Teachers of Construction Technology strands will plan and program the strand for 13 weeks on a rotational basis with the other 4 strands as they are taught concurrently, hence the total coverage of learning Technology and Industrial Arts as a subject. The learning integration is more relevant including the STEAM approach to teach the essential knowledge, skills, values and attitudes, and processes.

Technology and Industrial Arts: Construction Technology is to be timetabled for 200 minutes (5 periods) per week in junior high school.

Structure of the Teacher Guide

The Construction Technology Strand Teacher Guide comprises four main sections that provide essential information that all teachers should know and do to effectively implement the Construction Technology curriculum.

1. General Information of the Subject/Strand

The general information section of the Teacher Guide informs teachers on the Construction Technology Strand under the following headings below;

- Introduction of the Strand Teacher Guide
- Structure of the Strand Teacher Guide
- Purpose of the Strand Teacher Guide
- How to use the Strand Teacher Guide

2. Teaching and Learning Section

The teaching and learning section of the Teacher Guide informs and guides teachers to apply the teaching and learning theories, principles, pedagogies and practices in planning, programing, teaching and assessing students. They are outlined in the headings bulleted below;

- Syllabus and Teacher Guide Alignment
- Learning and Performance Standards
- Core Curriculum
- Science Technology Engineering Arts Mathematics (STEAM)
- Curriculum Integration
- Essential Knowledge, Skills, Values and Attitudes
- Teaching and Learning Strategies
- Strands, Units and Topics
- Sample SBC Lesson Plans

3. Assessment Section

The assessment section of the Teacher Guide informs and guides teachers to plan and program assessment activities, formulate assessment rubrics and apply assessment strategies to assess studies. This section also guides teachers to monitor and report students' progress of learning and performances of the attainment of standards.

4. Glossary, References and Appendices Sections

These sections guide teachers to refer to terms and definitions of the strand/ subject content, references outlined to guide the development of this teacher guide and essential and supplementary information provided to guide
teachers on the content and the delivery of this strand/subject.

Purpose of the Teacher Guide

This teacher guide describes what teachers should know and do to effectively plan, program, teach and assess Grade 11 Construction Technology content to enable all students to attain the required learning and proficiency standards.

Ample information with thorough guidelines is provided for the teacher to use to achieve the essential Knowledge, Skills, Attitudes and Values (KSAV) embedded in the set national content standards and grade level benchmarks.

The overarching purpose of this teacher guide is to assist teachers to;

- understand the significance of aligning all the elements of standards-based curriculum (SBC) as the basis of achieving the expected level of education quality,
- effectively align all the components of SBC when planning, programming, teaching, and assessing students learning and levels of proficiency,
- effectively translate and align the Technology and Industrial Arts Syllabi and Construction Technology Strand teacher guides to plan, program, teach and assess different Construction Technology Strand Teacher Guide units and topics, and the essential knowledge, skills, attitudes and values (KSAVs) described in the grade – level benchmarks,
- understand the Construction Technology Strand national content standards, grade-level benchmarks, and evidence outcomes,
- effectively make sense of the content (KSAVs) described in the Communication Technology Strand national content standards and the essential components of the content described in the grade – level benchmarks,
- effectively guide students to progressively learn and demonstrate proficiency on a range of Construction Technology Strand skills, processes, concepts, ideas, principles, practices, values and attitudes,
- confidently interpret, translate and use Construction Technology Strand content standards and benchmarks to determine the learning objectives and performance standards, plan and program appropriately to enable all students to achieve these standards,
- embed the core curriculum in the Construction Technology Strand lesson planning, programming, instruction, and assessment to permit all students to learn and master the core knowledge, skills, values and attitudes required of all students,
- provide opportunities for all students understand how STEAM has and continues to shape the social, political, economic, cultural, and environment contexts and the consequences, and use STEAM principles, skills, processes, ideas and concepts to inquire into and solve problems

relating to both the natural and physical worlds (human –made) as well as problems created by STEAM,

- integrate cognitive skills (critical, creative, reasoning, decision-making, and problem solving skills), high level thinking skills (analysis, synthesis and evaluation skills), values (personal, social, work, health, peace, relationship, sustain values), and attitudes in lesson planning, programming, instruction and assessment,

- meaningfully connect what students learn in Construction Technology Strand with what is learnt in other subjects to add values and enhance students learning so they can integrate what they learn and develop in-depth vertical and horizontal understanding of subject content,

- formulate effective SBC lesson plans using learning objectives identified for each of the topics,

- employ SBC assessment approaches to develop performance assessments to assess students' proficiency on a content standard or a component of the content standard described in the grade –level benchmark,

- effectively score and evaluate students' performance in relation to a core set of learning standards or criteria, and make sense of the data to ascertain status of progress towards meeting grade-level and nationally expected proficiency standards,

- use evidence from the assessment of students' performance to develop effective evidence – based intervention strategies to help students making inadequate or slow progress towards meeting the grade-level and national expectations to improve their learning performances.

- provide opportunities for all students understand how STEAM has and continues to shape the social, political, economic, cultural, and environment contexts and the consequences, and use STEAM principles, skills, processes, ideas and concepts to inquire into and solve problems relating to both the natural and physical worlds (human –made) as well as problems created by STEAM,

- integrate cognitive skills (critical, creative, reasoning, decision-making, and problem solving skills), high level thinking skills (analysis, synthesis and evaluation skills), values (personal, social, work, health, peace, relationship, sustain values), and attitudes in lesson planning, programming, instruction and assessment,

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- formulate effective SBC lesson plans using learning objectives identified for each of the topics,

- employ SBC assessment approaches to develop performance assessments to assess students' proficiency on a content standard or a component of the content standard described in the grade –level benchmark,

- effectively score and evaluate students' performance in relation to a core set of learning standards or criteria, and make sense of the data to ascertain status of progress towards meeting grade-level and nationally expected proficiency standards, and

- use evidence from the assessment of students' performance to develop effective evidence – based intervention strategies to help students making inadequate or slow progress towards meeting the grade-level and national expectations to improve their learning performances.

How to use the Teacher Guide

The Grade 11 Construction Technology Strand Teacher Guide is an expansion of the content in the Technology and Industrial Art Syllabus. The Syllabus contains the content standards, benchmarks and evidence outcomes which are expanded into teaching and learning Activities in the Teacher Guide. The Teacher Guide provides essential information about what the teacher needs to know and do to effectively plan, teach and assess students' learning and proficiency on learning and performance standards. It should be read in conjunction with the syllabus in order to understand what is expected of teachers and students to achieve the envisaged quality of education outcomes.

The first thing teachers should do is to read and understand each of the sections of the Teacher Guide to help them understand the key SBC concepts and ideas. A thorough understanding of these components will help teachers meet the teacher expectations for implementing the SBC curriculum, and therefore the effective implementation of Grade 11 Construction Technology Strand in TIA Curriculum. Based on this understanding, teachers should be able to effectively use the teacher guide to do the following:

The scope of learning is translated and programmed according to the four terms. The suggested teaching and learning strategies and the key important instructions provided for teachers can be used to design and manage teaching and learning activities for the students in the classroom.

The assessment methods, assessment samples, reporting and recording strategies contained in this guide will assist teachers to plan assessment in Strands for the school year.

The strand teacher guide can be used for developing both classroom learning and professional development activities. The document is a useful resource for developing school and community based in-service programs.

Teachers must thoroughly read the contents of the documents in order to develop an understanding and do the following;

Determine Learning Objectives and Lesson Topics

- The teaching and learning Standards are derived from the Content Standards and Benchmarks in the Syllabus. The Learning Objectives are extracted from the grade-level benchmarks and are used for teaching topics. And lesson objectives are derived from learning objectives and are used for teaching Lessons.

Identify and Teach Grade Appropriate Content

- Grade appropriate content has been identified and scoped and sequenced using appropriate content organisation principles. The content is sequenced using the spiralling sequence principles. The strand, topics and lesson concepts in the Teacher Guide can be spiralled and taught by Strand, by Topics or by lessons using the Benchmarks.

Using the Benchmarks, Content Mapping in Programing will enable teacher to see the content from what the students have already learned in line with current to be taught and link to the next learning content.

Integrate the Core Curriculum in Lesson Planning, Instruction and Assessment

- This sequencing of content will enable students to progressively learn the essential knowledge, skills, values and attitudes as they progress further into their schooling.

Integrate cognitive, high level and 21st Century skills in lesson planning, instruction and assessment

- Lesson titles in the teacher guide were drawn out from the benchmarks. From the lesson titles outlined in the planning and programming section, the values, the attitude, the skills and the knowledge are identified.

Integrate Technology and Industrial Arts: Construction Technology Values, and Attitudes in lesson planning, instruction and assessment

- When planning a lesson, it is important that, the values, attitudes, skills and knowledge of the lesson come out clearly in the teaching and learning activities as displayed in the sample guided lessons.

Integrate Science, Technology, Engineering, Arts and Mathematics (STEAM) principles and skills in lesson planning, instruction and assessment

- STEAM principles and skills must be effectively taught and learned by students. Teachers should use the teacher guide to help them make informed decisions when selecting the types of teaching and learning methodologies to use in their teaching of the subject content, including STEAM principles and skills.

Identify and Use Grade and Content Appropriate, Innovative, Differentiated and Creative Teaching and Learning Methodologies

Lesson titles in the teacher guide were drawn out from the benchmarks. From the lesson titles outlined in the planning and programming section, the values, the attitude, the skills and the knowledge are identified.

Plan and address the principles of Inclusive Teaching and Learning'

Teachers are obliged to create an inclusive learning environment to include students with special needs to promote learning for all. These special needs may include students who are gifted or disadvantaged physically, socially, emotionally and intellectually. Students may display combinations of any of these needs and therefore, the teaching and learning activities must have students with special needs in to participate to their fullest abilities. The different types of needs in students include;

- Physical disabilities
- Intellectual disabilities
- Hearing impairment
- Sight-vision impairment
- Speech impairment
- Behavioural and emotional disorders

It is important that the learning activities for TIA: Construction Technology are inclusive and foster the learning needs of all students.

Syllabus and Teacher Guide Alignment

The Grade 11 Construction Technology Strand Teacher Guide is closely aligned and complementary to the Technology and Industrial Art Syllabus.

They are the essential focus points for teaching and learning the essential knowledge, skills, values and attitudes.

Syllabus and Teacher Guide Alignment	
Syllabus Outlines the ultimate aim and goals, and what to teach and why teach it	**Teacher Guide** Describes how to plan, teach, and assess students' performance
• Overarching and SBC principles • Content overview • Core curriculum • Essential knowledge, skills, values and attitudes • Strands and units • Evidence outcomes • Content standards and grade-level benchmarks • Overview of assessment, evaluation, and reporting	• Determine topics for lesson planning, instruction and assessment • Formulate learning objectives • Plan SBC lesson plans • Select teaching and learning strategies • Implement SBC assessment and evaluation • Implement SBC reporting and monitoring

The syllabus outlines the ultimate aim and goals of SBE and SBC, what is to be taught and why it should be learned by students, the underlying principles and articulates the learning and proficiency standards that all students are expected to attain. On the other hand, the teacher guide expands on what is outlined in the syllabus by describing the approaches or the how of planning, teaching, learning, and assessing the content so that the intended learning outcomes are achieved.

This teacher guide should be used in conjunction with the syllabus. Teachers should use these documents when planning, teaching and assessing Grade 11 Construction Technology Strand content.

Teachers will extract information from the syllabus (e.g., content standards and grade-level benchmarks) for lesson planning, instruction and is for measuring students' attainment of a
content standard as well as progress to the next grade of schooling.

Learning and Performance Standards Alignment

Content Standards, Benchmarks and Evidence Outcomes are linked to Learning Objectives, Lesson Objectives and Performance Standards in the Teacher Guide. (see table). There is a close linear relationship between these standards. Students' performance on a significant aspect of a benchmark (KSVA) is measured against a set of performance standards or criteria to determine their level of proficiency using performance assessment. Using the evidence from the performance assessment, individual student's proficiency

on the aspect of the benchmark assessed and progression towards meeting the benchmark and hence the content standard are then determined.

Standards Alignment	
Standards in Syllabus	**Standards in Teacher Guide**
• SBC Aims and Goals • Content Standard • Benchmarks • Evidence Outcomes	• Learning Objectives • Lesson Objectives • Essential Knowledge, Skills, Values and Attitude • Performance Standard

Standard Alignment

Standard Alignment shows the link between different standards in the Syllabus and Teacher Guide. It begins with SBC Aims and Goals which are National Standards in which the Syllabus Standard are derived from. The Content Standards or Subject Standards are expanded into Benchmarks which are Achievable Benchmarks for particular Grade Levels and are translated into the Teacher Guide as Teaching and Learning Standards and Assessment Standards. And they become the components of Unit of Work.

The Unit of Work (UOW) consists of the Achievable Standards for a particular Grade Level and is translated into Teaching and Learning Activities and Assessment Tasks.

It is essential that teachers know and can do standards alignment when planning, teaching, and assessing students' performance so that they can effectively guide their students towards meeting the grade-level benchmarks (grade expectations) and subsequently the content standards (national expectations).

Below is a diagram to show the relationship between Standards in the Syllabus and the Teacher Guide.

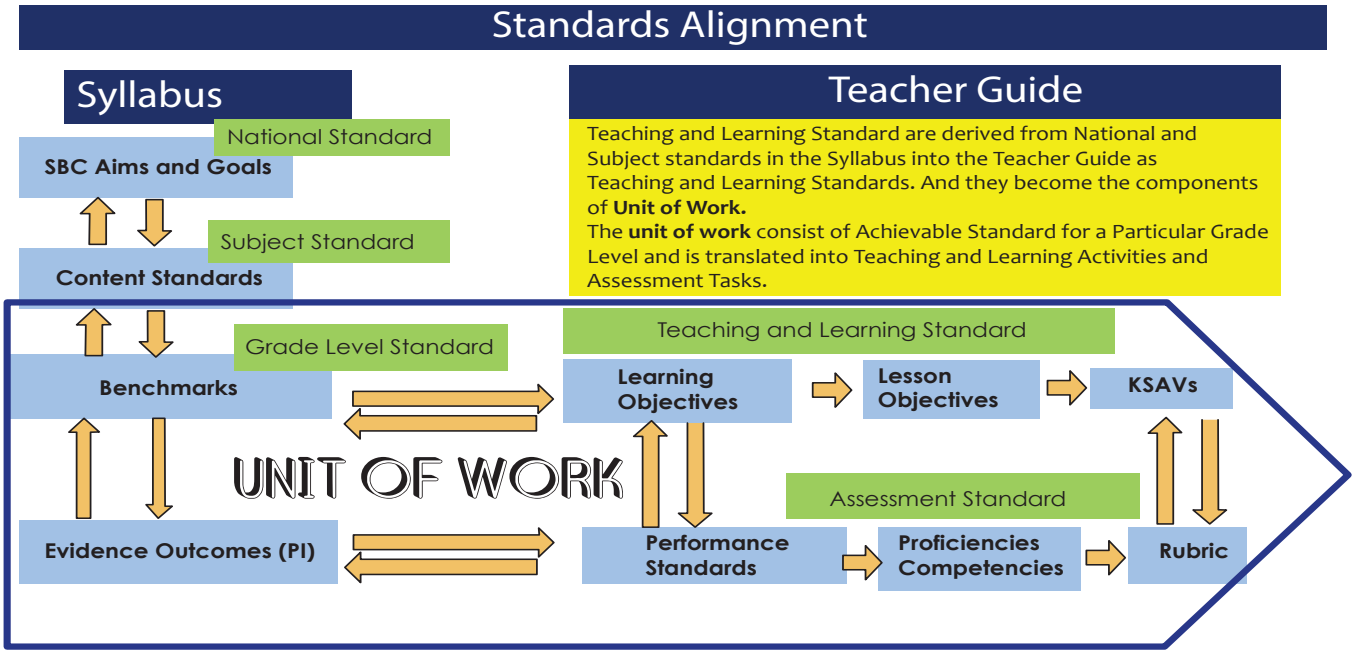


Figure 1 Standards Alignment that shows the alignment of standards in the syllabus and teacher guide

Learning and Performance Standards

Standards define the expected level of education quality that all students should achieve at a particular point in their schooling.

Content standards, benchmarks, and learning objectives are called learning standards while performance and proficiency standards (evidence outcomes) can be categorised as performance standards. These standards are used to measure students' performance, proficiency, progression and achievement of the desired level of education quality. Teachers are expected to understand and use these standards for programming, lesson planning, instruction and assessment.

Student's progression and achievement of education standard(s) are measured using performance standards or criteria to determine their demonstration or performance on significant aspects of the standards and therefore their levels of proficiency and competency. When they are judged to have attained a proficiency on a content standard or benchmark or components of these standards, they are then deemed to have met the standard(s) that is, achieve the intended level of education quality.

Content Standards

Content standards are evidence-based, rigorous and comparable regionally and globally. They have been formulated to target critical social, economic, political, cultural, environment, and employable skills gaps identified from a situational analysis. They were developed using examples and experiences from other countries and best practice, and contextualised to PNG contexts.

Content standards describe what **(content - knowledge, skills, values, and attitudes)** all students are expected to know and do **(how well students must learn and apply what is set out in the content standards)** at each grade-level before proceeding to the next grade. These standards are set at the national level and thus cannot be edited or changed.

Content Standards:

- are evidenced-based;
- are rigorous and comparable to regional and global standards;
- are set at the national level;
- state or describe the expected levels of quality or achievement;
- are clear, measurable and attainable;
- are linked to and aligned with the ultimate aim and goals of SBE and SBC and overarching and SBC principles;
- delineate what matters, provide clear expectations of what students should progressively learn and achieve in school, and guide lesson planning, instruction, assessment;
- comprise knowledge, skills, values, and attitudes that are the basis for quality education;
- provide teachers a clear basis for planning, teaching, and assessing lessons;

- provide provinces, districts, and schools with a clear focus on how to develop and organise their instruction and assessment programs as well as the content that they will include in their curriculum.

Benchmarks

Benchmarks are derived from the content standards and benchmarked at the grade-level. Benchmarks are specific statements of what students should know (*i.e.*, essential knowledge, skills, values or attitudes) at a specific grade-level or school level. They provide the basis for measuring students' attainment of a content standard as well as progress to the next grade of schooling.

Grade-level benchmarks:

- are evidenced-based;
- are rigorous and comparable to regional and global standards;
- are set at the grade level;
- are linked to the national content standards;
- are clear, measurable, observable and attainable;
- articulate grade level expectations of what students are able to demonstrate to indicate that they are making progress towards attaining the national content standards;
- provide teachers a clear basis for planning, teaching, and assessing lessons;
- state clearly what students should do with what they have learned at the end of each school-level;
- enable students' progress towards the attainment of national content standards to be measured, and
- enable PNG students' performance to be compared with the performance of students in other countries.

Learning Objectives

Learning or instructional Objectives are precise statements of educational intent. They are formulated using a significant aspect or a topic derived from the benchmark, and is aligned with the educational goals, content standards, benchmarks, and performance standards. Learning objectives are stated in outcomes language that describe- the products or behaviours that will be provided by students. They are stated in terms of measurable and observable student behaviour. *For example,* students will be able to identify all the main towns of PNG using a map.

Performance Standards

Performance Standards are concrete statements of how well students must learn what is set out in the content standards, often called the **"be able to do"** of "what students should know and be able to do." Performance standards are the indicators of quality that specify how competent a student's demonstration or performance must be. They are explicit definitions of what students **must do to demonstrate proficiency or competency at a specific level on the**

content standards. Performance standards:

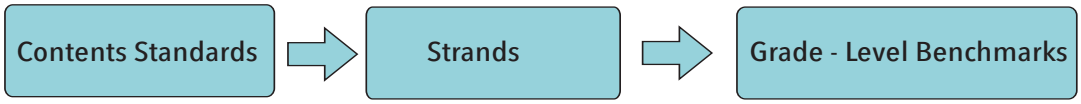
- measure students' performance and proficiency **(using performance indicators)** in the use of a specific knowledge, skill, value, or attitude in real life or related situations.
- provide the basis **(performance indicators)** for evaluating, reporting and monitoring students' level of proficiency in use of a specific knowledge, skills, value, or attitude.
- are used to plan for individual instruction to help students not yet meeting expectations **(desired level of mastery and proficiency)** to make adequate progress towards the full attainment of benchmarks and content standards.
- are used as the basis for measuring students' progress towards meeting grade-level benchmarks and content standards.

Proficiency Standards

Proficiency standards describe what all students in a particular grade or school level **can do** at the end of a strand, or unit. These standards are sometimes called evidence outcomes because they indicate if students can actually apply or use what they have learnt in real life or similar situations. They are also categorised as benchmarks because that is what all students are expected to do before exiting a grade or are deemed ready for the next grade.

As per presented above, should teachers wish to develop additional benchmarks to cater for their students learning needs. You are encouraged to follow the process below to develop them.

Approach for Setting National Content Standards and Grade - Level Benchmarks



Development of Additional Benchmarks

Teachers should develop additional benchmarks to meet the learning needs of their students. They should engage their students to learn about local, provincial, national and global issues that have not been catered for in the grade-level benchmarks but are important and can enhance students' understanding and application of the content. However, it is important to note that these benchmarks will not be nationally examined as they are not comparable. Only the benchmarks developed at the national level will be tested. This does not mean that teachers should not develop additional benchmarks. An innovative, reflective, creative and reflexive teacher will continuously reflect on his/her classroom practice and use evidence to provide challenging, relevant, and enjoyable learning opportunities for his/her students to build on the national expectations for students. Teachers should follow the following process when developing additional grade-level benchmarks.

Core Curriculum

Core curriculum refers to a core set of common learnings (knowledge, skills, values, and attitudes) that are integrated into the content standards and grade-level benchmarks for all subjects. The core curriculum includes:

- Cognitive skills (critical and creative thinking);
- Reasoning, problem-solving and decision-making skills;
- High level thinking skills (analysis, evaluation and synthesis);
- 21st Century skills;
- STEAM principles and skills;
- Seven Principles for Teaching Procedural and Technical Skills (Plan ahead, Demonstration, Observation of learner in action, Provide specific feedback, Encourage self-evaluation, Allow learner practice, Prepare to modify approach)
- Working Diagrams (sketching and technical drawing)
- Reading, writing and communication skills, and
- Essential values and attitudes.

Technology and Industrial Arts: Construction Technology teachers are expected to include the core learning's in their lesson planning, teaching and assessment of students in all their lessons. In addition to these are the essential core curriculums; OHS, designing, technical drawing, CAD Software and computer applications, engineering skills, methodology and construction materials, codes, standards and regulations, design process, design solutions and building structures in Construction Technology. Teachers may include other core curriculum concepts in relation to the subject to cater for students learning needs.

A practical example of integrating core curriculum in Teaching and Learning

Teachers can identify a set of core curriculum to teach in one lesson for example; in Technology and Industrial Arts: Construction Technology, students may be posed with an opportunity to find solutions on how technology can be used to utilise one of the core concepts of technology and industry in their area. The core concepts include; design process, design folio, design solutions, materials, processes, techniques, systems and safety.

Students will be required to use what they learnt in Construction Technology about designing, communication, the design process and how technology is engaging in people's livelihood in terms of designing and making products and marketing as a quicker and cheaper way of advertising and selling their products. They can use STEAM principles and skills in finding cause and solutions, use high level thinking skills to analyse and evaluate the effects and how to improve design products, use decision making and critical thinking skills to find the solutions for making and marketing a product.

They can be able to confidently and boldly communicate their findings and present intelligent and convincing arguments, which we can conclude that learning of the core curriculum is evident.

Science, Technology, Engineering, Arts and Mathematics

STEAM education is an integrated, multidisciplinary approach to learning that uses Science, Technology. Engineering, Arts and Mathematics as the basis for inquiring about how STEAM has and continues to change and impact the social, political, economic, cultural and environments contexts and identifying and solving authentic (real life) natural and physical environment problems by nitrating STEAM- based principles, processes, skills, values and attitudes to prepare them for careers, higher education and citizenship.

TIA: Construction Technology utilises both the goals of STEAM rather than just the goal of problem- solving. This is to ensure that all students are provided opportunities to learn, integrate and demonstrate proficiency on all essential STEAM principles, processes, skills, values and attitudes to prepare them for careers, higher education and citizenship.

Objectives:

Students will be able to:

i. Examine and use evidence to draw conclusions about how STEAM has and continues to change the social, political, economic, cultural and environmental contexts.
ii. Investigate and draw conclusions on the impact of STEAM solutions to problems on the social, political, economic, cultural and environments contexts
iii. Identify and solve problems using STEAM principles, skills, concepts, ideas and process
iv. Identify, analyse and select the best solution to address a problem
v. Build prototypes or model of solutions to problems.
vi. Replicate a problem solution by building models and explaining how the problem was or could be solved.
vii. Test and reflect on the best solution chosen to solve a problem
viii. Collaborate with others on a problem and provide a report on the process of problem solving used to solve the problem.
ix. Use skills and processes learnt from lessons to work on and complete STEAM related projects.
x. Demonstrate STEAM principles, skills, processes, concepts and ideas through simulation and modeling.
xi. Explain the significance of values and attitudes in problem solving.

STEAM Problem -Solving Methods and Approaches

Problem –solving involves the use of problem- solving methods and processes to identify and define a problem, gather information to understand its causes, draw conclusions, and use the evidence to design and implement solutions to address it. Even though, there are many different problem -solving methods and approaches; they share some of the steps of problem-solving, for example:

- Identifying the problem;
- Understanding the problem by collecting data;
- Analyse and interpret the data;
- Draw conclusions;
- Use data to consider possible solutions;
- Select the best solution;
- Test the effectiveness of the solution by trialing and evaluating it, and
- Review and improve the solution.

STEAM problem-solving processes go from simple and technical to advanced and knowledge- based processes. However, regardless of the type of process used students should be provided opportunities to learn the essential principles and processes of problem solving and more significantly, to design and create a product that addressed a real problem and meets a human need.

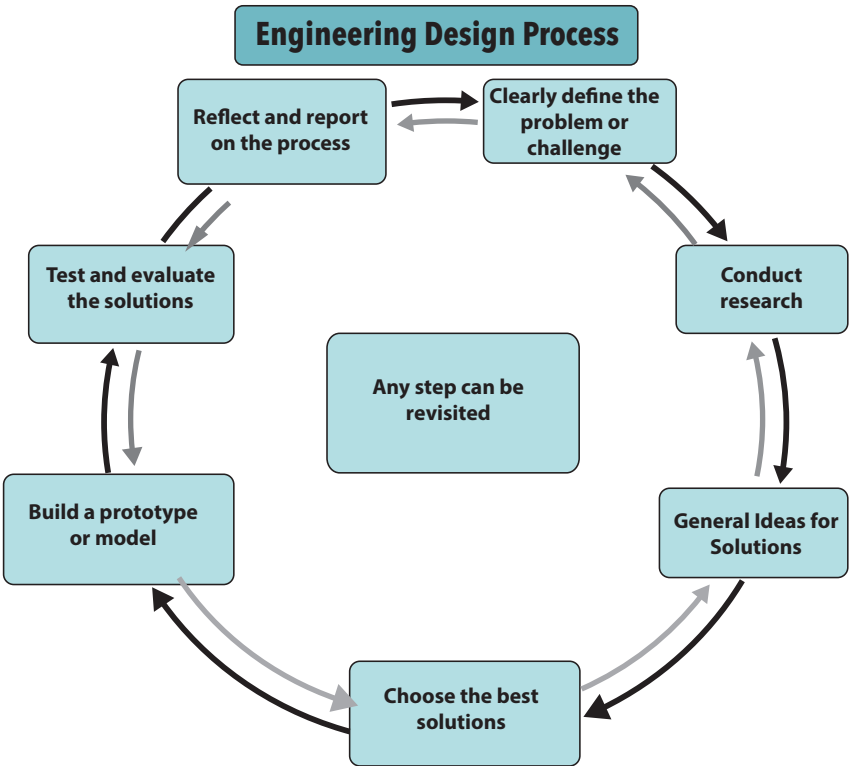
Engineering Design Process

Technological fields used the engineering design process to choose the best solution to solve the problem.

It is an open-ended problem solving process that involves the full planning and development of products or services to meet identified needs. It involves the following sequence of steps:

- Analyse the context and background, and clearly define the problem.
- Conduct research to determine design criteria, financial or other constraints, and availability of materials,
- Generate ideas for potential solutions, using processes such as brainstorming and sketching.
- Choose the best solution.
- Build a prototype or model.
- Test and evaluate the solution.
- Repeat steps as necessary to modify the design or correct faults.
- Reflect and report on the process.

The sequential engineering design process steps described above are illustrated in the diagram below.



Students should be guided through every step of the process so that they can explain it and its importance, and use the steps and the whole process proficiently to identify, investigate and solve problems. They should be provided with opportunities to practice and reflect on each step until they demonstrate the expected level of proficiency before moving on to the next one.
It involves the following sequence of steps;

Step 1: IDEA GENERATION
Step 2: RESEARCH
Step 3: PLANNING (DESIGN BRIEF)
Step 4: PROTOTYPING
Step 5: PRODUCTION
Step 6: COSTING
Step 7: MARKETING

Step 1: Idea Generation

- Ideation, iteration, and brain storming new product ideas

Students should be guided and provided opportunities to identify human made, natural and physical environment problems using their senses and describe what the problem is and its likely causes.

Example: *Residential backyard design that is not pleasing.*

Step 2: Research

- Questionnaires Feedback from a substantial and unbiased audience for product validation

After the problem is identified and described, several questions will be derived from a main issue question. The questionnaire will be formulated and then will be answered in the survey. This questionnaire will guide the researcher in conducting research and investigation for the appropriate solution to the problem.

Example: Main Question 'How can the residential backyard are designed including the elements of design that is aesthetically functional?'

Step 3: Planning (Design Brief)

- Bring the product to life through sketching, illustrations and working diagrams

Creating working sketches, illustrations and working diagrams helps the researcher to better understand his or her research problem, refine the research question and decide on investigation approach before the investigation is conducted.

Example: *Description of an Authentic Situation of an aesthetic and functional residential backyard design.*

The researcher may look into the various designs of backyards in the schools and surrounding residences outside of the school premises take pictures and produce sketches or other subject areas for tips or conduct online search on how to improve the design of residents' backyards from relevant websites. The researchers may even analyse information and past practices or similar but better regarding aesthetic and functional backyard designs.

Step 4: Prototyping

- Construct a scale model of a residential backyard design.

The researcher will make or develop a prototype of the solution and test how it would be used to solve the problem.

Example: Prototype

The illustration of sketches in the planning stage can be created in sketches and technical drafts or use CAD as the basic solution for residential back-yard design. He /she will complete a scale drawing, with annotation and development.

Step 5: Production

- Gather materials and production begins.

This step is the gathering of materials and producing of the product from the best prototype. This involves the identification of lists of materials, procedural steps with their respective tools or equipment to be used to produce the intended product.

It is obviously known during the production that certain procedural steps are needed to be done in certain order before the others because later steps depend on them being prioritized. In addition, concepts of other subjects needed for producing the product maybe gathered, integrated and utilised in the production of the product.

Example: *Producing the product*

Step 6: COSTING

- Total cost of product sold to determine retail price and gross margin

This stage is known as product pricing which involves the calculation of the costs of materials used, labour cost, markup and selling price.

The selling price may be influenced by responses to the questions in the survey due to the interest of the buyers which will determine the cost of the product.

The cost for producing the item are:

1) Material unit cost: K____
2) Labor costs (No of Hours Spent X Your Rate): 10 hrs x K ___ = K____
3) Selling/Marketing cost: K____

A simple formula to calculate a good markup percentage for the project:
Example: Pricing the product

Step 7: MARKETING

- **Launch product into market**

This stage involves the marketing of the finished product. The potential buyers of the product are the targeted audience that were used in the research.

The finished product can be promoted using flyers, put out on public places and market page can be created on social media networks.

STEAM- Based Lesson Planning

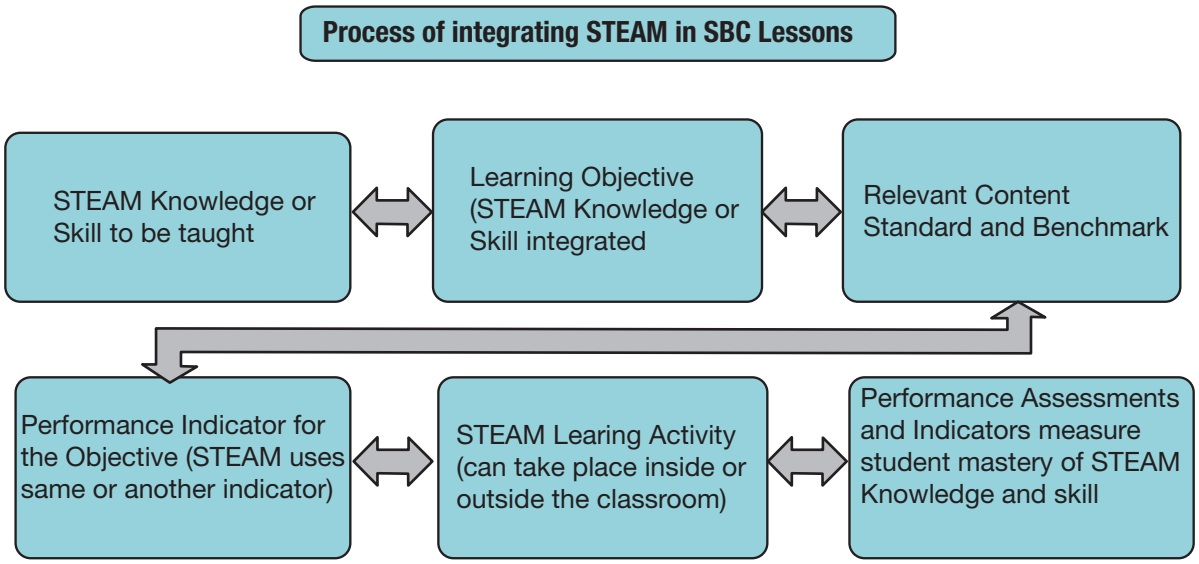
Effective STEAM lesson planning is the key to the achievement of the expected outcomes. STEAM Skills can be planned and taught using separate STEAM-based lesson plans or integrated into the standards- based lesson plans. To effectively do this, teachers should know how to write effective standards and STEAM-based lesson plans.

Developing STEAM-based Lesson Plans

An example of a standards- based lesson is provided below. Teachers should use this to guide them to integrate STEAM content and teaching, learning and assessment strategies into their standards- based lesson plans.

Integration of STEAM problem-solving skills into standards-based lesson plans

Process for Integrating STEAM Principles and Problem-Solving Skills into Standards-Based Lessons



Teachers should follow the steps given below when integrating STEAM problem-solving principles and skills into their standards-based lesson plans. (Refer to Appendices)

Step 1: Identify the STEAM knowledge or skill to be taught (From the table of KSAVs for each content standard and bench mark). **This could be already being captured in the learning objective stated in the standards-based lesson plan.**

Step 2: Develop and include a performance standard or indicator for measuring student mastery of the STEAM knowledge or skill (e.g. level of acceptable competency or proficiency) **if this is different from the one already stated in the lesson plan**

Step 3: Develop student learning activity (An activity that will provide students the opportunity to apply STEAM knowledge or skill specified by the learning objective and appropriate statement of standards). Activity can take place insideor outside the classroom and during or after school hours.

Step 4: Develop and use performance descriptors (standards or indicators) to analyze student STEAM related behaviors or products (results or outcomes), which provide evidence that the student has acquired and mastered the knowledge or skill of the learning objective specified by the indicator(s) of the standard(s).

STEAM- Based Assessment

STEAM-based assessment is closely linked to standards-based assessment where assessment is used to assess student's level of proficiency or competency of a specific knowledge, skill, value or attitude taught using a set of performance standards (indicators or descriptors). The link also includes the main components such as the purpose, the assessment principles and assessment strategies and tools.

In STEAM-based assessment, assessment is designed for what the students should know and be able to do. In STEAM learning students are assessed in a variety of ways including portfolios, project/problem-based assessment, backward designs, authenticity assessment, or other students centered approaches. When planning and designing the assessment, teachers should consider the authenticity of the assessment by designing an assessment that relates to a real world task or discipline specific attributes (such as simulation, role play, placement assessment, live projects, debates) should make the activity meaningful to the student, and therefore be motivating as well as developing employability skills and discipline specific attributes.

Effective STEAM-Based Assessment strategies

The following six sections describe six assessment tools and strategies shown to impact teaching and learning as well as help teachers foster a 21st century learning environment in their classrooms.

1. **Rubrics**
2. **Performance-based assessment (PBAs)**
3. **Portfolios**
4. **Student self-assessment**
5. **Peer-assessment**
6. **Students response system (SRS)**

Although the list does not include all innovative assessment strategies, it includes what we think are the most common strategies, and ones that may be particularly relevant to the educational context of developing countries in this 21st Century. Many of the assessment strategies currently use fit under one or more of the categories discussed. Furthermore, it is important to note that strategies also connect in a variety of ways.

1. Rubrics

Rubrics are both a tool to measure students' knowledge and ability as well as an assessment strategy. A rubric allows teachers to measure certain skills and abilities not measurable by standardized testing systems that assess direct knowledge at a fixed moment in time. Rubrics are also frequently used as part of other assessment strategies (portfolios, performances, projects, peer-review and self-assessment), they will be discussing in those sections as well.

2. Performance- Based Assessments

Performance- Based Assessments (PBA), also known as authentic assessment are generally used as a summative evaluation strategy to capture not only what students know about a topic, but if they have the skills to apply that knowledge in a; 'real-world' situation by asking them to create an end product. PBA pushes students to synthesize their knowledge and apply their skills to a potentially unfamiliar set of circumstances that is likely to occur beyond the confines of a controlled classroom setting. The implementation of performance-based assessment strategies can also impact other instructional strategies in the classroom.

3. Portfolio Assessment

Portfolios are a collection of student work gathered over time that is primary used as a summary evaluation method. The most salient characteristic of the portfolio assessment is that rather than being a snap shot of a student's knowledge at one point in time (like a single standardised test) it highlights student effort, development, and achievement over a period of time; portfolios measure as student's ability to apply knowledge rather than simply regurgitate. They are considered both student-centered and authentic assessment of learning.

4. Self-Assessment

Its main purpose is for students to identify their own strengths and weakness and to work to make improvements to meet specific criteria. Self-assessment occurs when students judge their own work to improve performance as they identify discrepancies between current and desired performance. In this way, self-assessment aligns well with standards-based education because it provides clear targets and specific criteria against which students or teachers can measure learning.

Self-assessment is used to promote self-regulation to help students reflect on their progress and to inform revisions and improvements on a project or paper. In order for self-assessment to be truly effective, four conditions must be in place, the self-assessment criteria, criteria is negotiated between the teachers and students, students are taught how to apply the criteria, students receive feedback on their self-assessments. Teachers then help students use assessment data to develop an action plan.

5. Peer Assessment

Peer assessment, much like self-assessment, is a formative assessment strategy that gives students a key role in evaluating learning. Peer assessment approaches can vary greatly but, essentially it is a process for learners to consider and give feedback to other learners about the quality or value of their work. Peer assessments can be used for a variety of products like papers, presentations, projects and or other skills behaviors. Peers assessment is understood as more than only a grading procedure and is also envisioned as teaching strategy since engaging in the process develops both the assessor and the assessees skills and knowledge. The primary goal for using peer assessment is to provide feedback to the learners. This strategy may be particularly relevant in the classrooms with many students per teacher since student time will be more plentiful than teacher time, although any single student's feedback may not be rich or in-depth as teachers feedback, the research suggests that peer assessment can improve learning.

6. Students Response system

Students response system (SRS), also known as classroom response (CRS), audience response system (ARS) is a general term that refers to a variety of technology-based formative assessment tools that can be used to gather student- level data instantly in the classroom through the combination of hardware, (voice recorders, PC, internet connection, projector and screen) and software.

Teachers can ask students a wide range of questions (both closed and open ended), where students can respond quickly and anonymously, and the teacher can display the data immediately and graphically. The use of technology also includes a use of video which examines how a range of strategies can be used to assess students understanding. The value of SRS comes from the teachers analysing information quickly and then devising real-time instructional solutions to maximise students learning. This includes a suggested approach to help teachers and trainers assess learning.

Essential Knowledge, Skills, Values, and Attitudes

Students' level of proficiency and progression towards the attainment of content standards for Technology and Industrial Arts subject will depend on their mastery and application of essential knowledge, skills, values, and attitudes in real life or related learning experiences and situations across the secondary curriculum.

Examples of the different types of knowledge, skills, values and attitudes, including processes, that all students are expected to learn and master as they progress through the grades are provided in;

- Technology and Industrial Arts syllabuses for grades 9&10 page 24-27

These knowledge, skills, values and attitudes have been integrated into the content standards, benchmarks and performance standards developed for Technology and Industrial Arts subject

Teachers are expected to plan and teach these in their lessons, and assess students' performance and proficiency, and progression towards the attainment of content standards.

Construction and Industrial Arts

Technology and Industrial Arts provides and instills in students the confidence to use a range of specific knowledge, skills, values and attitudes in various technologies. These are scoped and embedded within the strands curriculum content in the subject, with the intension to create related career pathways. The content in each strand encourage students to be proactive, competent, creative, responsible and reflective learners, enabling them to pursue career opportunities in respective fields of technology studied in this subject.

Provided herein are recognised knowledge for the subject which are applicable across the strands.

Types of common knowledge for Technology and Industrial Arts

These are specific content knowledge for the subject. They include;	
• Creativity • Branding • Communication skills • Technical expertise • Industry expertise • Critical thinking- • Information Technology skills • Innovation	• Building and Engineering Knowledge. • Physical Strength and Stamina. • Mathematical formulas in technology • **Technology and Industrial** Language Coordination. • Technology Skills. • Problem Solving Skills. • Prototype

skills oriented subject, therefore embraces all the commonly recognised skills which can be used across the strands scoped in the content. Listed here for teacher's convenience are commonly recognised skills across the strands.

Types of Skills for Technology and Industrial Arts

These are specific content Skills for the strand. They include;	
• Creativity • Critical thinking • Technical knowledge • Commercial awareness of food industries/catering services • Research and data handling capacity • Critical analysis and interpretation of materials • Management skills • Organisational Skills. • Problem solving skills • Mathematical skills • Language Literacy skills • Leadership • Innovative skills • trans formational skills	• Food Server Skills • Focus Communication skills (approachability, circumstantial awareness, diligence, efficiency, thoroughness • Multitasking skills • Attention to detail skills (multitasking , approachability, • Technical Skills • Decision making skills • Coding • information technology soft skills • logical thinking • collaboration • teamwork • software engineering • software quality assurance • customer Service • Modeling

Types of Values

Personal engagement and civic engagement strategies help young people to acquire and apply skills and dispositions that will prepare them to become competent and responsible citizens.

1. Personal Values (importance, worth, usefulness, etc

Core values	Sustaining values
• Sanctity of life • Truth • Aesthetics • Honesty • Human • Dignity • Rationality • Creativity • Courage • Liberty • Affectivity • Individuality	• Self-esteem • Self-reflection • Self-discipline • Self-cultivation • Principal morality • Self-determination • Openness • Independence • Simplicity • Integrity • Enterprise • Sensitivity • Modesty • Perseverance

2. Social Values

Core Values	Sustaining Values
• Equality • Kindness • Benevolence • Love • Freedom • Common good • Mutuality • Justice • Trust • Interdependence • Sustainability • Betterment of human kind • Empowerment	• Plurality • Due process of law • Democracy • Freedom and liberty • Common will • Patriotism • Tolerance • Gender equity and social inclusion • Equal opportunities • Culture and civilization • Heritage • Human rights and responsibilities • Rationality • Sense of belonging • Solidarity • Peace and harmony • Safe and peaceful communities

Types of Attitudes

Attitudes - Ways of thinking and behaving, points of view	
• Optimistic • Participatory • Critical • Creative • Appreciative • Empathetic • Caring and concern • Positive • Confident • Cooperative	• Responsible • Adaptable to change • Open-minded • Diligent • With a desire to learn • With respect for self, life, equality and excellence, evidence, fair play, rule of law, different ways of life, beliefs and opinions, and the environment.

Construction Technology strand

The **Construction technology** strand encourages students to “think out of the box”. This simply means to think openly and freely beyond the learning situation to bring about fresh creative ideas into the classroom lessons. This gives opportunity to the students to apply creativity and critical thinking to participate .Teachers must ensure that even students with rudimentary creativity skills end up improvising their designs, models of prototypes and

products.

Types of knowledge for Construction Technology

These are specific content knowledge for the Strand. They include;	
• Technical drawing • Print and layout reading • Design • Construction Materials specifications • Constructions Systems • Constructions Processes • Construction techniques • Prototype • Constructions materials estimates and costs‘	• Designs of structures • Construction tools • Construction equipment • Construction tools, equipment and correct functions • OHS • Maintenance skills, • Storage skills • Construction supervisory skills • Project management Skills

Processes in Technology & Industrial Arts

Technology and Industrial Arts expounds on the classroom practices using processes for effective and evidence based lesson deliveries. The commended/ suggested processes are for teachers to use as the starting points planning skills or practice based lessons in any of the strands as presented in the subject syllabus.

Types of Processes- Inquiry processes for Technology & Industrial Arts subject

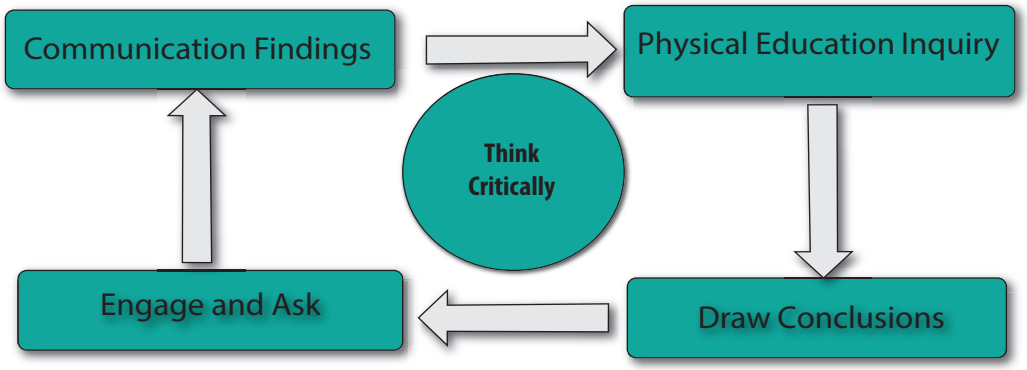
Technology & Industrial Arts Inquiry processes include:

- Gathering information
- Analysing information
- Evaluating information
- Making judgements
- Taking actions
- Instructional technology
- Integration process
- Project planning process
- Organization of learning experiences

Technology & Industrial Arts Inquiry Processes

Engage and Ask	How will I engage my students in the topic and prompt them to ask questions? • Determine the enduring understandings about the topic being studied. • Engage your students with the topic by grabbing their interest with a hook connected to the enduring understandings. • Allow students to generate questions based upon the topic and hook. • Determine what questions will be essential to achieving the enduring understandings. (Student generated or teacher determined • With students, determine what other information is needed in order to fully answer the questions.
Think Critically	How will students access and analyse information about this topic? • Have students think about where they can find answers to the questions posed about the topic. • Gather and organize multiple primary and secondary sources. • Ensure that sources used expose students to different perspectives and viewpoints about the topic. • Students should use sources to collect, analyse, and interpret data. • Ensure students are analysing sources for credibility, bias, and perspective in order to identify gaps in the research.
Draw Conclusion	How will students synthesize ideas to answer the questions posed based on sources used? • Students should engage in civic discussion to answer the questions posed while respecting diverse opinions. • Engage students in evaluating possible courses of action and their consequences. • Students should make and justify an informed decision or choice and/or design an action plan supported by evidence from sources. • Have students evaluate the consequences of a decision or choice. • Allow students to make revisions based on feedback and further study.
Communi-cate Findings	How will students demonstrate what they have learned and take action on that learning? • Determine how students will apply what they have learned and share their findings with others. • Explore appropriate audiences for students to present conclusions. • Determine if there is an opportunity for students to take action and influence others to make more informed decisions. • Have students develop strategies to persuade others, including policy makers when applicable. • Prepare students to defend their analysis against alternative.

Below is how the Technology & Industrial Arts Inquiry Process will be taught in the classroom. Be specific as you make notes of the activities or prompts you will use to ensure students will have the opportunity to practice these skills as a requirement in the Grade 10 content standards.



Technology & Industrial Arts Enquiry

1. **Developing Questions and Planning Inquiries**
   a. *Constructing Essential Questions*
   - Address essential questions that reflect an enduring issue in the field
   b. *Constructing Supporting Questions*
   - Explain how supporting questions contribute to an enquiry.
   c. *Determining Helpful Sources*
   - Develop new supporting and essential questions through investigations, collaboration and using diverse sources.

2. **Evaluating Sources and Using Evidence**

   a. *Gathering and Evaluating Sources*
   - Gather and evaluate information from multiple sources while considering the origin, credibility, point of view, authority, structure, context and corroborative value of the sources.
   b. *Developing Claims and Using Evidence*
   Identify evidence that draws information from multiple sources to revise or strengthen claims.
   - Communicating Conclusions and Taking Informed Action
   c. *Communicating Conclusions*
   - Construct and evaluate explanations and arguments using multiple sources and relevant, verified information.
   d. *Critiquing Conclusions*
   - Articulate explanations and arguments to a targeted audience in diverse setting.
   e. *Taking Informed Action*
   - Use interdisciplinary lenses to analyse the causes and effects of and identify solutions to local, regional or global concerns.
   - Use deliberative processes and apply democratic strategies and procedures to address local, regional or concerns and take action in or out of school.

5. Literacy Skills

A strong emphasis must be placed on various types of literacy, from financial to technological, from media to mathematical, from content to cultural. Literacy may be defined as the ability of an individual to use information to function in society, to achieve goals and to develop her or his knowledge and potential. Teachers emphasise certain aspects of literacy over others, depending on the nature of the content and skills they want students to learn.

The following literacy skills are intended to be exemplary rather than definitive;

Types of Literacy Skills – Skills in basic literacy, digital literacy and financial literacy

- Define and apply discipline-based conceptual vocabulary
- Describe people, places, and events, and the connections between and among them
- Arrange events in chronological sequence
- Differentiate fact from opinion
- Determine an author's purpose
- Determine and analyse similarities and differences
- Analyse cause and effect relationships
- Explore complex patterns, interactions and relationships
- Differentiate between and among various options
- he ability to locate, evaluate and use digital information.
- The ability to use information and communication technologies to find, evaluate, create, and communicate information, requiring both cognitive and technical skills
- The ability to effectively and critically navigate, evaluate and create information using a range of digital technologies.
- Making choices about personal finances and having the skills to make decisions that will have positive outcomes.
- Effectively use financial skills
- Improve personal financial management skills
- Improve budgeting and investing skills
- Create a savvy relationship with money application skills
- Create a lifelong journey of learning for education is the key to success when it comes to money
- Effective use financial skills
- Improve personal financial management skills
- Improve budgeting and investing skills
- Create a savvy relationship with money application skills
- Create a lifelong journey of learning for education is the key to success when it comes to money

6. Numeracy Skills

Numeracy skills refer to the ability to use, interpret and communicate mathematical information to solve real-world problems. These include the ability to understand basic math like addition, subtraction, division and multiplication. More advanced numeracy skills incorporate the use of graphical, spatial, statistical and algebraic concepts and the ability to interpret that data and apply it to real-world situations.

Types of Numeracy Skills – skills that are driven by the basic mathematical aspects

- Basic knowledge of numbers
- Calculation skills
- Budgeting
- Interpreting mathematical information
- Understanding the relationships between numbers
- Understanding trends
- Measurement and data analysis

Curriculum Integration

An integrated curriculum is described as one that connects different areas of study by cutting across subject-matter lines and emphasising unifying concepts. Integration focuses on making connections and linkages in content for students, allowing them to see the importance of all subjects in the curriculum. When students are able to see and understand the linkages between different subject matter, they engage in relevant, meaningful activities that can be connected to real life.

Curriculum integration is a holistic approach to learning thus curriculum integration in SBC will equip students with the essential 21st Century knowledge, skills, values and attitudes. Teachers must develop intriguing curriculum by going beyond the traditional teaching of content based or fragmented teaching to the teacher who is knowledge based and who should be perceived as a 21st Century innovative educator.

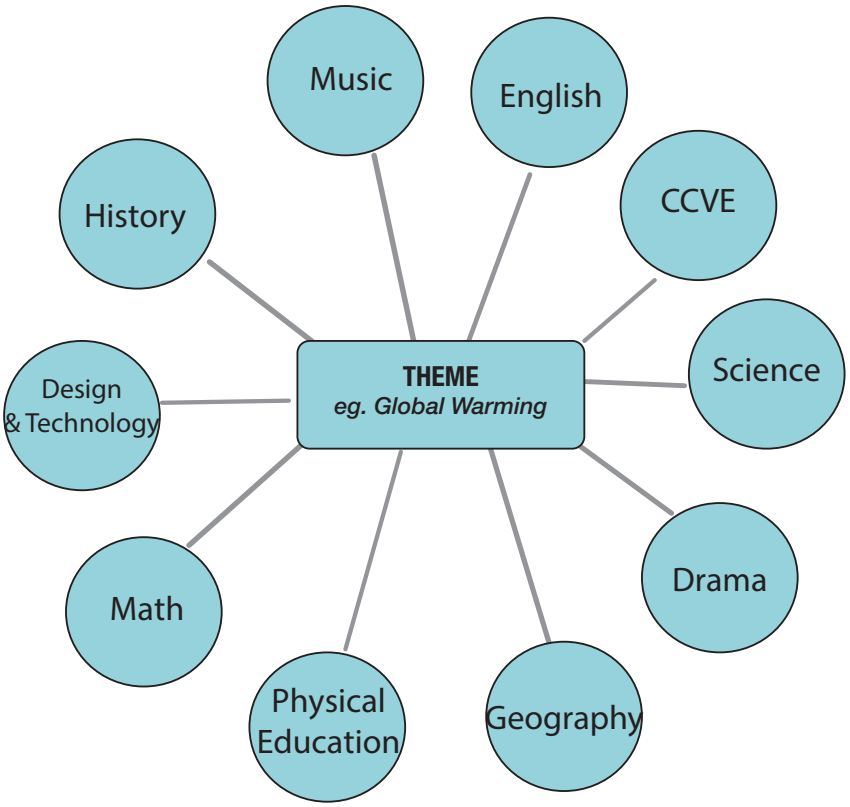
There are three approaches that SBC will engage to foster conducive learning for all children whereby they all can demonstrate proficiency at any point of exit. Adapting these approaches will have an immense impact on the lives of these children as they will not only see themselves as catalyst of change for a competitive PNG but also, comparable to the world standards as global citizens.

Engaging these three approaches in our curriculum will surely sharpen the knowledge and ability of each child, allowing them to see themselves as assets through their achievements and as agents of change contributing meaningfully to their country.

Integrated learning will bear a generation of knowledge-based populace who can solve problems and make proper decisions based on evidence. Thus, PNG can achieve its goals like the Medium Term Development Goals (MTDG) and aims such as the Vision 2050 for a happy, healthy and wealthy society whereby, all its citizens should have access and fair distribution to income, shelter, health, education and general good and services improving the general standard of living for PNG in the long run.

(i) Multidisciplinary Approach

In this approach, learning involves a theme or concept that will be taught right across all subject area of study by students. For instance, if the theme is “Advocacy for active Citizenship and Participation”, all subject areas create lessons or project-based learning and assessment as per their subjects around this theme. The content of the theme ““Advocacy for active Citizenship and Participation” will be taught right across all the different subjects through the different Benchmarks as shown in the diagram and table below.


Music
English
History
CCVE
THEME
eg. Global Warming
Science
Design
& Technology
Drama
Math
Physical
Education
Geography

Sample Curriculum Integration Outline of Linkages

THEME: "ADVOCACY FOR ACTIVE CITIZENSHIP AND PARTICIPATION"		
SUBJECT: CHRISTIAN AND CITIZENSHIP VALUES EDUCATION		**GRADE: 12**
STRAND 3: CHRISTIAN CITIZENSHIP AND SOCIETY		
UNIT 1: Christian Civics Systems		
TOPIC: Christian civic organizations use technology to advocate for good health, better education and for protection of the natural environment and its sustainability.		
Subject	**Benchmark**	**Concept of focus to learn and assessed for the Theme**
CCVE	**12.3.1.4** Inquire and discuss how Christian civic Organizations use technology to advocate for good health, better education and for protection of the natural environment and its sustainability.	How Civic Organizations use technology to advocate for protection of the natural environment and its sustainability
Agriculture	**12.3.1.4.3** Suggest ways for improving problems that a□ect conservation in Papua New Guinea	Improving Conservation problems in PNG as Citizens
Arts	**12.3.3.2** Conduct research and create artworks to advocate for social change. **12.1.2.2** Use a range of techniques and technological tools in a variety of applications relating to music to communicate a theme.	Use data from research to create artwork to advocate for active Citizenship Use Music Technological Tools to communicate active Citizenship
Business Studies	**12.4.2.9**. Establish the e-business by creating a website or using a mobile application (apps) using the Apple operating system (App Store) or Google Android operating system (Google Play).	Create a website or a mobile application to as a platform to advocate for active Citizenship[p
Character and Social Development		
English	**12.2.6.2:** Take advantage of technology's capacity to link to other information and to display information flexibly and dynamically. **12.5.4.2:** Give a clearly articulated, well-structured presentation on a complex topic.	How to display Citizenship information flexibly and dynamically with use of technology. Do a clearly articulated, well-structured presentation on active Citizenship

Mathematics	**12.4.4.3** Use appropriate technology to aid concept development as a tool for problem solving. (General Maths) **12.1.1.5** Apply quadratic equations to solve real-world situations and complex number problems. (Advance Math)	Application of quadratic equations to solve real-world situations as part of active citizenship Use appropriate technology as a tool for problem solving when they engage as active citizens in real life situations
Physical Education	**12.2.2.2** Distinguish and illustrate sporting greats of PNG in respect to their contribution in the country	How they can actively participate as sporting greats to model active citizenship participation
Science	**12.2.1.6** Investigate human population growth by comparing recent and future population growth in developed and developing countries (Biology)	Use of data from investigations to compare human population growth and use the information to participate in informed decision making
Social Science	**12.1.4.6**. Critique various national and global strategies, agenda, and actions for addressing climate change. (Geography) **12.2.4.2.** Examine the different ways the United Nations promote change and maintain stability in different regions of the world. (Political Science) **12.3.3.1** Identify and appraise the different ways people from different cultures, religions, and ethnic and ideological backgrounds relate to each other (History)	Use of strategies to actively participate in addressing climate change Understanding of how UN maintains stability to be able to actively advocate for understanding of world peace Learn how common grounds of understanding and relationships minimizes differences in cultures, religions, and ethnic and ideological backgrounds and advocate for tolerance
TIA	**12.5.2.4;** Describe the characteristics of client site scripting and creating interactive menus (Computer Tech)	The use of site scripting to create interactive menus for advocacy on issues of national and global interest as part of active citizenship participation

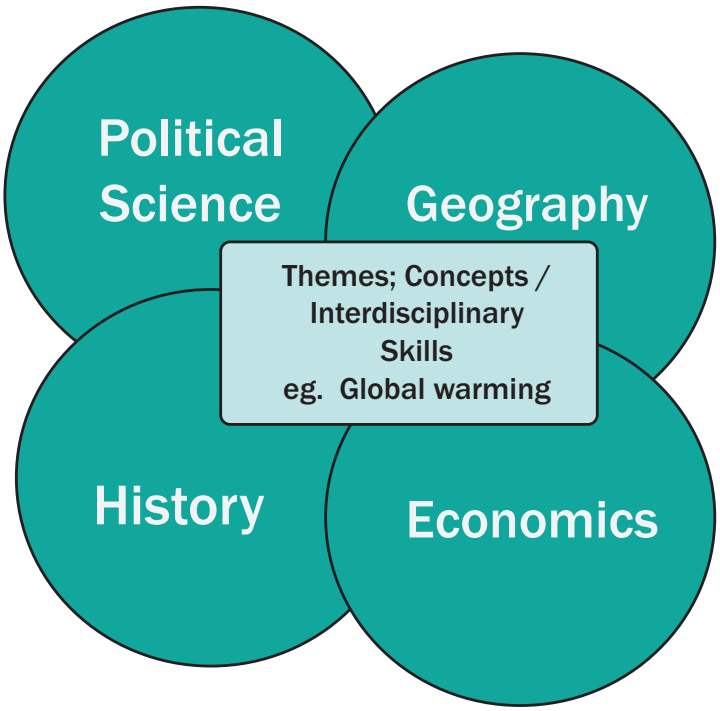
Planning for assessment will be a collaborative effort of all the subject teachers who wish their students to be part of the project with the CCVE subject Teacher as the overall coordinator of the Project and leading the Team.

See the process of this assessment in the Assessment Section.

(ii) Interdisciplinary Approach

This approach addresses learning similarly to the multidisciplinary approach of integrated learning whereby learning takes place within the subject area. It is termed interdisciplinary as the core curriculum of learning is interwoven into each subject under study by the students. For instance; in CCVE, under the strand "Governance and Leadership" students will learn the different types of leadership and common governance principles cut across the different leadership styles they will learn. Apart from learning these, students learning in CCVE are expected to use the application of writing, speaking and communication presentation skills in writing text types in their essay, such as argumentative essay, informative, explanatory, descriptive, expository and narrative essay, oral presentations and speech delivery in debates, advocacies and awareness campaigns. They must be able to capture the mechanics of English skills such as grammar, punctuation etc... Though these skills are studied under English, they are considered as core skills that cut across all subjects under study.

Therefore, essential knowledge, skills, values and attitudes comprising the core curriculum are interwoven and provide an essential and holistic framework for preparing all students for careers, higher education and citizenship in this learning.



(iii) Intra-disciplinary approach

This approach involves teachers integrating sub-disciplines within a subject area. For instance, within the subject CCVE, the four different strands will all be captured studying a particular content for CCVE. For example, under the Civic Systems and Principles, students will learn about civic different identities of different contexts and their participation likewise in the other 3 strands. Thus, children are well aware of their responsibility in active civic participation.

(iv) Trans-disciplinary Approach

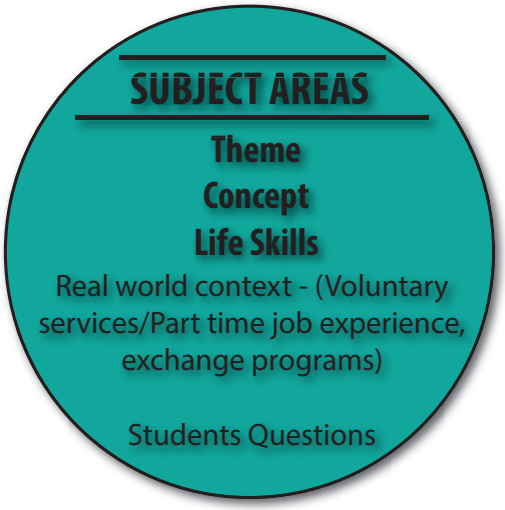
In this approach learning goes beyond the subject area of study. Learning is organised around students' questions and concerns. That is, where there is a need for change to improve lives, students develop their own curriculum to effect these needs. The Trans-disciplinary approach addresses real-life situations thus gives the opportunity to students to attain real life skills. This learning approach is more to do with Project–Based Learning also referred to as problem-based learning or place- based learning.

The three steps to planning project-based curriculum (Chard 1998).

1. Teachers and students select a topic of study based on student interests, curriculum standards, and local resources.
2. The teacher finds out what the students already know and helps them generate questions to explore. The teachers will also provide resources for students and opportunities to work in the field.
3. Students share their work with others in a culminating activity. Students display the results of their exploration and review and evaluate the project.

For instance; students may come up with slogans for school programs such as 'Our culture – clean city for a healthier PNG'. The main aim could be to curb betel nut chewing in public areas especially around bus stops and local markets. Here, students draw up their own instructions and criteria for assessment which is they have to clean the nearest bus stop or local market once a week throughout the year. They also design and create posters to educate the general public as their program continues. They can also involve the town council and media to assist them especially to carry out awareness. Studies (Susan M. Drake and Rebecca C. Burns) have proven that Project based-programs achievements have led to the following:

- Students go far beyond the minimum effort.
- Make connections among different subject areas to answer open-ended questions.
- Retain what they have learnt.
- Apply learning to real-life problems.
- Have fewer discipline problems.
- Lower absenteeism (Curtis, 2002).



These integrated learning approaches will demand for teachers to be more proactive in order to improve students learning and achievements. In order for SBC to serve its purpose fully; these three approaches must be engaged for better learning for the children of Papua New Guinea now and in the future.

7. High Level Thinking Skills

These skills include analysis, synthesis, and evaluation skills.

i. Analysis Skills – Analysis skills involve examining in detail and breaking information into parts by identifying motives or causes, underlying assumptions, hidden messages; making inferences and finding evidence to support generalisations, claims, and conclusions.

ii. Synthesis Skills – Synthesis skills involve changing or creating something new, compiling information together in a different way by combining elements in a new pattern proposing alternative solutions.

iii. Evaluation Skills – Evaluation skills involve justifying and presenting and defending opinions by making judgments about information, validity of ideas or quality of work based on set criteria.

Key Words				
Analyse	Differences	Find	Reproduce	Similar to
Appraise	Discover	Focus	Motivate	Simplify
Arrange	Discriminate	Function	Omit	Take part in
Assumption	Discussion	Group	Order	Test for
Breakdown	Distinction	Highlight	Organise	Themewebbing
Categorise	Distinguish	In-depth	Point out	Create
Cause & effect	Dissect	Inference	Research	Innovate
Choose	Divide	Inspect	See	Design
Classify	Establish	Isolate	Select	collaborate
Comparing	Examine	Investigate	Separate	recreate
				networking

Teaching and Learning Strategies

Technology & Industrial Arts emphasises and embraces the use of cognitive, reasoning, decision-making, problem solving and higher level thinking skills to teach to enhance students' understanding of inter-disciplinary concepts and issues in relation to environment, geography, history, politics and economic within PNG and globally.

It aims to provide a meaningful pedagogical framework for teaching and learning essential and in demand knowledge, skills, values, and attitudes that are required for the preparation of students for careers, higher education and citizenship in the 21st Century.

Students must be prepared to gather and understand information, analyse issues critically, learn independently or collaboratively, organise and communicate information, draw and justify conclusions, create new knowledge, and act ethically.

Teaching and learning is a two-way interactive interaction between teacher and a student , a student to a student/students and occurs in any learning environment in or outdoors depending on the nature of teaching strategies learning activities and performance assessments teachers plan to use in the delivering of the lesson.

Technology and Industrial Arts teaching and learning takes on a **blended perception and practices** of its content delivering with envisioning intentions to reinforce evidence based learning. It embraces these in the classrooms whereby each technology strand content in the form of content standards, benchmarks and performance standards direct or determine the planning of the types of learning situations and activities, assessments throughout the school year.

These standards, including the specific knowledge skills and attitudes ,how they are planned for students learning and performance attainment purposes in the respective grade levels are through highly commended teaching, learning and assessing strategies. For example; using blended learning strategies. This is where/when the traditionally recognised strategies(teacher centred) is blended with using e-teaching/learning strategies(online using smart phones) to learn about properties of fabrics, in a Textile Technology strand lesson.

Teaching strategies

Find listed for your convenience are identified teaching strategies commended for TIA subject lesson deliveries lessons However teachers can blend these in with the existing or current teaching practices using technology.

- Use of multimedia for content research.
- Utilisation of social media for fact finding on particular technology .
- Using variety of resources for meaningful teaching .

- Making most of games in electronic devices for learning.
- Use technology to empower students and reach out.

Learning Strategies

These are suggested learning strategies that can be used across the learning of all the five content strands in TIA subject.

- Using multiple types of instructional materials for learning
- Incorporate technology for reinforcement and motivation for learning
- Try new learning techniques for
- Keep your traditional teaching methods
- Vary your assessments
- Mix up group work styles
- Try a digital curriculum

Classroom assessment strategies

- Find for your convenience suggested assessment strategies to assess technology curriculum content.
- Clarifying learning intentions and criteria for success.
- Engineer effective classroom-based questioning and discussions on performance tasks that provoke or draw out evidence of learning.
- Constantly provide feedback that move learners forward.
- Present or address students as instructional resources for each other,
- Computer assisted video-based test

All Teachers teaching TIA from grades 9-10 and Construction Technology in Grade 11 and 12 are encouraged to also add to this list for the good of their student's learning.

TIA Classroom

This classroom will be a learning environment prepared especially for the teaching and learning of TIA subject. As we are moving through the 21st century technology era, TIA classrooms must reflect shadow image to encourage the teaching and learning of all the strands in the subject content.

It is suggested that teachers and students could work together to ensure that this technology classroom tips could be accommodated. These are:

- Regularly keep updates on new advancements in technology.
- Ongoing Effective Evaluation on an Ongoing Basis.
- Make Technology a Treat & Not an Expectation.
- Monitor closely usage of electronic devices .
- Set ground rules for all.
- Share knowledge on how to get technical support.
- Communicate with parents.
- Familiarise yourself with the Technology First aid.
- Use of Technology by students.

These teaching and learning strategies will help teachers to;

- familiarise themselves with different methods of teaching in the classroom,
- develop an understanding of the role of a teacher for application of various methods in the classroom.

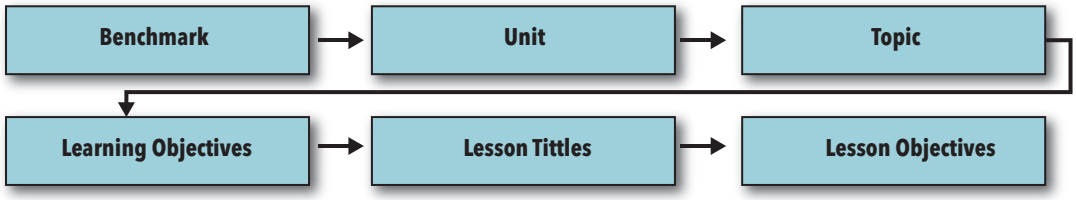
Successful teachers always keep in view that teaching must "be dynamic, challenging and in accordance with the learner's comprehension. He/she does not depend on any single method for making his/her teaching interesting, inspirational and effective".

Please find a list of the different teaching and learning strategies in the Appendix.

These strategies;

- make learning more engaging,
- make learning more effective,
- make learning fun,
- encourage higher motivational level,
- improve attention spans,
- develop higher order thinking and reflective skills,
- improve communication skills,
- develop the spirit of teamwork /collaboration,
- develop leadership skills and qualities, and
- encourage discovery learning.

Therefore, teachers are encouraged to utilise the suggested strategies as well as others.



Strands, Units and Topics

This section of the teacher guide contains the Technology and Industrial Arts: Construction Technology content to be taught in grade 9. It consists of;

- a brief explanation of how the topics, learning objectives and lesson topics are derived.
- an overview of the content distributed according to the four terms in an academic year;
- the unit of work per strand

Technology and Industrial Arts is organized around five main strands – Textiles, Food, Construction, Communication, and Computer of which Construction Technology is one strand. These strands embed the content that students are expected to learn and master at each grade and school level. National content standards are benchmarked at each grade level, which allows for essential KSAVs to be reinforced and expanded throughout the grades.

Benchmarks show grade level expectations of what students are able do to demonstrate that they are making progress towards attaining the content standard.

These grade-level benchmarks were then unpacked to identify the topics, learning objectives and the lesson topics. Below is a description of how topics were derived from the grade-level benchmarks.

Identifying topics from benchmarks

In order to identify the topic from the benchmark, we need to unpack the benchmark. When we unpack a benchmark, we are identifying what students will know and be able to do when they have mastered the benchmark.

1. Write out the benchmark that you want to unpack.
2. Write the verbs (skills/actions) – Higher order thinking skills
3. Underline or highlight the big idea (content) in the benchmark. The big idea (content) is the topic derived from the benchmark.
4. Write essential questions that would be engaging for students
5. Develop sub-topics from the big idea (topic)
6. Write learning objectives according to the sub-topics
7. Write lesson Topics from the learning objectives

Content Overview

The teaching and learning of Construction Technology in Grades 11 will follow the outline of content for the four terms in a year as a strand within the Technology and Industrial Arts.

This is only a sample to guide teachers as to how they are going to plan and teach the five strands in Technology and Industrial Arts in a school year.

TERM	STRAND	UNIT	CONTENT STANDARD
1	**Textiles Technology**	Fibres and Fabrics	**CS1.1** Investigate the evolution, characteristics, designs and trends of fabrics and fabric designs, their construction, production, representation, regulation and marketing.
		Textiles and Clothing	**CS1.2** Integrate and apply principles and techniques in presenting fashion ideas and illustrations in pattern making and garment construction for a variety of needs and occasions.
	Food Technology	Food and Nutrition	**CS2.1** Examine and analyse the characteristics and properties of different types of food and the social, economic, political, cultural and technological influences on their production and compliance with ethical principles and standards.
		Food Science	**CS2.2** Investigate and analyse the cultural, physical, chemical, nutritional, biological and sensory characteristics of food and how they influence the development and production of food to meet different demands (eg, health, occasions, lifestyle, business).
2	**Construction Technology**	Building Technology	**CS3.1** Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.
		Electrical Technology	**CS3.2** Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.

Unit 4: Welding Technology	Topic 1: Safety in Handling Tools and Equipment	1.Safe Handling for Tools 2. Safe Maintenance and Storage Procedures 3. Mechanical Fasteners used in Welding
	Topic 2: Measurements	1. Basic Measurement 2. Application of Measurement in Print Reading 3. Application of Measurement in Layout or Fit-up Techniques
	Topic 3: Metals	1. Types of Metals 2. Preparations and use of Metals According to Job Specification
	Topic 4: Fabrication Fundamentals	1. Fundamentals of Fabrication 2. Application of Welding Processes and Techniques 3. Application of Cutting Processes and Techniques
Unit 5: Engineering Technology	Topic 1 Scope of Engineering	1. General Functions of Engineering Innovations 2. Types of Innovations 3. Product Designs 4. Manufacturing Processes
	Topic 2: Engineering Materials	1. Properties of Materials 2. Engineering Materials 3. Engineering Tools and Equipment.
	Topic 3: Problem Solving Engineering	1. Architectural Basics 2. 3D Sketching 3. Comparison of the Engineering Design and Scientific Method 4. Graphical Methods
	Topic 4: Graphic Techniques	1. Graphics Communication 2. Elements of Graphics Communication 3. Drawing Formats and Elements 4. Graphics Applications
	Topic 5: Planning and Management Skills	1. Analytical Thinking 2. Teamwork and Clear Communication 3. Leadership Skills 4. Organisational Skill
	Topic 4: Engineering Applications	1. Engineering Applications 2. Engineering Innovations 3. Impacts of Engineering Innovations on Society

Unit 1: Building Technology

Unit	Topics	Lesson Titles
1.Building Technology	Topic 1. Building Project Management	1. Building Project Management 2. Types of Project Management 3. Building Project Process and Procedure 4. The Role of Project Manager
	Topic 2. Building Materials and Specification	1. Types of Building Materials 2. Timber Building and Specifications 3. Methods of Processing Timber 4. Types of Timber Used 5. Brick wall Building and Specifications 6. Types of Bricks Used 7. Concrete Building and Specification 8. Methods of Mixing Concrete 9. Steel Building Structure and Specification
	Topic 3. Trade Drawing Application using CAD program	1. Surface Development 2. Types of CAD Program or Free CAD 3. Using CAD Program. 4. Methods of Downloading and Installing CAD Program 5. Methods of Sketching Domestic Building-Gable Roof.
	Topic 4. Health and Safety Practices with Building Materials	1. Safety Methods of using Timber in Framing 2. Safety Methods of Handling Bricks During Construction 3. Safety Methods of Mixing Concrete 4. Safety Methods Handling Steel in Construction
	Topic 5. Building Procedures and Processes	1. Building Construction Process, Plan-Construction 2. Types of Building Plan 3. The Role of the Builder 4. The Role of Architect and Draftsman
	Topic 6. Building Costs Estimation	1. Building Costs Estimation 2. Methods of Estimating Building Costs 3. Method of Preparing Material List and Quotation 4. The Role of Building Estimator

Grade 11

Construction Technology

Teaching Content

UNIT 1. Building Technology

Content Standard 3.1. Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.

Benchmark 11.3.1.1 Explore and analyse the main fundamental of building project management

Topic 1: Building Project Management

Learning Objectives

By the end of this topic, the students will be able to;

1. Analyse the types of building project management.
2. Apply the building project processes and procedures.

Essential Questions:

1. What is building project management?
2. What are the types of building project management
3. What are the methods used or applied on building project management processes and procedures?
4. What is the role of a project manager?

Essential Knowledge, Skills, Values and Attitudes:
Knowledge: Fundamental of building project management
Skills: Explore and analyse the main concepts of building project management.
Values: Value **the** importance project management processes in a building.
Attitudes: Be adaptable to change

Content Background

Building project management is the basic knowledge on which every construction project is founded. Construction project management could be defined as the administering the project by following direction, regulation, and supervision of a project from early development to completion. The ultimate goal of construction project management is the full satisfaction of the client's demands for a viable project both in terms of functionality and budget.

Building project management is the key to the stability of the whole procedures. A construction project manager has to obtain a variety of skills and competences in order to navigate through the project and to establish a functional connection with the numerous teams. In this topic we would be exploring the definition of project management, apply the basic of building process and procedures and the major roles of project manager.

The ultimate goal of construction project management is the full satisfaction of the client's demands for a viable project both in terms of functionality and budget.

Types of Building Project Management

The types of building construction projects management that are involved in administering the particular project varies according to the nature of the project.

Construction management is a professional service that provides a project's owner(s) with effective management of the project's schedule, cost, quality, safety, scope, and function. Construction management is compatible with all project delivery methods. No matter the setting, a Construction Manager's (CMs) responsibility is to liaise with the owner and to be successful in completion of project.

At its core, a capital project is made up of three parties (excluding the CM):

• The owner, who commissions the project and either funds the project directly or finances it through a variety of methods.

• The architect/engineer, who designs the project.

• The general contractor, who oversees day-to-day operations and manages subcontractors.

There are four main types of construction projects;

- Private construction project,
- Residential construction,
- Commercial construction
- Industrial construction.

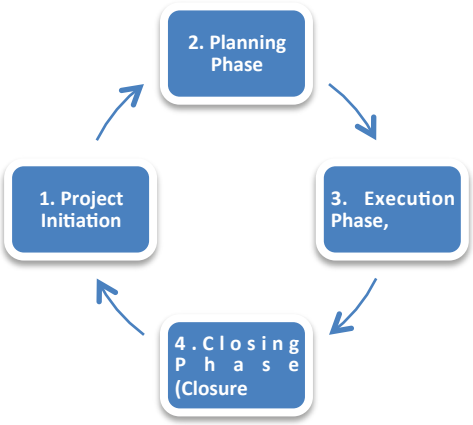
i. Private Construction Projects; The private construction projects are projects of every type that are owned, controlled or commissioned by a private party. Private parties include individuals, homeowners, corporations, other business entities, non-profit associations, privately funded schools, hospitals, publicly traded companies, etc. Anything, in other words, that is operating without the harm of the government.

ii. Residential Construction; Whenever, construction work is being performed to a single-family residence or a residential facility with (usually) less than 3 or 4 units. If you are working on an apartment complex this would more likely be considered a commercial project instead of a residential project. Similarly, if you are working at a condominium, the work would be residential if upon a single unit, but if on the entire complex or the common elements, the work would be more likely be considered as commercial.

iii. Commercial **Construction**; Commercial construction is the construction of any buildings or similar structures for commercial purposes. Commercial construction includes a huge variety of projects including building restaurants, grocery stores, skyscrapers, shopping centers, sports facilities, hospitals, private schools and universities, etc.

iv. Industrial Construction; this is a relatively small segment of the construction industry. These projects include power plants, manufacturing plants, solar wind farms, refineries, etc. While termed "industrial construction," it is pretty interchangeable with "commercial construction."

Building project management process and procedures: is a process or cycle where the project manager has initiated a plan and developed a plan of project after the successful bidding process is over and it's time for all the people involved in the project to execute the plan to reality**.** This structure could be outlined into four basic stages:



1. Project Initiation; during the first phase, the objective and the feasibility of the project are determined. This is a crucial stage of the whole process, since it can indicate whether this project is a good opportunity or not. If necessary, a feasibility study is conducted and based on its results a recommended solution/plan is issued.
Once everything is decided, a project initiation document (PID) is created. The project initiation document provides the groundwork for the construction plan and is one of the most vital stages in project management.

2**. Planning Phase.** The project planning stage is where the team singles out all the work to be done. It's an ongoing activity almost to the end of the project. The main priority, during the planning phase, is to **plan time**, **costs** and **resources** for the project. Based on those requirements the team is developing the strategy that has to be followed. This is also known as **scope management**. Another important document that has to be prepared is a **work breakdown structure (WBS**), a checklist that divides all the necessary work into smaller more functional categories.

3. Execution Phase. In the execution phase, the construction project management plan is put to work. As a rule, this phase is divided into three main processes: the **executing** and the **monitorin**g and **controlling**. The project team makes sure that the required tasks are being performed. At the same time, progress is monitored and changes are being made accordingly.

4. Closing Phase (Closure). The final stage of the project represents its official completion. The project manager is **evaluating** what went well and refers to any potential failures. In the end, the team conducts a project report, calculates the final budget and offers information about any tasks that remain unfinished. The project report in combination with the analysis of the

potential failures will be valuable feedback for future construction projects. **Project Scheduling:** Reliable scheduling can eliminate many risks that may come up during a construction project.
Coursera,(2023)Guide to Construction Project Management, Retrieved on May 2023 https://www.coursera.org.articles/construction-project-management

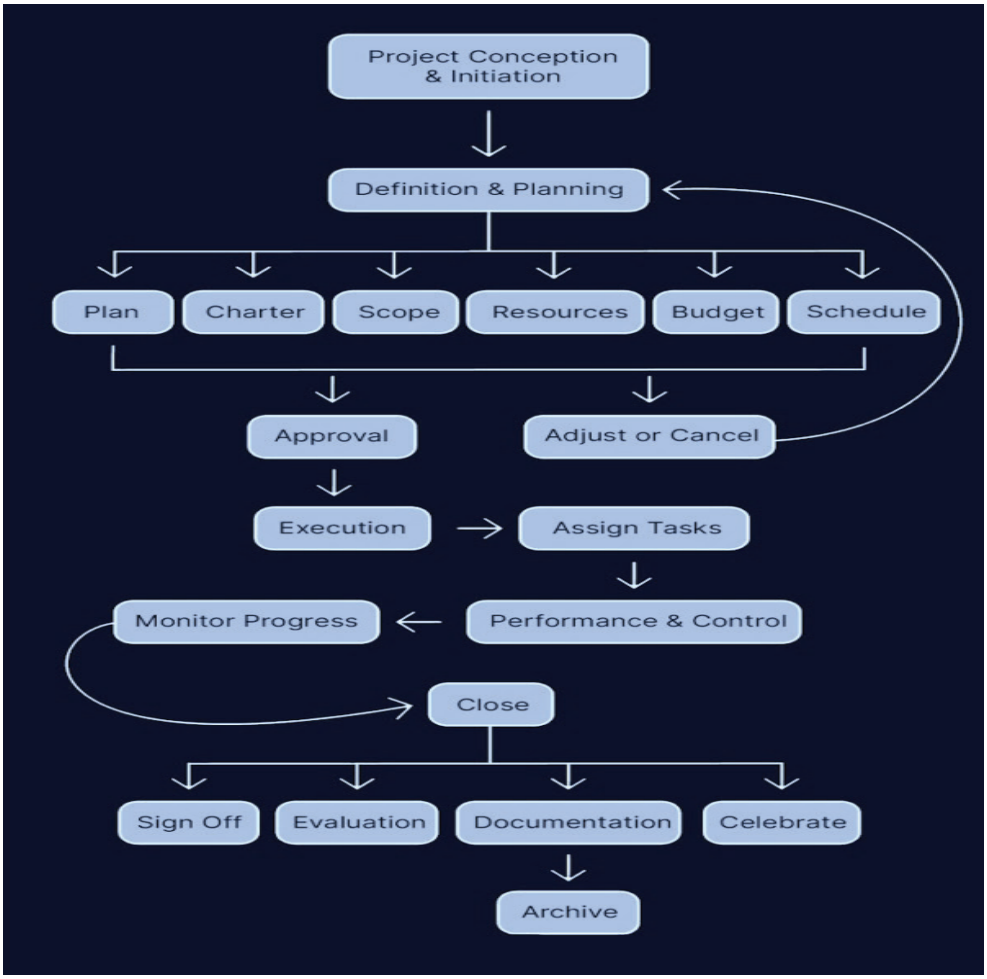


Figure 1.1a The project management process flow chart to see the progression of work in each stage. Source: https://www.projectmanager.com/blog/sample-project-management-flow-chart

1) The roles and responsibilities of the project manager

The project manager's role and responsibility extend beyond making small and large decisions and controlling risk. Below are the methods used by Project managers to execute projects.

i. Create the big idea

Even the basic structure of a project will not be clear when it is born. The Project manager is responsible for developing the big idea. The project manager should be able to identify an idea and get involved at the very beginning of the project. Next, develop a complete business case and then turn it into a project plan. The Project manager manages them all, starting from scratch and imagining the feasibility of execution.

ii. Get the team together

Once the idea is feasible, the Project manager will form a team to turn it into reality. It will be impossible to hire members every time, so it is up to the project manager to coordinate and get the resources available.

iii. Coordinate and organise the plan

When the team is in its initial stages, the Project manager helps the members of the team to clearly define their tasks. By defining the work, he ensures that everyone in the team is clear about the goals and objectives. This can be expressed in terms of business benefits or business value. In other words, it is important to explain why you are starting this new work.

iv. Lead the team

The project manager will bring the team together once everyone is clear about the benefits. He is the leader of the team and aims to achieve success together. It is not an easy task to lead a team. One must be able to negotiate the difficulties of conflict and disagreements and stay on top of all communications. To do a great job even in difficult times, he must coordinate and motivate the team.

Project managers are responsible for mentoring, coaching, developing, and training the team members. The Project manager must recognise and address the strengths and weaknesses of the team to be able to lead them. For smooth project execution, he can use online tools for project management or face-to-face team meetings. This image is taken from the digital project administration. It shows the methods of project management.

v. Managing the expense

Executing a project costs money. Project managers must be able to budget effectively. These methods will help project managers manage money and control costs. This is how project managers can achieve this:

- Estimates that include the costs of the project and the resources needed.
- The project manager must work closely with the field experts to ensure that the estimate is complete and accurate.
- To calculate the project budget, you will need to use all data and estimates.
- After the finalised project budget has been approved, the Project Manager will explain it to the customer. This will make sure that they understand all aspects of the budget.
- The Project manager must be vigilant in project management, comparing expenditures to estimates. The Project manager's efficiency is determined by his ability to control costs and stick to the budget.

vi. The decision power

The Project manager is responsible for all major decisions. The Project manager has the power to make decisions, whether it is through suggestions, recommendations, or demand. The Project manager's negotiation skills and persuasive ability are essential for customer approval of decisions. The Project manager engages with stakeholders by working closely with them to ensure they are aware of the changes and plan accordingly. The project manager's experience and focus are essential to these skills.

vii. Deliver the goals committed

The ultimate goal of the team is to deliver the project on time. The project manager makes sure that it happens by being accountable. The success of the project manager is determined by his ability to deliver on the promises. The project manager can control the deliverables by having a checklist and assessing it using the assessment of works completed versus works committed. It is important to have strong leadership, good planning, and the ability to see every detail.

The diagram below is the summary of the role of a Project Manager:

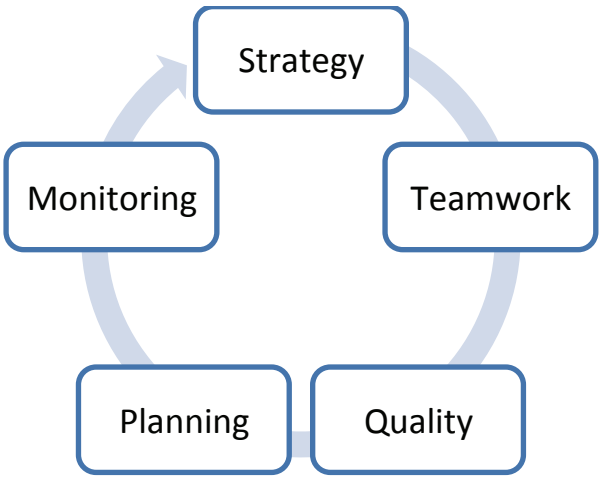


Figure 1.1 b. Roles of Project Manager
Source: https://activecollab.com/blog/project-management/project-manager-roles-and-responsibilities

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get to explain building project management. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Building Project Management

Lesson Objective: Students will be able to:
1. Define building project management and its other associated terminologies.
2. Research and analyse the other terminologies used in building project management flow chart and processes.

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
• Project Management	Research and analysis of project management processes and procedures.	Appreciate	Rationality. Be open minded in directing and organising each part of a project life from ideation to completion.

Teaching Strategies
Students engage in brainstorming exercise to discover the definitions of building project management and explain the functions and principals of building project management.
They are then allowed to design guiding questions that will enable them to conduct research on the definitions of building project management.
Discussions in groups on the research findings.

Learning Strategies
Be involved in brainstorming exercise to discover definitions of building project management and other terminologies used on building management flow chart.

Teacher	Students
Introduction	
Pose the question for discussion. What is a building project in general?	General discussions on building projects.
Body	
Modelling	
Activity 1 Discuss all types of projects that can be undertaken in construction.	Do brainstorming activity
Guided Practice	
Activity 2 Plan and carry out Research activity.	Conduct research
Independent Practice	
Activity 3 Group Presentation of research activity on project management.	Group presentation

Conclusion	
Conclude lesson with main concepts being explained.	Take lesson notes
Assessment	
Assess the research and presentation activity.	Complete assessment task.

Resources

1. Flowcharts of project management
2. Library resources

Lesson 2: Types of Project Management

Teaching Strategies
Engage students in brainstorming exercise on the types of building project management.
Engage students in the discussion of different types of building project management.

Learning Strategies
Discover types of building project management

Activity 1 Brainstorming activity on the four types of building project management.
Activity 2 Conduct research on four types of building project management and their descriptions.
Activity 3 Discussions and presentation of research findings on the four types of building project management and their descriptions.

Resources
Types of building project management tutorials
Library books, construction project management books

Lesson 3: Building Project Process and Procedure

Teaching Strategies
Engage students in brainstorming of building project processes and procedures.
Engage students in the discussion of the building project processes and procedures.

Learning Strategies

Activity 1 Brainstorming activity on building project processes and procedures.
Activity 2 Conduct research on building project processes and procedures.
Activity 3 Discussions and presentation of research findings on building processes and procedures.

Resources
Building project process and procedure tutorial
Library books, construction project management books

Lesson 4: The Role of Project Manager

Teaching Strategies
Teachers Introduces students the roles of project manager.
Engage students in the discussion and brain storming on the role of project manager.

Learning Strategies
Conduct a research with guiding questions that will lead to discovering what the roles of project manager.
Activity 1 Brainstorming activity on the roles of project manager.
Activity 2 Conduct research on the roles of project manager.
Activity 3 Discussions and presentation of research findings the roles of project manager.

Resources
The role of project manager tutorial
Library books, construction project management books

STEAM Activity Teacher to identify and provide a project (building plan of 3m high and 20m long brick wall) and divide the project into parts (eg; concrete making, digging and laying of footer, brick laying and welding). Divide students into each part groups to research and present how they will manage their part, avoiding potential errors, be cost wise and state or discuss the STEAM involved.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to analyse the Introduction to Building project management process and procedures. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

Define building projects management
Analyse the types of project management
Apply the building project process and procedure
Define the role of project manager

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
Define building projects management	Correctly and accurately define and explain building projects management	Correctly define building projects management	Partially define building projects management	Cannot define building projects management

Analyse the types of project management	Correctly and accurately analyse and explain the types of project management	Correctly analyse the four types of project management	Partially analyse the two types of project management	Cannot analyse one the types of project management
Apply the building project process and procedure	Correctly and accurately apply correctly the building project process and procedure	Correctly apply the building project process and procedure	Partially apply few of the building project process and procedure	Cannot apply correctly the building project process and procedure
Define the role of project manager	Correctly and accurately define correctly the role of project manager	Correctly define the role of project manager	Partially define the role of project manager	Cannot define the role of project manager

UNIT 1. Building Technology

Content Standard 3.1 Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.

Benchmark 11.3.1.2 Investigate and analyse appropriate materials and their specifications in building.

Topic 2: Building Materials and Specification

Learning Objectives

By the end of this topic, the students will be able to;

1. Analyse the types of building materials, their specifications and methods of processing.

Essential Questions:

1. What are the building materials?
2. What are the types of building material used?
3. What are the suitable specifications and measurements that are used?

Essential Knowledge, Skills, Values and Attitudes:
Knowledge: Building materials and specification
Skills: Analyse and define building materials and their specifications.
Values: Consideration of the construction task and building materials.
Attitudes: Open minded and appreciative of the knowledge gained in describing products, materials and work required by construction task.

Content Background

Building materials and specification
There are many different types of building materials that are used in the building of various structures. In this topic we will identify their names, correct shapes and sizes (depending on their particular purposes in construction and specification.

Types of building materials; The types of building materials that are used in construction such as timbers, masonry, concrete, steel material,(PVC) material use to build various structures. In these materials we will extremely discover the names and their uses, specifications that are applied on building structures. The main types of materials used in constructions are; timber, masonry, concrete, steel materials, (PVC) materials.

The types of building materials used in building are;
- Timber materials;

- Masonry materials;
- Concrete materials;
- Steel materials;
- (PVC)) polyvinyl chloride materials;

Timber building materials and specification: Timber building materials and specifications are the materials that are made of wood or logs that are used to construct building structures. They come in different sizes, shapes and specifications. For an instance, post/stumps are used on building to carry load from above structures with the correct standard sizes, 150mm x 150mm, bearer is 150mm x 75mm, floor joist sizes, studs, trimmer, etc.

Timber materials	Descriptions	Sizes
Substructure materials	Materials used on foundation Reinforcement rods, mesh wire footings, etc.	Minimum,500mm-700mm depth with reinforcements required
Superstructure(wall-framing, roof framing)	Materials used on wall/roof framing, (studs, noggings, trimmer rafters etc.)	Wall frame;75x50mm, Rafters 150x50 mm
Door framing/Window framing	Door jam, Window mullion	150x38mm
Stairs construction	Materials used on steps, stairs,	150x50mm

Note: Detail Specification of the names for each members of the building structure from foundation to the roof on timber house model should be taught and demonstrated

Methods of processing timber; the methods of processing timbers are the processes that are involved in producing timbers from the raw materials (tree/logs) to the finished product (timbers).

Step 1: Felling of Trees
To get timber, the trees are cut down or caused to fall to the ground. This is known as the felling of trees. Considerations to consider when felling trees are;
1.1 Age of Trees for Felling
1.2 Methods of Felling
1.3 Season for Felling

Step 2: Seasoning of Timber
When a tree is newly felled, it contains about 50per cent or more of its own dry weight as water. This water is in the form of sap and moisture. The water is to be removed before the timber can be used for any engineering purpose. In other words the timber is to be dried.
2.1 Meaning of Seasoning
2.2 Free Moisture and bound Moisture
2.3 Determination of Moisture Content
2.4 Objects for Seasoning
2.5 Methods for Seasoning
2.6 Comparison of Natural and Artificial Seasoning
2.7 Classification of Timbers for Respect to Seasoning

Step 3: Conversion of Timber
The process by which timber is cut and sawn into suitable sections is known as the conversion. There are important facts in connection with the conversion of timber to be remembered.

Step 4: Preservation of Timber
4.1 Objects from of preservation of timber
4.2 Requirements of a good preservative
4.3 Types of preservatives
4.4 Methods for preservation for timber

Below is the cycle of processing timbers;

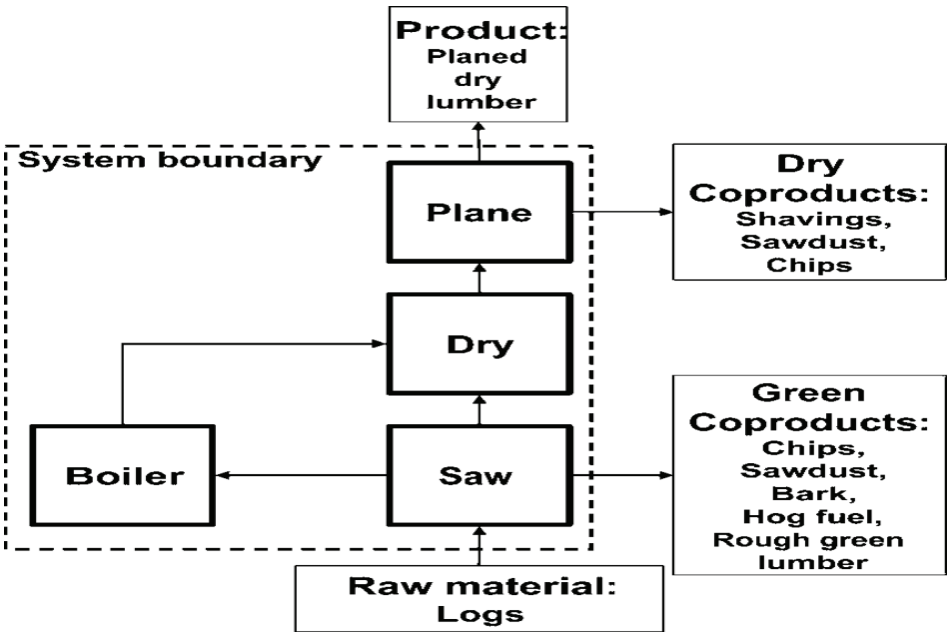


Figure 1.2a Cycle of processing timber
Source: https://www.engineeringenotes.com/engineering-materials-2/timber/varieties-or-types-of-industrial-timber-materials-engineering/46720

Types and sizes of timbers used in building

The types and sizes of timbers used in the building are determined by the purpose used in the building. The types of timbers that are used in wall framing is 100mm x50,75mmx50, whilst the timbers used on roof framing would be 100x50,buttens sizes used are,75x38mm. The types and sizes of the timbers used in building vary according to the load that they are carrying. All the specifications would be identified from the building plan (Blue Print).

Types of Brick wall Building and their specification

The brick wall buildings or structures that are built using bricks masonry with the correct sizes and specifications. The foundations bricks that are laid would be different compared to the bearing walls, beams.

There are two types of brick masonry works;

1. Brick Work in Mud
2. Brick Work in Cement

Brick masonry is a highly durable form of construction. It is built by placing bricks in mortar in a systematic manner to construct solid mass that withstand exerted loads. There are several types of bricks and number of mortars which can be used to construct brick masonry.

The bond in brick masonry, which adhere bricks together, is produced by filling joints between bricks with suitable mortar. Special cautions shall be practiced while mortar is mixed and placed since it greatly affects the performance and durability of masonry structure.

1. Brick Work in Mud

- The mud is used to fill up various joints brick masonry work.
- Thickness of the mortar joint is 12 mm.
- it is the cheapest type of brick masonry
- Employed for construction of walls with maximum height of 4 m.

Figure 1.2b : Brick work in mud
Source: https://theconstructor.org/building/brick-masonry-definition-types-construction/25916/

2. Brick Work in Cement

This type of brick masonry is construction by laying bricks in cement mortar rather than mud which is used in brick work in mud. There are three major classes of brick work in cement which are summarised in Table 1.

Table 1 Different classes of brick work in cement and their descriptions

Classes	Descriptions

First Class	1. Cement of lime mortar is used. 2. The surface and edges of bricks are sharp. 3. And the thickness of mortar joints doesn't exceed 10mm.
Second Class	1. Ground molded bricks are used. 2. Bricks are rough and shape is slightly irregular. 3. The thickness of mortar joint is 12 mm.
Third Class	1. Bricks are not hard ,rough surface with distorted shape. 2. Used for temporary structures. 3. Used in places where rainfall is not heavy.

Figure 1.2c: Brick work in cement
https://theconstructor.org/building/brick-masonry-definition-types-construction/25916/

There are different types of brick used in the construction of brick masonry which include:

- Common burnt clay bricks
- Concrete bricks
- Sand lime bricks (Calcium Silicate Bricks)
- Fly ash clay bricks
- Engineering bricks
- Other brick types include bullnose, channel, coping, cow nose and hollow bricks.

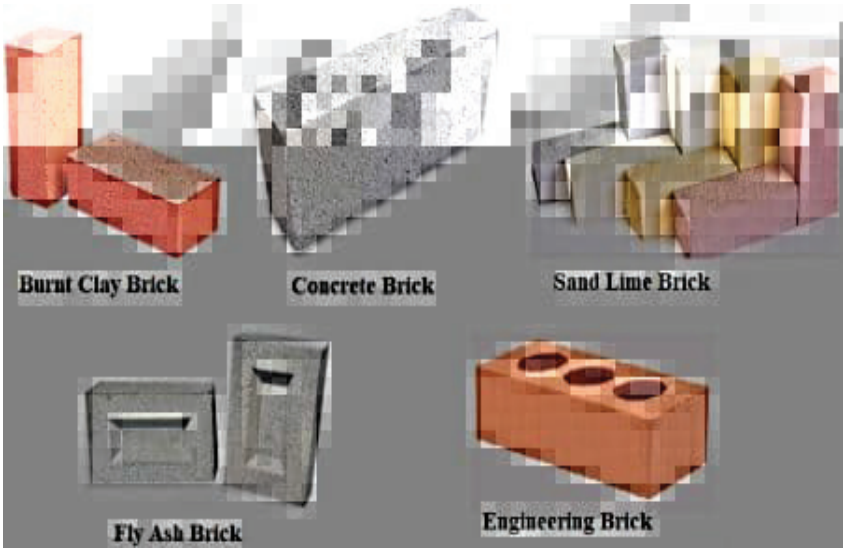


Figure 1.2d. Types of masonry bricks
Source: https://theconstructor.org/building/brick-masonry-definition-types-construction/25916/

Concrete materials; concrete is a building material made by mixing cement paste (Portland cement and water) and aggregate (sand and stone). The cement-paste is the "glue" which binds the particles in the aggregate together. The strength of the cement-paste depends on the relative proportions of water and cement; a more diluted paste being weaker. Also the relative proportions of cement-paste and aggregate affects the strength; a higher proportion of the paste making stronger concrete. The concrete hardens through the chemical reaction between water and cement without the need for air. Once the initial set has taken place concrete cures well under water. Strength is gained gradually, depending on the speed of the chemical reaction

Methods of mixing concrete: The methods of mixing concrete is the process of mixing cement powder, aggregates and water to any form of structures. The common ratios to mix concrete on domestic building foundations with the reinforcement attached as follows; 1:2, 2:4, 4:8 etc., the ratio simply explain as 1:2, one scope of cement powder and two scopes of aggregates using shovel or buckets (10mm diameter). The ratio to be used on any structure would be specified from the drawing or building Plan.

Properties of Concrete: Concrete is associated with high strength, hardness, durability, imperviousness and mouldability. It is a poor thermal insulator, but has high thermal capacity. Concrete is not flammable and has good fire resistance, but there is a serious loss of strength at high temperatures. Concrete made with ordinary Portland cement has low resistance to acids and sulphates but good resistance to alkalis.

Compressive strength is measured by crushing cubes having 15cm per side. The cubes are cured for 28 days under standardized temperature and humidity and then crushed in a hydraulic press. Characteristic strength values at 28 days are those below which not more than 5% of the test results fall. The grades used are C7, C10, Cl5, C20, C25, C30, C40, C50 and C60, each corresponding to a characteristic crushing strength of 7.0, 10.0, 15.0 N/mm2, etc.

Table Suggested *Use for Various Concrete Grades and Nominal Mixes*

Grade	Nominal mix 1:3:8 Cement: Aggregate: Water	Use
C7 C10	1:3:8 1:4:6 1:3:6 1:4:5 1 :3:5	Strip footings; trench fill foundations; stanchion bases; non reinforced foundations; over site concrete and bindings under slabs; floors with very light traffic; mass concrete, etc.
Cl5 C20	1:3:5 1:3:4 1:2:4 1:3:3	Foundation walls; basement walls; structural concrete; walls; reinforced floor slabs; floors for dairy and beef cattle, pigs and poultry; floors in grain and potato stores, hay barns, and machinery stores; septic tanks, water storage tanks; slabs for farm yard manure; roads, driveways, pavings and walks; stairways.
C25 C30 C35	1:2:4 1:2:3 1:1.5:3 1:1:2	All concrete in milking parlours, dairies, silage silos and feed and drinking troughs; floors subject to severe wear and weather or weak acid and alkali solutions; roads and pavings frequently used by heavy machinery and lorries; small bridges; retaining walls and dams; suspended floors, beams and lintels; floors used by heavy, small-wheeled equipment, for example lift trucks; fencing posts, precast concrete components.
C40 C50 C60		Concrete in very severe exposure; prefabricated structural elements; pre-stressed concrete.

Steel/Metal building materials; the steel/metal building materials are materials that are used on building structures using metal/steel. Most of these metal/steel materials come in different types, names, shapes, sizes and specifications. All these materials are utilised and served in various purposes in the building structure. The types of metals would be used depends on the plan specification.

PVC/ Rubber materials; are the materials that are made from rubber (PVC) polyline vinyl Chlorine are materials like PVC pipes and fittings, poly pipes and fittings, conduit pipes. Most of these materials are used by plumbers, electricians, for connecting water system, cable wiring for electricity etc**.**

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of building technology. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way

that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Types of Building Materials

Teaching Strategies
Engage in brainstorming exercise to discover types of building materials.
They then are allowed to design guiding questions that will enable them to conduct research on different types of building material used and their specification.
Discussion in groups on the research findings.

Learning Strategies
Activity 1 Brainstorming activity on the types of building materials used.
Activity 2 Conduct research on the types of building materials used and specifications.
Activity 3 Discussions and presentation of research findings.

Resources
Types of building materials tutorials
Building Construction Text books,

Lesson 2: Timber Building and Specifications

Teaching Strategies
Engage in brainstorming exercise to discover timber building and specifications.
They then are allowed to design guiding questions that will enable them to conduct research on different types of timber building and specifications.
Discussions in groups on the research findings.

Learning Strategies
Identify types of timbers used in building with their correct sizes.
Types of timbers used in foundation, bearers, floor joist, wall framing, roof framing, stairs, veranda.

Activity 1 Brainstorming activity the types of timbers used in foundation, bearers, floor joist, wall framing, roof framing, stairs, and veranda.
Activity 2 Conduct research on types of timbers used on foundation, bearers, floor joist, wall framing, roof framing, stairs, veranda.
Activity 3 Discussions and presentation of research findings.

Resources
Timber building and specification tutorial
Building Construction books,

Lesson 3: Methods of Processing Timber

Teaching Strategies

Engage in brainstorming exercise to discover methods of processing timber.

They then are allowed to design guiding questions that will enable them to conduct research on methods of processing timber from logs/wood to finished product.
Discussions in groups on the research findings.

Learning Strategies
Activity 1 Brainstorming activity methods of processing timber.
Activity 2 Conduct research on methods of processing timber.
Activity 3 Discussions and presentation of research findings.

Resources

Methods of processing Timber tutorial
Carpentry Text books

Lesson 4: Types of Timber Used

Teaching Strategies

Engage in brainstorming exercise to discover types of timbers used in building structure.
They then are allowed to design guiding questions that will enable them to conduct research on different types of timbers used in building.
Discussions in groups on the research findings.

Learning Strategies
Conduct a research with guiding questions that will lead to discovering what types of timbers used in building.

Activity 1 Brainstorming activity on the types of timbers used in building.
Activity 2 Conduct research on types of timbers used in building.
Activity 3 Discussions and presentation of research findings.

Resources
Types of timbers used in building tutorial
Building text books

Lesson 5: Brick Wall Building and Specifications

Teaching Strategies
Students engage in brainstorming exercise to discover brick wall building and specification.
They then are allowed to design guiding questions that will enable them to conduct research on different types of bricks that are used in building.
Discussions in groups on the research findings.
Teachers introduce students to the types of bricks, blocks and measurements.

Learning Strategies
Conduct a research with guiding questions that will lead to discovering types of bricks or blocks and how they are made**.**

Activity 1 Brainstorming activity on brick wall building and specification.
Activity 2 Conduct research on brick wall building and specification.
Activity 3 Discussions and presentation of research findings.

Resources
Brick wall building tutorial and demonstration of making Brick/blocks in the workshop.
Masonry text books

Lesson 6: Types of Steel Material Used

Teaching Strategies
Students engage in brainstorming exercise to discover types of steel material used in building.
They then are allowed to design guiding questions that will enable them to conduct research on different types of steel material used in building.
Discussions in groups on the research findings.
Teachers introduce students to the types of steel material used in building.

Learning Strategies
Conduct a research with guiding questions that will lead to discovering types of steel material used in building.

Activity 1 Brainstorming activity types of steel material used in building.
Activity 2 Conduct research on types of steel material used in building.
Activity 3 Discussions and presentation of research findings.

Resources

Steel structure text books

Lesson 7: Concrete Building and Specification

Teaching Strategies

Students engage in brainstorming exercise to discover **c**oncrete building materials and specification.
They then are allowed to design guiding questions that will enable them to conduct research on concrete building and specification.
Discussions in groups on the research findings.

Teachers Introduce students on concrete building and specifications

Learning Strategies
Conduct a research with guiding questions that will lead to discovering what the terms and identify concrete building structures**.**

Activity 1 Brainstorming activity on concrete building and specification.
Activity 2 Conduct research on concrete building and specification.

Activity 3 Discussions and presentation of research findings.

Resources
Concrete Building and specification tutorial and sight scene on concrete building structure

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Lesson 8: Methods of Mixing Concrete

Teaching Strategies

Students engage in brainstorming exercise to discover the different methods of mixing concrete.
They then are allowed to design guiding questions that will enable them to conduct research on different methods of mixing concrete.
Discussions in groups on the research findings.

Learning Strategies

Conduct a research with guiding questions that will lead to discovering the different methods of mixing concrete.

Activity 1 Brainstorming activity on methods of mixing concrete.
Activity 2 Conduct research on methods of mixing concrete.
Activity 3 Discussions and presentation of research findings.

Resources

Methods of mixing concrete tutorial and practical lesson on mixing concrete in the workshop
Concrete Books, Masonry text books

Lesson 9: Steel Building Structure and Specification

Teaching Strategies

Students engage in brainstorming exercise to discover steel building structure and specification.
They then are allowed to design guiding questions that will enable them to conduct research on steel building structure and specification.
Discussions in groups on the research findings.
Teachers introduce students steel building structures and specification.

Learning Strategies
Conduct a research with guiding questions that will lead to discovering how steel building structures are constructed.

Activity 1 Brainstorming activity on steel building structure and specification.
Activity 2 Conduct research on steel building structure and specification.
Activity 3 Discussions and presentation of research findings.

Resources

Steel building structure and specification tutorial and practical lesson on how steel materials are used in construction.
Metal text books

STEAM Activity Students work in groups to design and build a model of steel building structure hip Roof or gable roof. They are also to identify and explain the STEAM involved in building the model.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to analyse building materials and specification. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Analyse the types of building materials
2. List and describe timber building members and specification
3. Apply methods of processing timber.
4. Identify types and sizes of timbers used in building.
5. Identify types of brick wall building and their specification.
6. Apply correct methods of mixing concrete.
7. Identify types the steel building structure with correct specifications

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. State building materials and specification	Accurately state building materials and specification	Correctly state building materials and specification	Partly state building materials and specification	Cannot state building materials and specification
2.Apply methods of processing timber	Correctly apply methods of processing timber	.Apply methods of processing timber	Partially apply methods of processing timber	Cannot correctly apply methods of processing timber
3.Identify correctly the types of steel building structure with correct specifications	Accurately identify correct types of steel building structure with correct specifications	Correctly identify types of steel building structure with correct specifications	Partially identify types of steel building structure with correct specifications	Difficult to identify types of the steel building structure with correct specifications
4. List and describe timber building members and specification	List and describe correct timber building members and	List and describe timber building members and specification	List and describe few timber building members and specification	Difficult to list and describe timber building members and specification

	specification			
5.Types of brick wall building and their specification	Identify and apply correctly types of brick wall building and their specification	Identify types of brick wall building and their specification	Identify few types of brick wall building and their specification	Identify one type of brick wall building and their specification
6.Apply correct methods of mixing concrete	Apply correct methods of mixing concrete	Apply methods of mixing concrete	Apply wrong methods of mixing concrete	Difficult to apply methods of mixing concrete

UNIT 1. Building Technology

Content Standard 3.1 Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.

Benchmark.11.3.1.3 Apply drawing skills in surface development and intersection of solids related to project designs and specifications using AutoCAD program

Topic 3: Trade Drawing Application using CAD Program

Learning Objectives

By the end of this topic, the students will be able to;

1. Define AutoCAD or FreeCAD Program and analyse the types of AutoCAD or FreeCAD program.
2. Analyse technical drawings of surface development and intersection of solids
3. Apply correct methods of sketching/designing domestic building(Gable roof) plan

Essential Questions:

1. What is AutoCAD or FreeCAD program?
2. What are the types of AutoCAD or FreeCAD Program?
3. What are the Basic methods of using AutoCAD or FreeCAD Program?
4. How do you download and install AutoCAD or FreeCAD program
5. How do you sketch/design domestic building (Gable roof plan?)

Essential Knowledge, Skills, Values and Attitudes:
Knowledge: AutoCAD Program or FreeCAD program
Skills: Practice and apply correctly the AutoCAD or FreeCAD
Values: Appreciate and value the importance CAD
Attitudes: Designing technical drawings creatively and confidently using the CAD program.

Content Background

Development of Surfaces

In the industrial world, an engineer is frequently confronted with problems where the development of surfaces of an object has to be made to help him to go ahead with the design and manufacturing processes. For example, in sheet metal work, it plays a vital role, thus enabling a mechanic to cut proper size of the plate from the development and then to fold at proper places to form the desired objects, namely, boilers, boxes, buckets, packing boxes, chimneys, hoppers, air-conditioning ducts etc.

“The development of surface of an object means the unrolling and unfolding of all surfaces of the object on a plane.” “If the surface of a solid is laid out on a plain surface, the shape thus

obtained is called the development of that solid." In other words, the development of a solid is the shape of a plain sheet that by proper folding could be converted into the shape of the concerned solid.

Importance of Development:

Knowledge of development is very useful in sheet metal work, construction of storage vessels, chemical vessels, boilers, and chimneys. Such vessels are manufactured from plates that are cut according to these developments and then properly bend into desired shaped. The joints are then welded or riveted.

Principle of Development:

Every line on the development should show the true length of the corresponding line on the surface which is developed.

Methods of Development:

(a) Parallel-line development
(b) Radial-line development
(c) Triangulation development
(d) Approximate development

Parallel-line Method: It is used for developing prisms and single curved surfaces like cylinders, in which all the edges/generation of lateral surfaces are parallel in each other.

Radial-line Method: It is employed for pyramids and single curved surfaces like cones in which the apex is taken as centre and the slant edge or generator as radius of its development.

Triangulation Method: It is used for developing transition pieces.

Approximate Method: It is employed for double curved surfaces like spheres, as they are theoretically not possible to develop. The surface of the sphere is developed by approximate method. When the surface is cut by a series of cutting planes, the cut surfaces is called a zone

DEVELOPMENT OF SECTIONS

Develop the surfaces of the cube side 1″:

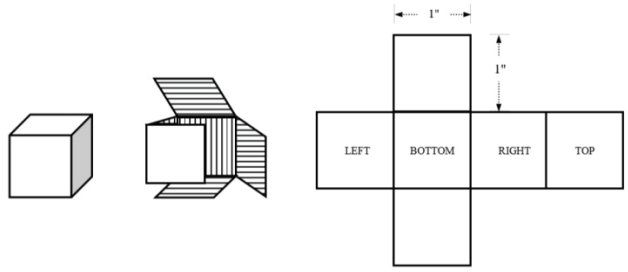


Figure 1.3a Surface of cube
Source: https://pipleyasunil.wordpress.com/development-of-surfaces/

Develop the surfaces of a triangular prism Side 1″ and Height 3″:

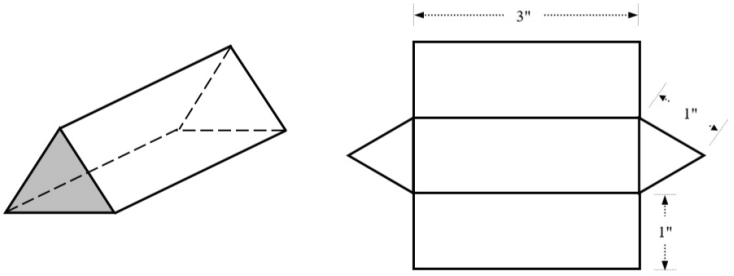
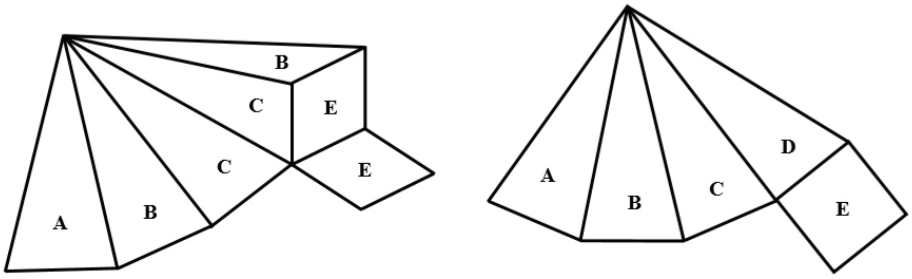


Figure 1.3b Surface of triangular prism
Source: https://pipleyasunil.wordpress.com/development-of-surfaces/

Develop the surfaces of a pyramid:



Draw the development of a cone of diameter 1.5" and inclined height of 2"

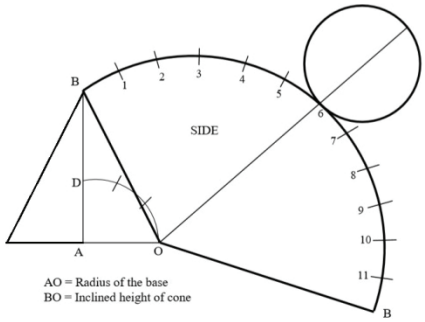


Figure 1.3c Surface of cone
Source: https://pipleyasunil.wordpress.com/development-of-surfaces/

What is intersection of solids?

Intersection of solids. when one solid penetrates another solid then their surfaces intersect and at the junction of intersection a typical curve is formed, which remains common to both solids. This curve is called curve of intersection and it is a result of interpenetration of solids.

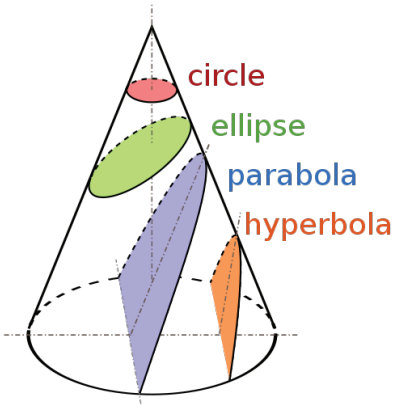


Figure 1.3d Intersection of surface
Source: https://pipleyasunil.wordpress.com/development-of-surfaces/

Finding the intersection of two surfaces is important for many Computer Aided Design tasks concerned with surface modeling. An adaptive algorithm is developed for finding the intersection curve(s) of pairs of rectangular parametric patches which are continuously differentiable

Technical specifications are prepared to provide consistency and to instruct construction contractors on how the works are to be carried out, the quality of the workmanship and methods of quality assurance for the construction. Technical specifications describe the project design and construction practices, technical standards, specifications and principles to be followed during construction. Technical specifications may specify a performance goal (a performance specification) or procedures used to meet the performance goal (design specification). A performance specification permits flexibility and change. For example, a performance specification for a feed processing system may specify that the capacity be a nominated tonnes per hour at a particular standard of quality. In general, the scope and detail of technical specifications will depend on the nature and complexity of the project. Technical specifications should form part of all construction projects. The level of adherence to the design drawings and technical specifications ultimately determines the quality of the project and influences the performance of the constructed works.

When making a multiview sketch, hidden edges and surfaces are usually shown with hidden (dash) lines.
When an object becomes more complex, as in the case of an automobile engine block, a clearer presentation of the interior can be made by sketching the object as it would look if it were cut apart. In that way, the many hidden lines on the sketch are eliminated.
The process of sketching the internal configuration of an object by showing it cut apart is known as sectioning. Sectioning is used frequently on a wide variety of Industrial drawings.
In this example, blocks A and B result after the block in figure 1.3e has been “Sectioned”. When you cut an apple in half you have sectioned it. Just as an apple can be sectioned any way you choose, so can an object in a sectional view of a drawing or sketch.

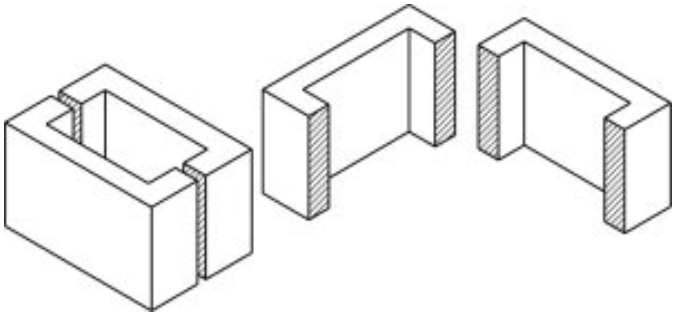


Figure 1.3e Cutting plane
Source: https://openoregon.pressbooks.pub/blueprint/chapter/unit-7-sectional-views/

Cutting Plane

A surface cut by the saw in the drawing above is a cutting plane. Actually, it is an imaginary cutting plane taken through the object, since the object is imagined as being cut through at a desired location.

Cutting Plane Line

A cutting plane is represented on a drawing by a cutting plane line. This is a heavy long-short-short-long kind of line terminated with arrows. The arrows in show the direction of view.

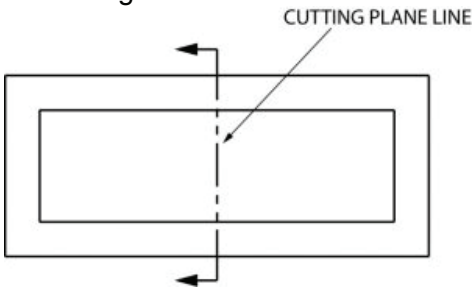


Figure 1.3f Cutting plane line
Source: https://openoregon.pressbooks.pub/blueprint/chapter/unit-7-sectional-views/

Once again, here is an graphic example of a cutting plane line and the section that develops from it.

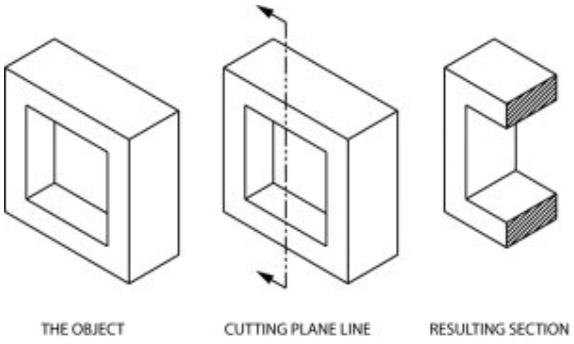


Figure 1.3g Section lining
Source: https://openoregon.pressbooks.pub/blueprint/chapter/unit-7-sectional-views/

Section Lining

The lines in the figure above, which look like saw marks, are called section lining. They are found on most sectional views, and indicate the surface which has been exposed by the cutting

plane. Notice that the square hole in the object has no section lining, since it was not changed by sectioning.

Different kinds of section lining is used to identify different materials. When an object is made of a combination of materials, a variety of section lining symbols makes materials identification easier. Here are a few examples:

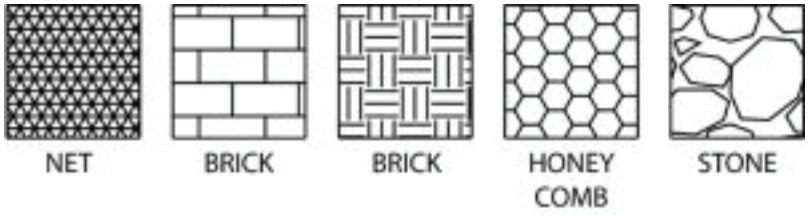


Figure 1.3h Sections line
Source: https://openoregon.pressbooks.pub/blueprint/chapter/unit-7-sectional-views/

Section lines are very light. When sketching an object or part that requires a sectional view, they are drawn by eye at an angle of approximately 45 degrees, and are spaced about 1/8" apart. Since they are used to set off a section, they must be drawn with care.
It is best to use the symbol for the material being shown as a section on a sketch. If that symbol is not known, you may use the general purpose symbol, which is also the symbol for cast iron.

Full Sections
When a cutting plane line passes entirely through an object, the resulting section is called a full section Fig. 7 illustrates a full section.

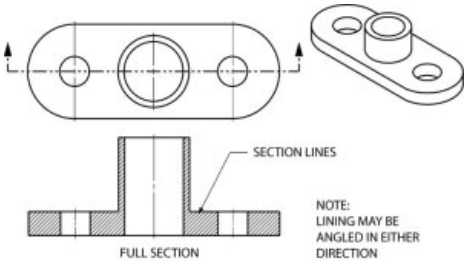


Figure 1.3i Full sections
Source: https://openoregon.pressbooks.pub/blueprint/chapter/unit-7-sectional-views/

It is possible to section an object whenever a closer look intentionally is desired. Here is an object sectioned from two different directions.

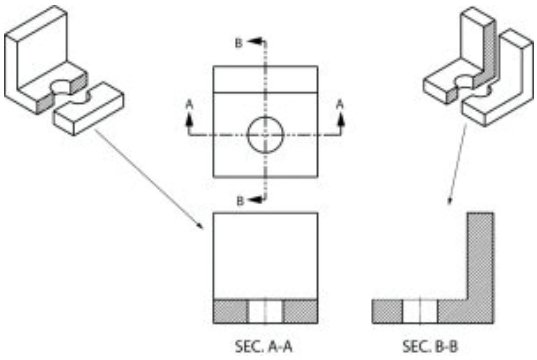


Figure 1.3j Half sections
Source: https://openoregon.pressbooks.pub/blueprint/chapter/unit-7-sectional-views/

Half Sections
If the cutting plane is passed halfway through an object, and one-quarter of the object is removed, the resulting section is a half section. A half section has the advantage of showing both inside and outside configurations.
It is frequently used for symmetrical objects. Hidden lines are usually not shown on the un-sectioned half unless they are needed for clearness or for dimensioning purposes. As in all sectional drawings, the cutting plane take precedence over the center line.

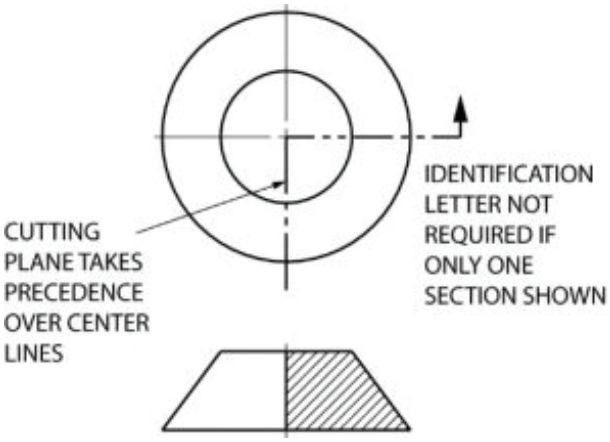


Figure 1.3k Half sections
Source: https://openoregon.pressbooks.pub/blueprint/chapter/unit-7-sectional-views/

Here is another example of a half section. Remember that only one fourth of the object is removed with a half section, whereas half of the object is generally removed with a full section.

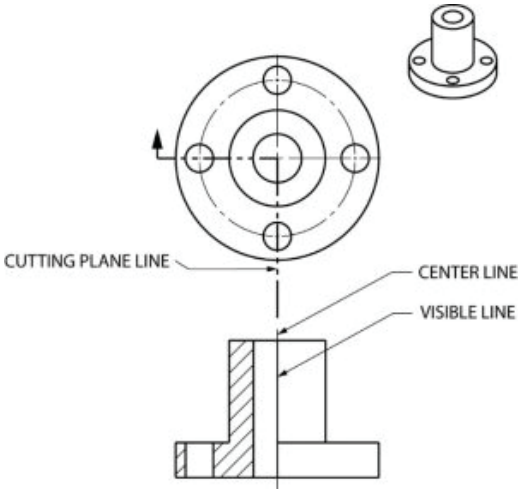


Figure 1.3l Half sections
Source: https://openoregon.pressbooks.pub/blueprint/chapter/unit-7-sectional-views/

This manufacturer's drawing, using both full and half section, illustrates the advantages of sectional views. The different line directions indicate different parts and materials used in the assembly of this valve.

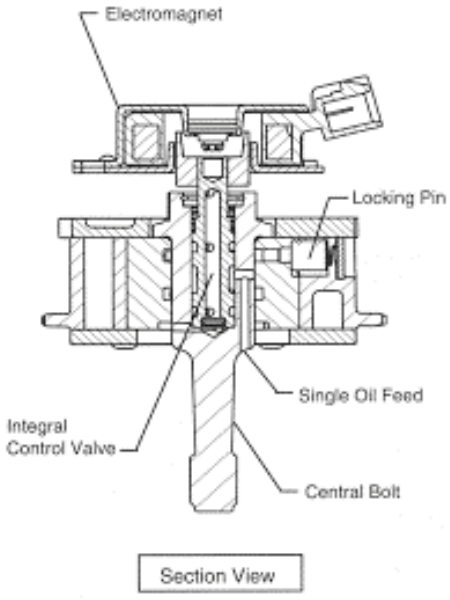


Figure 1.3m Manufacturer's drawing
Source: https://openoregon.pressbooks.pub/blueprint/chapter/unit-7-sectional-views/

AutoCAD Program

AutoCAD is a computer-aided drafting software program that enables the user to create precise 2- and 3-dimensional drawings used in construction and manufacturing. People who learn how to use AutoCAD can create scaled drawings that are used to manufacture equipment, plan infrastructure projects, design electrical circuitry, and build homes and commercial structures.

While drafters work in a number of specialties, the five most common specialisation areas are as follows: mechanical, architectural, civil, electrical, and electronics.

- Mechanical drafters prepare plans for machinery and mechanical devices.
- Architectural drafters draw up plans for residential and commercial buildings.
- Civil drafters draw up plans for use in the design and building of roadways, bridges, sewer systems, and other major projects.
- Electrical drafters work with electricians to prepare diagrams of wiring electrical system layouts.
- Electronics drafters also prepare wiring diagrams for use in the making, installing, and repairing of electronic gadgets.

Trade drawing application using Autocad is basically the transition concept of manual trade drawing of plans,perspective,isometric, pictorial to the modern technological software files called AutoCad (Automatic computer Aided Drafting). They are different types of Autocad software programs, for an instance Autodesk,DWG-fast view,.etc. The most convient AutoCAD program software that we are going to explore is the Autodesk 2020 version. And we will learn the steps on Downloading and Installing program and apply basic methods on setting up new drawing site before starting to do designing a floor plan of two bed room house plan.

- Basic methods of using AutoCAD or FreeCAD Program

Information is found in the Appendix section

- method of downloading and Installing AutoCAD Program
- methods of sketching/designing domestic building(Gable roof) Plan

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of Trade Drawing Application using CAD Program. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Surface Development

Teaching Strategies
Students engage in brainstorming exercise to discover and define surface development.
They then are allowed to design guiding questions that will enable them to conduct research on surface development.
Discussions in groups on the research findings.

Learning Strategies
Conduct a research with guiding questions that will lead to discovering what the terms are used on surface development.

Activity 1 Brainstorming activity define surface development.
Activity 2 Conduct research on define surface development.
Activity 3 Discussions and presentation of research findings.

Resources

Lesson 2: Sectional View of Solids

Teaching Strategies
Students engage in brainstorming exercise to discover sectional view of solids.
They then are allowed to design guiding questions that will enable them to conduct research on the sectional view of solids.
Discussions in groups on the research findings.

Learning Strategies
Conduct a research with guiding questions that will lead to discovering sectional view of solids and the drawing of using them.
Activity 1 Brainstorming activity types of sectional view of solids.
Activity 2 Conduct research on types of sectional view of solids.
Activity 3 Discussions and presentation of research findings.

Resources

Lesson 3: Method of Using AutoCAD program.

Teaching Strategies
Students engage in brainstorming exercise to discover methods of using AutoCAD or Free CAD program.
They then are allowed to design guiding questions that will enable them to conduct research on using AutoCAD /Free CAD program.
Discussions in groups on the research findings.

Learning Strategies
Conduct a research with guiding questions that will lead to discovering what the terms are used on AutoCAD Program or Free CAD.
Activity 1 Brainstorming activity methods of using AutoCAD or Free CAD Program.
Activity 2 Conduct research on methods of using AutoCAD or Free CAD Program.
Activity 3 Discussions and presentation of research findings.

Resources
Using AutoCAD or Free CAD program tutorial and practical lesson demonstration.
AutoCAD program book 2020 Version

Lesson 4: Methods of Downloading and Installing AutoCAD program

Teaching Strategies
Students engage in brainstorming exercise to discover methods of downloading and installing AutoCAD program.

They then are allowed to design guiding questions that will enable them to conduct research to discover methods of downloading and installing AutoCAD or FreeCAD program.
Discussions in groups on the research findings.
Teachers introduce students the methods of downloading and installing AutoCAD or FreeCAD program.

Learning Strategies
Conduct a research with guiding questions that will lead to discovering methods of downloading and installing AutoCAD or Free CAD program.
Activity 1 Brainstorming activity methods of downloading and installing AutoCAD or Free CAD program.
Activity 2 Conduct research on methods of downloading and installing AutoCAD or Free CAD program.
Activity 3 Discussions and presentation of research findings

Resources
Methods of downloading and installing AutoCAD or Free CAD program tutorial
AutoCAD program book 2020 Version

Lesson 5: Methods of Sketching Domestic Building-Gable Roof.

Teaching Strategies
Students engage in brainstorming exercise to discover methods of sketching domestic building-gable roof.
They then are allowed to design guiding questions that will enable them to conduct research on methods of sketching domestic building-gable roof.
Discussions in groups on the research findings.
Teachers introduce students to methods of sketching domestic building-gable roof.

Learning Strategies
Conduct a research with guiding questions that will lead to discovering methods of sketching domestic building-gable roof.
Activity 1 Brainstorming activity methods of sketching domestic building-gable roof.
Activity 2 Conduct research on methods of sketching domestic building-gable roof.
Activity 3 Discussions and presentation of research findings.

Resources

Methods of sketching domestic building-(gable roof) tutorial and practical lesson of designing gable roof using Autodesk program
AutoCAD program book 2020 Version

STEAM Activity Students work in groups to apply methods of sketching Domestic Building-using Autodesk Program to design two bed room house (gable roof). Identify and explain the STEAM concepts involved.

Assessment

The main purpose of assessment is to find out if students can use the skill of synthesis to trade drawing application using AutoCAD program. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Define AutoCAD program.
2. Types of AutoCAD program.
3. Apply Basic methods of using AutoCAD program.
4. Analyse the correct method of downloading and Installing AutoCAD program.
5. Apply correct methods of sketching/designing domestic building (Gable roof) plan.

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1.Define AutoCAD program	Accurately define AutoCAD program using correct language	Correctly define AutoCAD program	Partly define AutoCAD program	Cannot define AutoCAD program
2.Types of AutoCAD program	Accurately analyse the types of AutoCAD Program AutoCAD program competently	Correctly analyse the types of AutoCAD program	Partially analyse a few types of AutoCAD program	Cannot analyse the types of AutoCAD program
3.Apply basic methods of using AutoCAD program	Highly competent in applying basic methods of AutoCAD program	Competent in applying basic methods of AutoCAD program	Fairly competent in applying basic methods of AutoCAD program	Not Yet competent in applying basic methods of AutoCAD program
4.Analyse the correct method of downloading and Installing AutoCAD program	Highly competent in downloading and installing AutoCAD program.	Competent in downloading and installing AutoCAD program.	Fairly competent in downloading and installing AutoCAD program	Not Yet competent in downloading and installing AutoCAD program

UNIT1. Building Technology

Content Standard 3.1 Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.

Benchmark 11.3.1.4 Describe and apply appropriate health and safety practices pertaining to wood and non-wood products.

Topic 4: Health and Safety Practices with Building Materials

Learning Objectives

By the end of this topic, the students will be able to;

1. Analyse the health and safety practices when handling building materials in construction.
2. Apply safety methods in using timber during framing, laying bricks, mixing concrete, and handling steel in construction.

Essential Questions:

1. What are safe methods of applying timber on wall framing?
2. What are the correct methods of handling and laying bricks?
3. What are the safe methods of mixing concrete?
4. What are the correct methods of handling steel during construction?

Essential Knowledge, Skills, Values and Attitudes:
Knowledge: Safe methods in construction
Skills: Practice safety in construction.
Values: Essential and prioritise health and safety.
Attitudes: Responsible and careful in the application of health and safety rules when handling building materials.

Content Background

OHS on Building material

OHS on building material is Occupational Health and safety that are applied on building materials.This is basically to familiarise the safety measures when handling building materials during construction, the safe methods of using timbers during wall framing,roof framing,form works etc,the safe and correct methods of handling and laying bricks in construction, safe methods of mixing concrete, safe and correct method of handling steel in construction.

Timber Framing and "Post-and-Beam" Construction: Safe methods of mixing concrete
Timber framing and "post-and-beam" construction are methods of building with heavy timbers rather than dimensional lumber such as 2″x4″s. Traditional timber framing is the method of creating structures using heavy carefully fitted mortise and tenon joints secured by large wooden pegs. It is commonplace in wooden buildings from the 19th century and earlier. The

method comes from making things out of logs and tree trunks without modern high tech saws to cut lumber from the starting material stock. Using axes, adzes, and draw knives, hand-powered auger drill bits (bit and brace), artisans or farmers are able to assemble a building capable of bearing heavy weight without excessive use of interior supports. Since this building method has been used for thousands of years in many parts of the world, there are many styles of historic framing. These styles are often categorised by the type of foundation, walls, how and where the beams intersect, the use of curved timbers, and the roof framing details.

Timber-framed structures differ from conventional wood-framed buildings in several ways. Timber framing uses fewer, larger wooden members, commonly timbers in the range of 6″ to 12″) while common wood framing uses many more timbers with dimensions usually in the 2″ to 10″ range. The methods of fastening the frame members also differ. In conventional framing, the members are joined using nails or other mechanical fasteners, whereas timber framing uses the traditional mortise and tenon or more complex joints that are usually fastened using only wooden pegs. Modern complex structures and timber trusses often incorporate steel joinery such as gusset plates, for both structural and architectural purposes.

For thousands of years, people have worked with timber. It's beautiful, natural and can be rewarding to build and create with. However, before a new project starts, take the time to plan and ensure that safety is maintained.

Safety considerations when working with timber:

1. Timber can be heavy, so use the right technique when lifting (spread your feet wide, bend at the knees and keep back straight).
2. When handling and working with timber, always wear suitable gloves and eye protection
3. Ensure to attain clear knowledge on how to safely use the tools and equipment before start starting a project.
4. Always cut away from your body unless absolutely necessary.
5. Do not alter any floors or walls without checking what they are made of, so you can select the correct tools.
6. Be very careful to locate all services (e.g. electrical, plumbing etc) prior to starting a building project.
7. Ensure there is good lighting and ventilation.
8. Keep tools in excellent condition. Power cables should not be frayed or damaged and blades should be sharp.
9. Recycled timber may contain hazards such as nails - carefully remove any metal before cutting.
10. After working with treated timber products, wash hands thoroughly before smoking, eating or using the bathroom.

Handy how to guide: Bricklaying

Learning how to lay bricks properly is a core skill necessary for long-lasting, reliable brickwork. There is no secret technique to laying a brick, you simply need to be committed, be able to work outdoors, and be confident in your fitness abilities.
Before getting started, ensure the area is measured out correctly, cement is mixed and the appropriate PPE is worn.

The step by step on how to brick lay.

Materials needed:

- String
- Spirit level
- Tape measure
- Trowel
- Bricks
- Mortar
- Mortar board
- Chisel and hammer
- Flat surfaced footing to work on

1. Prepare for the first row
Measure out the space where your brickwork will be. Place a brick at either end of your structure's footing; these will be your guide bricks. Stretch a string between them like a tightrope to create a guide for the first layer to help keep it straight. Another option is placing timber boards at either end to make sure it's all even.

2. Lay a mortar bed
Prepare the surface for the bricks with mortar. Use a trowel to lay a bed of mortar on the footing between your guide bricks, create a V-shaped trench in the mortar. Be careful not to use excessive amounts of mortar as this will affect the setting. Lift your guide brick, put mortar under it and place it in the same place.

3. Butter and place the first brick
Start at an end where you laid one of the 1st guide brick. Use mortar to butter up a new brick and header (ends). One of the ends will face the 1st brick. Press this end-to-end next to the first brick but not so tight that the bricks touch. Cut away excess mortar and tap down with the end of your trowel.

4. Continue and check levels
Continue buttering and placing bricks until the first row is complete. Place a spirit level on top of the bricks to ensure the first row is completely level. If it isn't, use the end of your trowel to tap down any bricks out of line. It's easier to make adjustments at this point than have to undo your work later.

5. Laying the next row
Begin and end second rows with half bricks or overhang them so the joints don't line up as this will make the structure weak. On a single wall, you can use a hammer and chisel to cut bricks in half. If the wall will become a corner, overhang a whole brick so the wall will interlock.

6. Repeat until desired height and shape
Before every row, lay the spirit level on top again and tap down any uneven bricks. Continue from step 3 until the brick structure is at the height and shape required, ensuring joints never line up for strong brickwork. Shaped walls can be created by gradually adjusting the brick angles as you lay them.

Working Safely with Concrete
Concrete is easy to work with, versatile, durable, and economical. By taking a few basic precautions, it is also one of the safest building materials known. Relatively few people involved in mixing, handling, and finishing concrete have experienced injury.

Outlined below is some simple suggestions-protection, prevention, common sense precautions-useful to anyone working with Portland cement and concrete.

Protect Your Head and Eyes

Construction equipment and tools represent constant potential hazards to busy construction personnel. That's why hard hats are required on construction projects. It is therefore recommended that some sort of head protection, such as a hard hat or safety hat, be worn when working any construction job, large or small.

Proper eye protection is essential when working with cement or concrete. Eyes are particularly vulnerable to blowing dust, splattering concrete, and other foreign objects. On some jobs it may be advisable to wear full-cover goggles or safety glasses with side shields. Sight is precious. Protect the head and eyes by using proper safety equipment and remaining alert.

Protect Your Back

All materials used to make concrete—Portland cement, coarse aggregate, sand, and water—are quite heavy even in small quantities. When lifting heavy materials, your back should be straight, legs bent, and the weight between your legs as close to the body as possible. Do not twist at the waist while lifting or carrying these items. Rather than straining your back with a heavy load, get help. Remember to use your head, not your back.

Let mechanical equipment work to your advantage by placing concrete as close as possible to its final position. After the concrete is deposited in the desired area by chute, pump, or wheelbarrow, it should be pushed—not lifted—into final position with a shovel. A short-handled, square-end shovel is an effective tool for spreading concrete, but special concrete rakes or come-alongs also can be used. Excessive horizontal movement of the concrete not only requires extra effort, but may also lead to segregation of the concrete ingredients.

Protect Your Skin

When working with fresh concrete, care should be taken to avoid skin irritation or chemical burns. Prolonged contact between fresh concrete and skin surfaces, eyes, and clothing may result in burns that are quite severe, including third-degree burns. If irritation persists consult a physician. For deep burns or large affected skin areas, seek medical attention immediately.

The A-B-Cs of fresh concrete's effect on skin are:

Abrasive Sand contained in fresh concrete is abrasive to bare skin.

Basic & Portland cement is alkaline in nature, so wet

Caustic concrete and other cement mixtures are strongly basic (pH of 12 to 13). Strong bases-like strong acids-are harmful, or caustic to skin.

Drying Portland cement is hygroscopic-it absorbs water. In fact, Portland cement needs water to harden. It will draw water away from any material it contacts-including skin.

Clothing worn as protection from fresh concrete should not be allowed to become saturated with moisture from fresh concrete because saturated clothing can transmit alkaline or hygroscopic effects to the skin.

Waterproof gloves, a long-sleeved shirt, and long pants should be worn. If you must stand in fresh concrete while it is being placed, screeded, or floated, wear rubber boots high enough to prevent concrete from getting into them.
The best way to avoid skin irritation is to wash frequently with pH neutral soap and clean water.

Placing and Finishing

Waterproof pads should be used between fresh concrete surfaces and knees, elbows, hands, etc., to protect the body during finishing operations. Eyes and skin that come in contact with fresh concrete should be flushed thoroughly with clean water. Clothing that becomes saturated from contact with fresh concrete should be rinsed out promptly with clear water to prevent continued contact with skin surfaces. For persistent or severe discomfort, consult a medical attention.

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Correct method of handling steel in construction

What is Steel Erection?

Steel erection is the process of constructing, altering, or repairing steel buildings, bridges, and other structures. It also involves the assembly, connection, and installation of steel beams, metal decking, and planking used in the erection of a steel structure. Steel workers assigned in steel erection activities are commonly employed in building, contracting, and construction companies.
The Occupational Safety and Health Administration (OSHA) recognises steel erection as one of the 10 most hazardous occupations and has laid down regulations to promote safety for workers.
According to the International Labour Organisation (ILO), the structural steel erection process involves:

- setting up hoisting equipment for raising and placing structural-steel members;
- raising, placing, and uniting girders, columns, and other structural-steel members for the formation of completed structures or structure frameworks;
- fastening steel members to cable hoist using a chain, cable, or rope;
- pulling, pushing, or prying steel members into approximate positions while member is supported by a hoisting device;
- forcing members into final position using turnbuckles, crowbars, jacks, and hand tools;
- aligning rivet holes in member with corresponding holes in previously placed member by driving drift pins or the handle of a wrench through holes;
- verifying vertical and horizontal alignment of members using plumb bob and level;
- bolting aligned members to keep them in position until they can be permanently riveted, bolted, or welded in place;
- catching hot rivets tossed by rivet heater (heat treating) in bucket and inserting rivets in holes using tongs; and
- cutting and welding steel members to make alterations using oxyacetylene welding equipment.

Hazards

The risks and hazards associated with steel structure erection vary at each location, depending on the types of materials, sizes of structures, and other working conditions. Prior

to any project, a comprehensive job hazard analysis is required to identify the potential risks and establish appropriate safety plans.

Identified Hazards in the Steel Erection Process

Identified Hazards in Defined Aspects	
Materials	• Carrying heavy tools • Handling heavy suspended loads
Tools	• Many tools required for connections (falling object hazard) • Safety hook device might not be used correctly (beamer)
Design	• Working with structural elements having irregular shapes • Unstable loads when rigging (elements has to be rigged at centre of gravity
Process	• Walking on narrow surfaces • Walking on irregular surfaces • Having to ride beams to connection points • Walking to other side to make connection • Walking to centre of element for unhooking • Moving at high elevations • Interaction with moving equipment

Source: Effect of Safety and Environmental Variables on Task Durations in Steel Erection (Irizarry et al., 2005)

"Effect of Safety and Environmental Variables on Task Durations in Steel Erection" (Irizarry, Simonsen, & Abraham) lists the major identified hazards involved in the steel erection process:

- **Materials** – carrying heavy tools and handling heavy suspended loads.
- **Tools** – using tools needed for connections exposes workers to falling object hazards.
- **Design** – working with structural elements that have irregular shapes and unstable loads when rigging.
- **Process** – walking on narrow and irregular surfaces, to the other side to make connections, and to the center of element for unhooking; moving at high elevations; and interacting with moving equipment.

Causes of Steel Erection Accidents

Data from OSHA show that steel erection accidents leading to fatalities are often due to the following factors:

- Premature crane disconnections before the piece was secured.
- Workers landing or placing a load on unsecured or unabridged joists.
- Workers getting hit by objects while walking or working under a load.
- Workers being struck by objects while landing a load or making a connection, by a tool slipping, or by a piece of decking being blown off a pile when fall protection is neither provided nor used.
- Failure to use available fall protection systems even though the worker was wearing a safety harness.
- Stepping onto or working on unsecured decking that slipped out of place when fall protection was neither provided nor used.
- Workers not being tied off while at the workstation.

- Walking or standing on the beam/joist where fall protection wasn't provided or used, resulting in slips, trips, and falls.
- Flying metal splinters; working with a chisel and hammer; and conducting sharpening, cutting, or welding works without using Personal Protective Equipment (PPE), resulting in eye injury.
- Lifting and moving heavy loads, causing back and spinal column injury,
- Touching live electrical wires or working with portable power tools which may lead to electrocution.
- Exposure to high noise levels.
  https://safetyculture.com/checklists/hand-and-power-tools/

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of Health and Safety Practices with Building Materials. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Safety Methods of Using Timber in Framing

Teaching Strategies
Students engage in brainstorming exercise to discover OHS on building material.
They then are allowed to design guiding questions that will enable them to conduct research on OHS on building material
Discussions in groups on the research findings.

Learning Strategies
Teacher Introduce OHS methods of using timber in constructing wall frame
Activity 1 Brainstorming activity on OHS methods of using timber in framing.
Activity 2 Conduct research on OHS methods of using timber in framing.
Activity 3 Discussions and presentation of research findings

Resources
OHS on Building material tutorial and practical safety demonstration on handling material
OHS text books,

Lesson 2: Safety Methods of Handling Bricks During Construction

Teaching Strategies
Students engage in brainstorming exercise to discover safety methods of handling bricks during construction.
They then are allowed to design guiding questions that will enable them to conduct research on safety methods of handling bricks during construction.

Discussions in groups on the research findings.

Learning Strategies
Teacher introduces the topic on safety methods of handling bricks during construction.
Activity 1 Brainstorming activity on safety methods of handling bricks during construction.
Activity 2 Conduct research on safety methods of handling bricks during construction.
Activity 3 Discussions and presentation of research findings.

Resources
Safety methods of handling bricks during construction
OHS textbooks

Lesson 3: Safety Methods of Mixing Concrete

Teaching Strategies
Students engage in brainstorming exercise to discover safety methods of mixing concrete.
They then are allowed to design guiding questions that will enable them to conduct research on different safety methods of mixing concrete.
Discussions in groups on the research findings.

Learning Strategies
Teacher introduces the topic on safety methods of mixing concrete.
Activity 1 Brainstorming activity safety methods of mixing concrete.
Activity 2 Conduct research on safety methods of mixing concrete.
Activity 3 Discussions and presentation of research findings.

Resources
Safety methods of mixing concrete tutorial and practical lessons on mixing cement.
OHS text books

Lesson 4: Safety Methods Handling Steel in Construction

Teaching Strategies
Students engage in brainstorming exercise to discover safety methods handling steel in construction. They then are allowed to design guiding questions that will enable them to conduct research on safety methods handling steel in construction
Discussions in groups on the research findings
Teachers introduce students to safety methods handling steel in construction

Learning Strategies
Conduct a research with guiding questions that will lead to discovering what the safety methods handling steel in construction
Activity 1 Brainstorming activity on safety methods of handling steel in construction.
Activity 2 Conduct research on safety methods of handling steel in construction.
Activity 3 Discussions and presentation of research findings.

Resources

Safety methods handling steel in construction tutorial and practical lesson on Safety
OHS Resource books

Lesson 5: Building Procedures and Processes

Teaching Strategies
Students engage in brainstorming exercise to discover building procedures and processes.
They then are allowed to design guiding questions that will enable them to conduct research on different building procedures and processes.
Discussions in groups on the research findings.
Teachers introduce students to building procedures and processes.

Learning Strategies
Conduct a research with guiding questions that will lead to discovering what the building procedures and processes.
Activity 1 Brainstorming activity building procedures and processes.
Activity 2 Conduct research on building procedures and processes.
Activity 3 Discussions and presentation of research findings.

Resources
Building procedures and processes tutorial and practical lesson
Building OHS resource books

STEAM Activity Students work in groups to construct a building Hip Roof House Model by following the procedures and processes. They are to identify and explain the health and safety measures and STEAM involved in the project.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to building procedures and processes of Hip Roof house model. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Safety methods of using timber during framing.
2. Apply correct methods of handling and laying bricks in construction.
3. Analyse the safe methods of mixing concrete.
4. Apply correct method of handling steel in construction.

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1.Explain Safety methods of using timber during framing	Excellently explain safety methods of using timber during framing using appropriate terminology	Correctly explain safety methods of using timber during framing using appropriate terminology	Partially explain safety methods of using timber during framing	Cannot explain safety methods of using timber during framing
2. Apply correct	Accurately and	Competently	Partly	Cannot apply

methods of handling and laying bricks in construction	competently apply correct methods of handling and laying bricks in construction	apply correct methods of handling and laying bricks in construction	competent in applying correct methods of handling and laying bricks in construction	correct methods of handling and laying bricks in construction
3. Apply correct methods of handling and laying bricks in construction	Excellent application of correct methods of handling and laying bricks in construction	Good application of correct methods of handling and laying bricks in construction	Poor application of correct methods of handling and laying bricks in construction	Unacceptable application of correct methods of handling and laying bricks in construction
4. Apply correct method of handling steel in construction	Correctly and with precision apply correct method of handling steel in construction	Correctly apply correct method of handling steel in construction	Poorly apply correct method of handling steel in construction	Not Yet competent in applying correct method of handling steel in construction

UNIT 1. Building Technology

Content Standard 3.1 Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.

Benchmark 11.3.1.5 Explore and describe the fundamental building procedures.

Topic 5: Building Procedures and Processes

Learning Objectives

By the end of this topic, the students will be able to;

1. Define and analyse building constructions processes and procedures.
2. Analyse the types of building plan and the roles of a builder.
3. Analyse the role of an architect and draftsman.

Essential Questions:

1. What are building construction processes and procedure?
2. What the types of building plan?
3. What is the role of a builder?
4. What is the role of an architect and draftsman?

Essential Knowledge, Skills, Values and Attitudes:
Knowledge: Building constructions processes and procedures.
Skills: Analyse and define building constructions processes and procedures.
Values: Appreciate the importance of building processes.
Attitudes: Appreciative of understanding the basic building construction procedures.

Content Background

Building procedures and processes
The building procedures and processes are the set of procedures and processes that are used to construct any building structures. The procedures and processes of building construction has to abide by the regulations, from the beginning of the project to the completion. The building construction process includes stages such as planning, estimate, site survey and layout, excavation, substructure and superstructure, Electric and Plumbing work and finishing

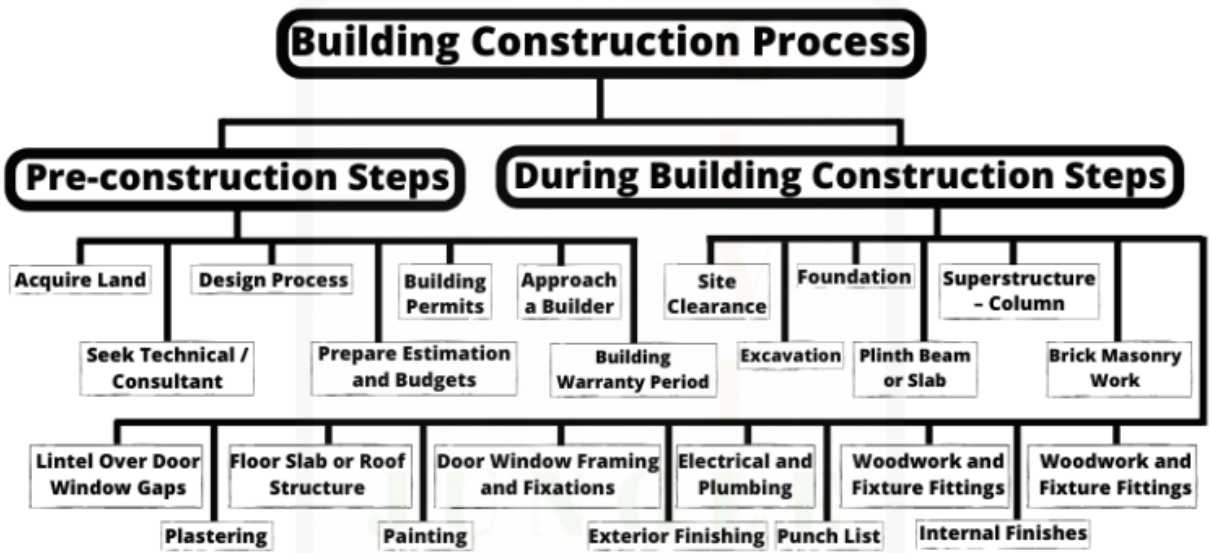


Figure 1.5a Building construction process
Source: https://civiljungle.com/tag/building-construction-process-flow-chart/

Sub Building Construction Steps with Main Building Construction

1. Pre-construction Steps

In this building construction process the first step as per construction possesses describes some points like plot hiring, planting, budget, consult hiring, contractor, design process, etc.

a. Acquire Land

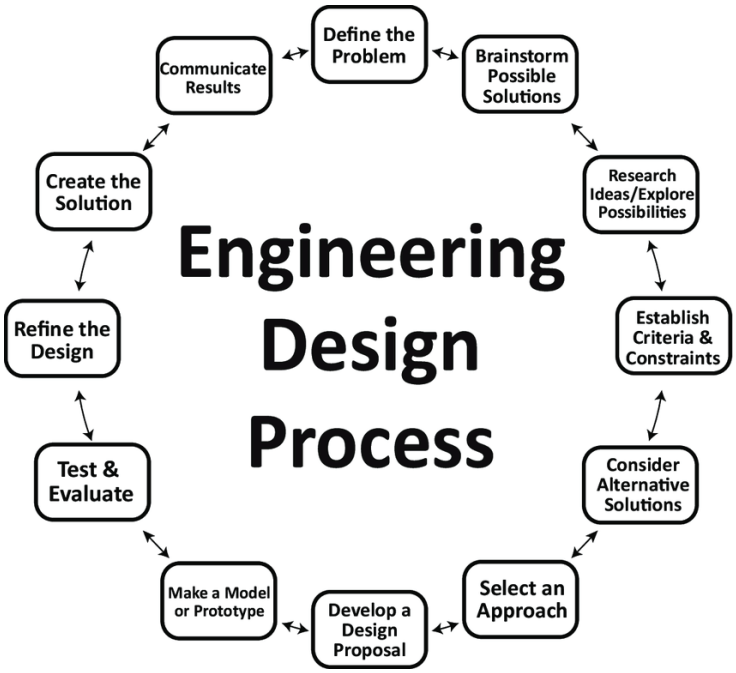
It is the main step in building construction. Search for the location for the building, which is most appropriate for building construction purposes. Be careful while selecting land that has all the desired facilities available nearby and should be free from all land-related issues.

It's suggested that do prior data collection before buying land either by doing research online or seek help / consultant from real estate agents or concerned persons regarding the effective cost of the same.

b. Seek Technical/Consultant

After selecting proper land for building, seek the help of a professional architect to create building designs, and take advice. An architect prepare plan according to building requirement, a number of flats, shops based on your requirements also budget. Then after the architect consults with a structural engineer and engineer for details of the reinforcements and other detail for use, how deep your foundation will be, the size of gravel to be used, column width, electrical, plumbing, etc.

c. Design Process



Before finding/meeting up with an architect, make a rough requirement list for your home. This process must cover the basic concepts of your home, like living space, number of bedrooms you would like, guest bedrooms, hall, kitchen, Baths, where you want the stairs, car porch, garden/landscaping, etc.

Stages of work in a glance.

d. Prepare Estimation and Budgets
Building construction involves a huge quantity of material and budget. After planning and structural detailing is done, these details are transferred into the building estimator.
The building estimation will estimate the material quantity, quantity of different items of works, and prepare an abstract sheet that shows the cost of building construction.
If financial resources are limited, there will be the need to seek pre-approval for loans in advance, or else you might end up in a cash crunch situation.

e. Building Permits
This is important work to do after the project is ready to be executed. For that, we must take permission from different boards before you can go for the construction, like this municipal, airport authority, pollution control, etc. Following are the list of document project required before applying for permission. This document may differ from state to state, but a few are essential for every building construction work.

- Land Survey
- Soil test report (SBC report)
- All drawing like Plan, Elevation, Section
- Structural Certificate
- Architect Certificate

f. Approach a Contractor
A contractor for construction needs to be chosen carefully because it's a major factor for securing building construction quality and timely construction of work.

Pre investigation has to be done about the builder before handing work. From the contract document, all of the work-related details must be clearly stated. The contract document must cover layout and work details along with the cost payment methods and time scales. The condition of the contract ought to be thoroughly checked before signing a final deal.

g. Building Warranty Period
Once the project is complete and handed over to the owner, the contractor specifies a warranty period. In this period, any defects found in the building constructed have to be fixed and replaced with the contractor in charge. The warranty for appliances and materials are obtained from manufacturers and supplier

2. During Building Construction Steps

In this building construction process the first step as per the construction possesses some points like site clearance, exaction, brick-masonry, plastering, different types of construction, etc. are discussed.
More detail below as per point.

a. Site Clearance
Before starting any construction work, it becomes necessary to clear the place from the unwanted grass, Boulder, etc.
In case of any hill like appearance on the ground, that also has to be cleared of the excess earth, and when there's a pit, it's required to be filled up. This total job is known as site clearance.

b. Excavation
Following the site clearance, the layout of this structure in the site could be planned with respect to the given foundation plans. Begin earth excavation and take trenches accordingly.

c. Foundation

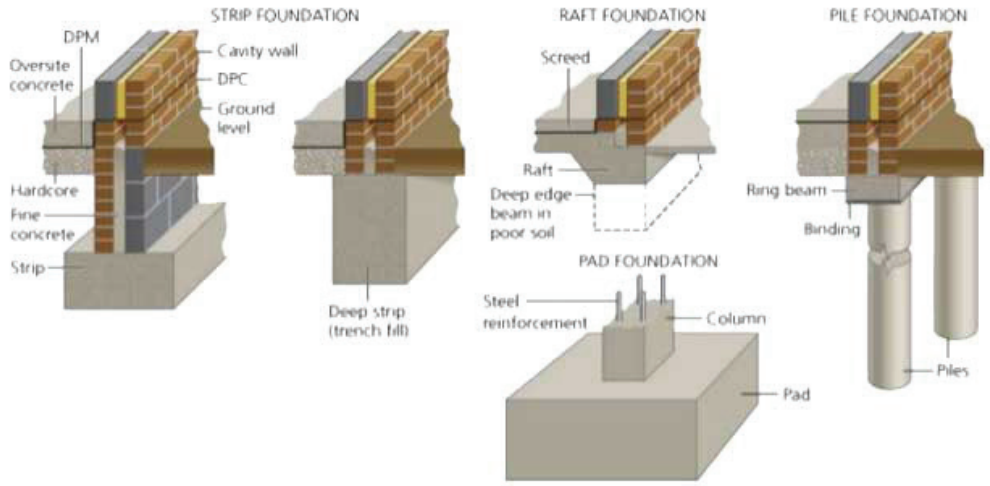


Figure 1.5b Building foundation
Source: https://civiljungle.com/difference-between-footing-and-foundation/

A foundation is the lower portion of building a structure that transfers its gravity loads into the earth. Foundation work is done based on drawings provided by the architect. i.e., the size of

the foundation, depth, width, and length, etc. and the kind of foundation (Rubble Packing or Raft and beams, etc.)

d. Plinth Beam or Slab
After the foundation work is completed, ground beam formwork preparation has been started and poured with concrete. Over the plinth beam, masonry work has been started. And space between foundation and plinth beam filled with soil.

e. Superstructure Column and Beam
The superstructure is the portion above the plinth level of the building. The main component of the superstructure is a beam and column. The columns are built up to the slab level, and the frame for further construction is prepared.

f. Brick Masonry Work
As beam and column framework completed, masonry work is started with various materials like fly ash bricks, concrete blocks, bricks, etc. according to building drawing.
Masonry work is done with a cement mortar mix. It's a mixture of cement & sand. During this carefully and as per drawing, gaps are laid for windows and doors during the masonry work.

g. Lintel Over Door Window

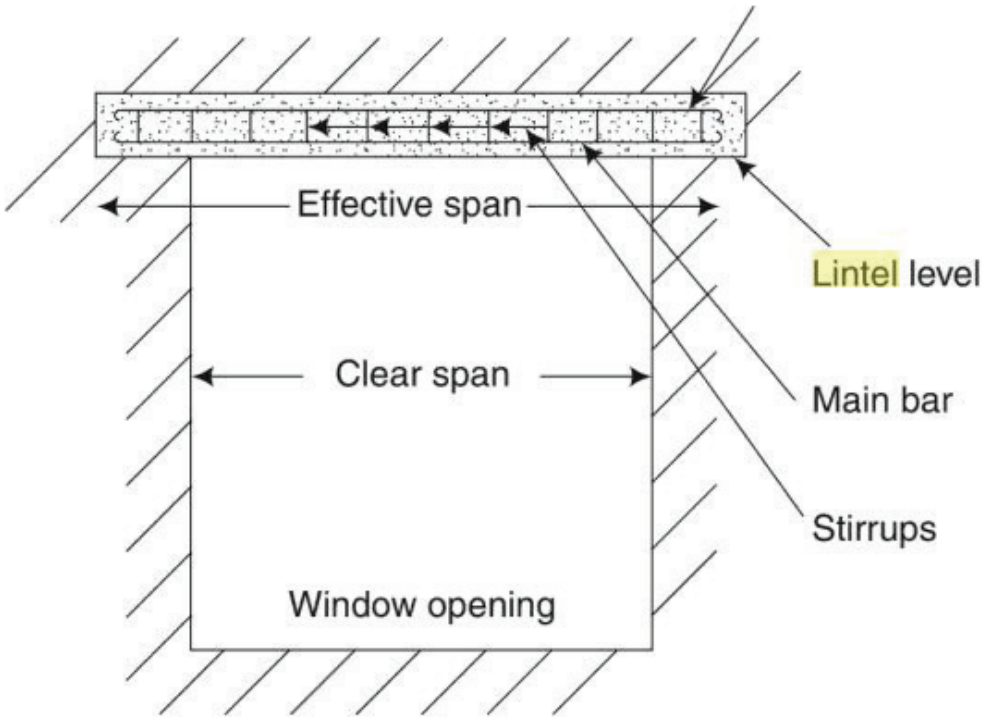


Figure 1.5c Lintel over window
https://civiljungle.com/brick-masonry/

The lintel is constructed on the Window and door to support the masonry work over it. After this, further masonry work is done.

h. Floor Slab or Roof Structure
Then the formwork is started to construct slab resting on the column and beam. Over slab formwork, slab reinforcement is put according to slab detailed drawing.

i. Plastering
Plastering work can commence after the initial lighting and electrical plumbing work was completed. Cement plaster is generally used with 12 mm thickness, and sometimes it may be of 20 mm thickness.
On completion of brickwork, plastering is to be done.
To make the building structurally strong,
To protect it in the effect of weather, and
To provide it an attractive look.

j. Door and Window Framing and Fixations
After that door and window frames have been fixed at their specified position given in drawing.

h. Painting
It is done with cement primer after initial wiring work, and plumbing works are done.

i. Electrical and Plumbing
As we know that buildings have been constructed with a clean finish in which electrical and plumbing work isn't visible. They're installed in the walls and slabs such that they are concealed and not visible after the finishing work is done. The pipe and point end left out this later. They may be finished with the electric fitting and plumbing fixtures.

j. Exterior Finishing
After this work is completed, outside plastering and finishing work are started. Waterproofing can also be done to prevent rising dampness from the wall. External cladding may also be done to enhance the elevation of the house.

k. Internal Finishes
Internal walls are plaster with a smooth finish, and flooring is done with tiles. Later on, the walls are stained or painted.

l. Woodwork and Fixture Fittings
By following the above step, almost construction work is completed and then after furniture work is started. Side by side, electrical fitting, switchboard, and plumbing fittings are complete in the kitchen and bathrooms areas too.

m. Boundary Wall and Gates
Compound walls must be built ideally just before beginning major construction activities. It's to protect the site, and the material stored at the storage shed, in the outside environments, and from thieves. Latest gate designs.

n. Hardscaping and Landscaping
Once your builder has completed your home, there is still the"hardscaping" to be done – the driveway, patio and walkways, and then the"landscaping" plan could be put into action – the irrigation system, laying of grass bed and planting of trees, as well as outdoor lighting, to be considered.

o. Punch List

When the project is complete, the contractor inspects the whole work one by one and make a punch list. These structural units or areas that weren't constructed properly or are below the quality level is listed in the punch list. This is later corrected by the contractor in charge.

p. Warranty Period
When the project is complete and handover into the owner, the contractor specifies a warranty period. Within this period, any defects found in the building constructed have to be fixed and replaced with the contractor in charge. The warranty for appliances and materials are obtained from manufacturers and suppliers.

The Different Types of Architectural Plans Used in Construction
A building plan, which is commonly referred to as an architectural plan, is used to graphically represent the complete layout of a building before construction. Building plans are also useful in estimating building materials, project costs, and budgets.

What Is Building Plan?
A building plan is simply a graphical representation of a building and its different elements. It contains different types of plans of a building such as site plan, floor plan, structural plan, cross-sections, elevations, electrical detailing, plumbing, and landscape drawings.
The construction is done followed by such plans and drawings. Building plan is sometimes also referred as building drawing, architectural plan, or architectural drawing.

Types of Building Plans

The different types of building plans are as follows:
Site Plan
Floor Plan
Structural Plan
Terrace Plan
Cross-section
Elevation
Landscape plan

1. Site Plan
Site plan is the first design made for any project that represents the whole plan of the construction site. Site plans contain details of property boundaries, access to the site, and existing structures on or near the construction project, such as roads and buildings.
The site plan also shows all the service connections such as water supply, drainage, and sewer lines, electrical lines, communication cables, etc. Site plan must comply with the existing bye-laws and local development codes.

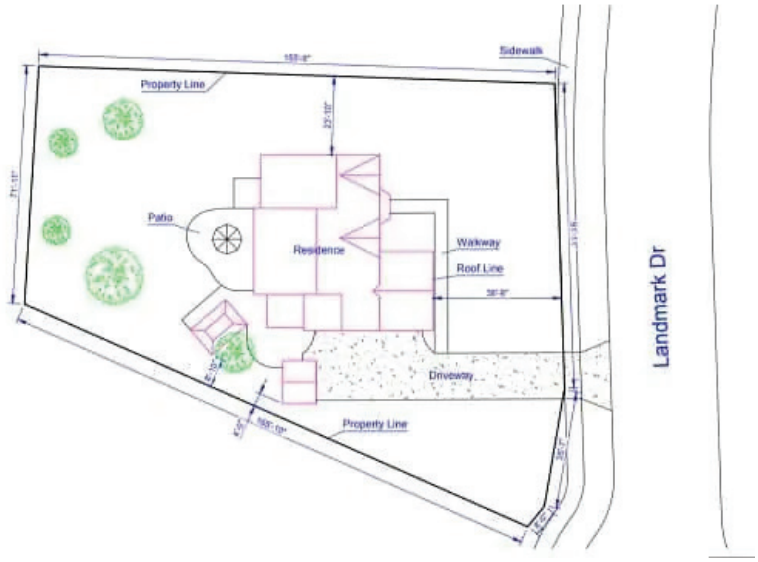


Figure 1.5d Site plan
Source: https://dailycivil.com/types-of-building-plans-used-in-construction/

2. Floor Plan
Floor plan is one of the most interesting types of building plans. It is the top view of a floor layout. Floor plans are a form of vertical orthographic projection which is represented by a plan cut at sill level of windows on that floor.
Buildings with multiple levels generally have different floor plans for each level. Floor plans include specifications such as
Dimensions of rooms (room sizes),
Dimensions of interior and exterior walls,
Dimensions of doors, windows,
Positions of furniture,
Stairs and their direction.
Floor plans are typically two types
2d floor plan
3d floor plans

2D floor plan is a flat representation of the floor layout that shows measurements of rooms, walls doors, windows, stairs, etc.

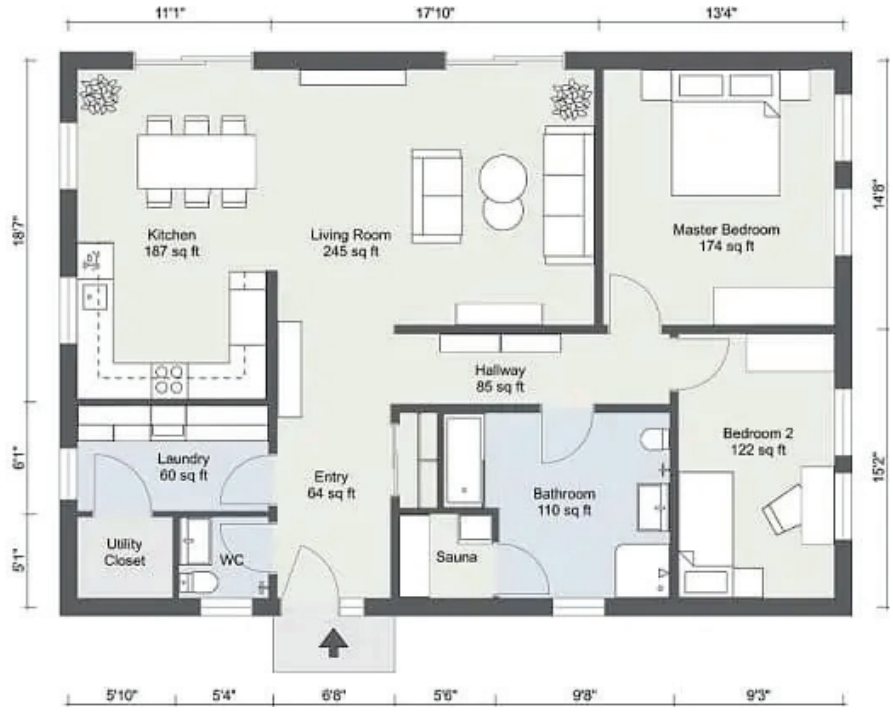


Figure 1.5e Floor plan
Source: https://dailycivil.com/types-of-building-plans-used-in-construction/

3D floor plan shows the actual look of the entire building with furniture from above. It gives you a chance to see your fully furnished and decorated building before its completion.

Figure 1.5f 3D floor plan
Source: https://dailycivil.com/types-of-building-plans-used-in-construction/

3. Structural Plan
This type of plan provides a complete view of structural aspect of the building. The structural plan contains location, nomenclature, size and placement of reinforcement, details of structural

elements, and load-carrying members of the building. Structural plan is very important because it focuses on the strength of the structure.

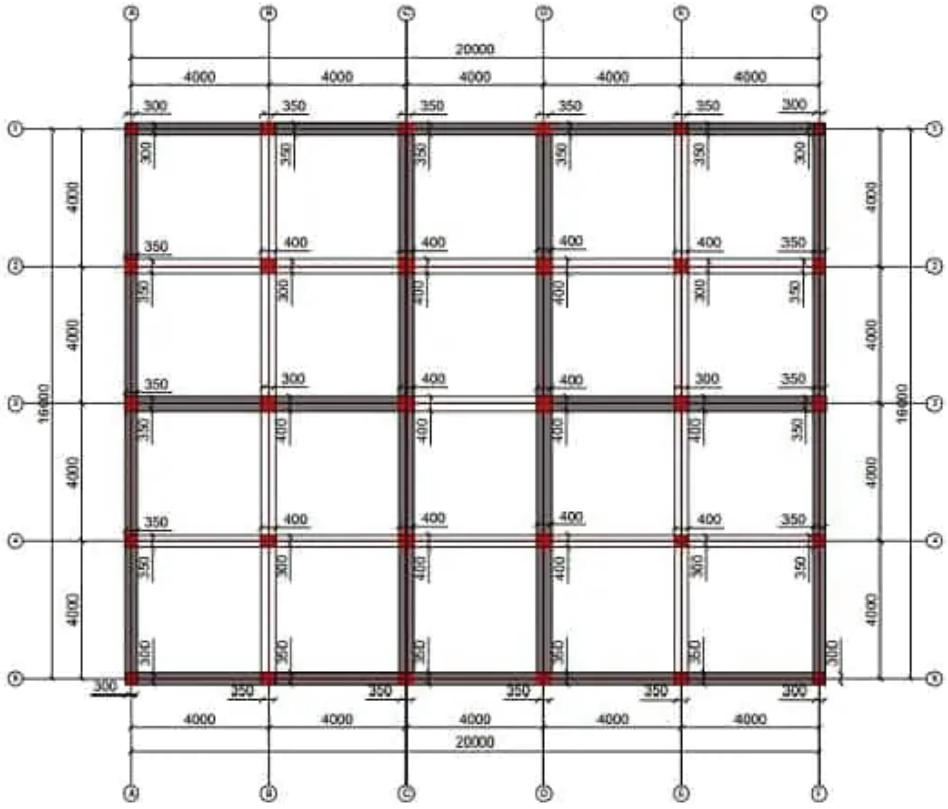


Figure 1.5g Structural plan
Source: https://dailycivil.com/types-of-building-plans-used-in-construction/

4. Terrace Plan

The terrace plan is the plan at the roof level of the building. It shows stair cabin, lift cabin (if any) overhead water tanks, etc along with roof drainage pattern. The terrace plan also shows the parapet walls.

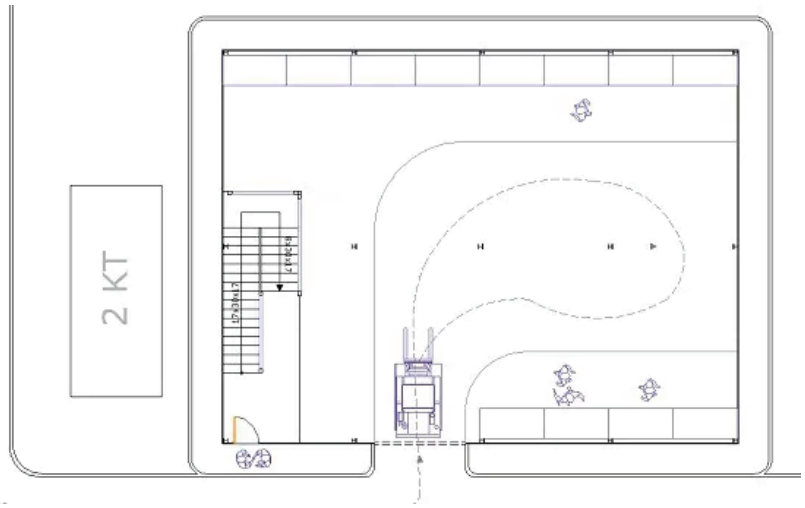


Figure 1.5h Terrace plan

Source: https://dailycivil.com/types-of-building-plans-used-in-construction/

5. Cross-section

Section plan is a vertical cut section through the building showing the details of dimension, thickness of any component of a building. In simple, it shows the view of a structure in sliced form. Section plan includes

Floor height,
Sill height,
Lintel height,
Beams
Columns etc.

The section plan is represented in the 2d floor plan by a bold dotted straight line.

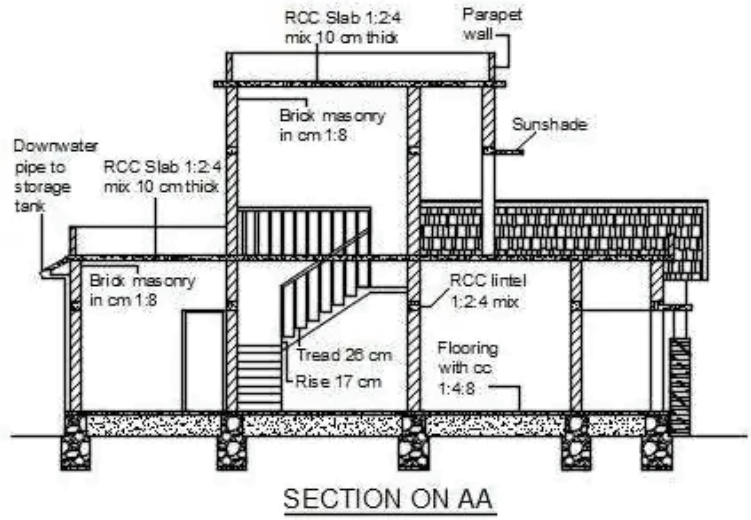


Figure 1.5i Section plan
Source: https://dailycivil.com/types-of-building-plans-used-in-construction/

6. Elevation

Elevation plan drawing is an orthographic projection that shows one side face of the building. It is a 2d drawing of the building's facade. The main purpose of elevation drawing is to show the finished look of a particular side of the building.

Figure 1.5j elevation plan
Source: https://dailycivil.com/types-of-building-plans-used-in-construction/

Elevation plans are two types:
External Elevation
Internal Elevation

i) External Elevation
The external elevation shows the exterior of the building. It provides the details of type of finish, floor height, and projections. Exterior elevation can be represented in 2D or 3D drawings.

2d drawings typically provide measurements whereas 3D renderings show an exact look of your building when completed.

ii) Internal Elevation
Internal elevations provide a pre-visualization of the building's interior. It shows the interior of different rooms along with the details of paint color, furniture designs, lighting types, and floor patterns. Internal elevations are mostly represented in 3D form.

7. Landscape Drawings
A perfect home or building is always incomplete without proper landscaping. Landscape plan provides all the details of flowers, plants, sidewalks, lawn decorations, fountains swimming pools (if any), etc. A proper landscape design can enhance the living area and increase your property value. This is why landscape plan has become one of the top trending types of building plans in today's world.

Figure 1.5k Landscape plan
Source: https://dailycivil.com/types-of-building-plans-used-in-construction/

The Architect in Society

The role of the architect has evolved over centuries to cover an expanding array of tasks and responsibilities. Today the core role of the architect is usually that of the primary professional design service provider, coordinating the various stakeholders during the planning, design, and construction process of buildings. Technological and sociological changes, as well as increasing globalization, continue to affect the way architecture is practised. Architects continue to shape our built environment, as their training experience and regulated status allow them to design buildings of all types. Their work has a major impact on human activity and the planet; hence, they have a tremendous responsibility towards fellow citizens and the environment. Architects add value to the built environment; their primary contribution and impact are its design, as well as their ability to coordinate and oversee projects to completion within schedules and budgets.

The Evolving Role of the Architect

Challenges and Opportunities for Architects in the 21st Century

Traditionally, an architect was considered to be a professional with general knowledge of the many disciplines involved in the design, construction, maintenance and alteration of buildings. Over time, technological advancement, population redistribution, and the growth of cities have both physically changed the built environment and changed expectations for the built environment. Architects' responsibilities have also changed as more and different disciplines introduced into the design-construction-operation supply chain are required. The architect's role in society has evolved with these changes and continues to evolve. Today, an architect must have the skills necessary to synthesize, integrate and coordinate various parts of a project into a composite whole. This is not only to satisfy functional and safety requirements, but also to contribute to an orderly, visually pleasing, and sustainable environment. As architects are increasingly being asked more specific questions with regards to specific subjects, there is a growing trend to specialize to meet complex issues, requirements or contexts. Areas of specialization may include aspects of planning and programming, building regulations, design, production, management, sustainability, site supervision or construction. The individual architect

may thus become an expert in a specific building type, or accredited or certified in specialties such as building code, building envelope, project management, sustainable design, or heritage conservation. However, maintaining a general expertise in all aspects of the profession remains a foundation of keeping architecture healthy and enhances the credibility of the profession in the eyes of the public. The architect also maintains an ethical responsibility for passing along their knowledge and skills, through teaching, mentoring, and hiring and training the next generation of architects.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of building procedures and processes. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: The Outline of Building Construction Process, Plan-Construction

Teaching Strategies
Students engage in brainstorming exercise to discover the outline of building construction process, Plan-Construction.
They then are allowed to design guiding questions that will enable them to conduct research on
Teachers introduce the lesson topic on the outline of building construction process, Plan-Construction.
Discussion in groups on the research findings.

Learning Strategies
Activity 1 Brainstorming activity the outline of building construction process, Plan-Construction.
Activity 2 Conduct research on the outline of building construction process, Plan-Construction.
Activity 3 Discussions and presentation of research findings.

Resources

Building Construction Text book, Construction manual books

Lesson 2: Types of Building Plan

Teaching Strategies
Students engage in brainstorming exercise to discover types of building plan.
They then are allowed to design guiding questions that will enable them to conduct research on types of building plan.
Teacher introduce the topic on types of building plan.
Discussions in groups on the research findings types of building plan.

.**Learning Strategies**
Activity 1 Brainstorming activity types of building plan.
Activity 2 Conduct research on types of building plan.
Activity 3 Discussions and presentation of research findings.

Resources

Building Text book, Library, Construction resource book

Lesson 3: The Role of the Builder

Teaching Strategies
Students engage in brainstorming exercise to discover the role of the builder.
They then are allowed to design guiding questions that will enable them to conduct research on the role of the builder.
Teacher introduces the lesson on the role of the builder.
Discussions in groups on the research findings.

Learning Strategies
Activity 1 Brainstorming activity the role of the builder.
Activity 2 Conduct research on the role of the builder.
Activity 3 Discussions and presentation of research findings.

Resources
Building Text book, Library resources on Construction

Lesson 4: The roles of Architects and Draftsman

Teaching Strategies
Students engage in brainstorming exercise to discover the roles of architect and draftsman.
They then are allowed to design guiding questions that will enable them to conduct research on the roles of architect and draftsman.
Discussions in groups on the research findings.

Learning Strategies
Activity 1 Brainstorming activity the roles of architect and draftsman.
Activity 2 Conduct research on the roles of architect and draftsman.
Activity 3 Discussions and presentation of research findings.

Resources
Building Text book, Library, Construction resource book

STEAM Activity Students work in groups to create a project(a small building model) incorporating the building construction processes using the engineering design process. Identify the STEAM components involved.

Assessment

The main purpose of assessment is to find out if students can use the skill of synthesis to analyse building procedures and processes

Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Building constructions processes and procedures.
2. Analyse the types of building plan.
3. Outline the role of a builder.
4. Analyse the role of an architect and draftsman.

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Explain building constructions processes and procedures	Accurately and correctly explain building constructions processes and procedures	Correctly explain building constructions processes and procedures	Partially explain building constructions processes and procedures	Cannot explain building constructions processes and procedures
2 .Analyse the types of building plan	Analyse the types of building plan	Correctly analyse the types of building plan	Partially analyse the types of building plan	Cannot analyse the types of building plan
3. Outline the role of a builder	Accurately outline the role of a builder	Correctly outline the role of a builder	Partially outline the role of a builder	Cannot outline the role of a builder
4. Analyse the role of an Architect and draftsman	Accurately analyse the role of an architect and draftsman	Correctly analyse the role of an architect and draftsman	Partially analyse the role of an architect and draftsman	Cannot analyse the role of an architect and draftsman

UNIT 1. Building Technology

Content Standard 3.1 Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.

Benchmark 11.3.1.6 Estimate and apply building materials using AUTO-CAD -computer aided drafting of the building.

Topic 6: Building Cost Estimation

Learning Objectives

By the end of this topic, the students will be able to;

1. Define building cost estimation and analyse the basic methods involved in it. .
2. Apply correct method of preparing material list and quotation.

Essential Questions:

1. What is a building cost estimation?
2. What are basic methods of estimating building costs?
3. What are the methods of preparing material list and quotation?
4. What is the role of a building estimator?

Essential Knowledge, Skills, Values and Attitudes:
Knowledge: Building cost estimation
Skills: Analyse and apply correct formulae in estimation building costs.
Values: Essential and accuracy in building cost estimation.
Attitudes: Accuracy and correctness in building cost estimation.

Content Background

Building Cost Estimation

Building cost estimation is the process of estimating and costing used in construction to calculate the quantities of materials, tools, equipment's, labors etc. and cost associated with them. It is the fundamental concept on estimating building cost before moving to intermediate and advance estimating techniques and principal in higher level. This will give appropriate concepts to students to estimate building cost before bidding processes takes place. The main concept to discuss as follows;

- Basic methods of estimating building cost
- Method of preparing material list and quotation
- Role of Building Estimator

The degree of accuracy used in the estimation of various material quantities used in the construction is crucial. This is to prevent cost estimate errors due to lack of proper accuracy and time consuming because of considering great accuracy .There are four primary methods used to estimate construction costs. Those methods are known as

- Project Comparison Estimating or Parametric Cost Estimating
- Area & Volume Estimating,
- Assembly & System Estimating,
- Unit Price & Schedule Estimating.

Construction estimator plays essential role in the success of building construction projects. There are several requirements that each construction estimator need to have in order to produce proper estimation. For instance, he/ she needs to have sufficient knowledge about drawings. The most basic requirement for the preparation of a good bid is a precise and accurate estimate.

They are different types of cost estimates used in construction,

1. Preliminary Cost Estimate
2. Plinth Area Cost Estimate
3. Cube Rate Cost Estimate
4. Approximate Quantity Method Cost Estimate
5. Detailed Cost Estimate
6. Revised Cost Estimate
7. Supplementary Cost Estimate
8. Annual Repair Cost Estimate

1. **Preliminary Cost Estimate**

Preliminary cost estimate is also called as abstract cost estimate or approximate cost estimate or budget estimate. This estimate is generally prepared in initial stages to know the approximate cost of the project. By this estimate, the competent sanctioning authority can decide the financial position and policy for administration section.

Preliminary estimates are prepared with reference to cost of similar type projects in a practical manner. In this estimate, approximate cost of each important item of work is displayed individually to know the necessity and utility of each item of work. The items of work include cost of lands, cost of roads, electrification, water supply costs, cost of each buildings etc.

2. **Plinth Area Cost Estimate**

Plinth area cost estimate is prepared on the basis of plinth area of building which is the area covered by external dimensions of building at the floor level and plinth area rate of building which is the cost of similar building with specifications in that locality.

Plinth area estimate is obtained by multiplying plinth area of building with plinth area rate. For example if we require plinth area estimate of 100 sq.m in a particular locality and plinth area rate of a building in same locality is 2000 per sq.m then plinth area estimate is 100 X 2000 = 200000.Open areas, courtyards etc. are should not be included in plinth area. If building is multi storied, plinth area estimate is prepared separately for each floor level.

3. **Cube Rate Cost Estimate**

Cube rate cost estimate of a building is obtained by multiplying plinth area with the height of building. Height of building should be considered from floor level to the top of the roof level. It is more suitable for multi storied buildings.

This method of estimation is accurate than plinth area method. The rate per cubic meter is taken into consideration based on the costs of similar type of buildings situated in that location. Foundation, plinth and parapet above the roof level are not considered in this type of estimate.

4. **Approximate Quantity Method Cost Estimate**

In approximate quantity method cost estimate, Total wall length of structure is measured and this length is multiplied by rate per running meter which gives the cost of building. Rate per running meter is calculated separately for foundation and superstructure.
In case of foundation, rate per running meter is decided by considering quantities such as excavation cost, brick work cost up to plinth. While in case of superstructure quantities like brickwork for wall, wood works, floor finishing etc. are considered for deciding rate per running meter.

5. **Detailed Cost Estimate**

Detailed cost estimate is prepared when competent administrative authority approved the preliminary estimates. This is very accurate type of estimate. Quantities of items of work are measured and the cost of each item of work is calculated separately.

The rates of different items are provided according to the current workable rates and total estimated cost is calculated. 3 to 5 % of estimated cost is added to this for contingencies as miscellaneous expenditure.
The detailed Estimated should consist following details and documents.
Report
General Specifications
Detailed Specifications
Drawings/plans – layout plans, elevation, sectional views, detailed drawings etc.
Designs and calculations – In case of buildings design of foundations, beams, slab etc.
Schedule of rates

6**. Revised Cost Estimate**

Revised cost estimate is a detailed estimate and it is prepared when the original sanctioned estimate value is exceeded by 5% or more.The increase may be due to sudden increase in cost of materials, cost of transportation etc.

7. **Supplementary Cost Estimate**

Supplementary cost estimate is a detailed estimate and it is prepared freshly when there is a requirement of additional works during the progress of original work. The estimate sheet should consists of cost of original estimate as well as the total cost of work including supplementary cost of work for which sanction is required.

8. **Annual Repair Cost Estimate**

Annual repair cost estimate is also called as annual maintenance estimate which is prepared to know the maintenance costs of building which will keep the structure in safe condition. White washing, painting, minor repairs etc. are taken into consideration while preparing annual repair estimate for a building.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of the building costs and estimation of building. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Building Cost Estimation

Teaching Strategies
Students engage in brainstorming exercise to discover define building cost estimation.
They then are allowed to design guiding questions that will enable them to conduct research on define building estimation.
Discussions in groups on the research findings.
Teachers introduce students to building estimation cost.

Learning Strategies
Conduct a research with guiding questions that will lead to discovering building estimation cost.

Activity 1 Brainstorming activity define building cost estimation
Activity 2 Conduct research on define building cost estimation
Activity 3 Discussions and presentation of research findings

Resources

Define Building Estimation tutorial
Building cost and Estimation Textbook

Lesson 2: Methods of Estimating Building Costs

Teaching Strategies
Students engage in brainstorming exercise to discover methods of estimating building costs.
They then are allowed to design guiding questions that will enable them to conduct research Methods of estimating building costs.
Discussions in groups on the research findings.

Teachers introduce to students the methods of estimation of building costs.

Learning Strategies
Conduct a research with guiding questions that will lead to discovering building cost estimation.
Activity 1 Brainstorming activity methods of estimation building cost.
Activity 2 Conduct research on methods of estimation building cost.
Activity 3 Discussions and presentation of research findings.

Resources

Building Estimation cost tutorial
Building cost and Estimation Textbook

Lesson 3: Method of Preparing Material List and Quotation

Teaching Strategies
Students engage in brainstorming exercise to discover method of preparing material list and quotation.
They then are allowed to design guiding questions that will enable them to conduct research on different methods of preparing material list and quotation.
Discussions in groups on the research findings.
Teachers introduce students to methods of preparing material list and quotation.

Learning Strategies
Conduct a research with guiding questions that will lead to discovering what the terms are.

Activity 1 Brainstorming activity method of preparing material list and quotation.
Activity 2 Conduct research on method of preparing material list and quotation.
Activity 3 Discussions and presentation of research findings.

Resources

Method of preparing material list and quotation tutorial and practical lesson
Building cost and Estimation Textbook, Library resources

Lesson 4: The Role of a Building Estimator

Teaching Strategies
Students engage in brainstorming exercise to discover the role of a building estimator.
They then are allowed to design guiding questions that will enable them to conduct research on the role of a building estimator.
Discussions in groups on the research findings.
Teachers introduce students to the role of a building estimator.

Learning Strategies
Conduct a research with guiding questions that will lead to discovering what the role of a building estimator.

Activity 1 Brainstorming activity role of a building estimator.
Activity 2 Conduct research on role of a building estimator.
Activity 3 Discussions and presentation of research findings.

Resources

Role of Building Estimator tutorial and practical lesson
Building cost and Estimation Textbook

STEAM Activity Students work in groups to create estimate the cost of building of two bed room house (Hip-Roof) using Blueprint Plan.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to calculate Building Estimation costs
Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Define building costs estimation.
2. Analyse basic methods of estimating building costs.
3. Apply correct method of preparing material list and quotation.
4. The role of building estimator.

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1.Define building estimation	Accurately define building estimation	Correctly define building estimation	Partially define building estimation	Cannot define building estimation
2.Analyse basic methods of estimating building costs.	Accurately analyse basic methods of estimating building costs.	Correctly analyse basic methods of estimating building costs.	Partially analyse basic methods of estimating building costs.	Cannot analyse basic methods of estimating building costs.
3.Apply correct method of preparing material list and quotation	Accurately apply correct method of preparing material list and quotation	Correctly apply correct method of preparing material list and quotation	Partially apply correct method of preparing material list and quotation	Cannot apply correct method of preparing material list and quotation
4. Describe the role of building estimator	Accurately describe the role of building estimator	Correctly describe the role of building estimator	Partially describe the role of building estimator	Cannot describe the role of building estimator

Unit 2: Electrical Technology

Units	Topics	Lesson Titles
2. Electrical Technology	Topic 1. Licensing & Wiring Rules	1. Role of statutory/ regulatory body, National Energy Authority Electrical Licensing 2. Electrical Standards 3. Wiring Rules (AS/NZS 3000)
	Topic 2. Safety Practices	1. Electrical Accidents 2. Risk Assessment 3. Risk Management
	Topic 3. Concepts and principles of motors	1. Introduction to Motors 2. Generators and Transformers 3. Generation, Transmission and Distribution of Electricity
	Topic 4. Distinguish between single-phase and three-phase system	1. Single Phase 2. Three – phase
	Topic 5. Circuit Diagrams	1. Technical Drawing 2. Schematic diagrams 3. Pictorial diagrams 4. Wiring diagrams
	Topic 6. Parts and Components	1. Electrical, accessories, tools and materials 2. Installation Process

UNIT 2. Electrical Technology

Content Standard 3.2. Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.

Benchmark 11.3.2.1. Discover and interpret the licensing and standard wiring requirements for an electrician in the electrical technology.

Topic 1: Licensing and Wiring Rules

Learning Objectives

By the end of this topic, the students will be able to;

1. Describe the role of National Energy Authority and how it regulates electricity.
2. Define and state the different types of electrical licensing and their requirement.
3. Discover electrical standards in Papua New Guinea
4. Describe the purpose of the wiring rules and interpret and apply the sections of the wiring rule books in real life situations

Essential Questions:

1. What is an electrical license?
2. How many types of licenses are there?
3. What standards do we use in PNG?
4. What is the name and role of the statutory or regulatory body for electricity in PNG?

Essential Knowledge, Skills, Values and Attitudes:
Knowledge: Licensing and wiring requirements of an electrician
Skills: Discover and Interpret
Values: Awareness, value and caring and concerned
Attitudes: Appreciative and responsibly follow the standard wiring rules and electrical licensing regulations of PNG

Content Background

Roles of statutory/ regulatory body in PNG
National Energy Authority
National Energy Authority is a fully integrated power authority responsible for generation, transmission, distribution and retailing of electricity throughout Papua New Guinea and servicing individual electricity consumers.
NEA services customers in almost all urban centres throughout the country encompassing industrial, commercial, government and domestic sectors. Where possible, the services extend to rural communities adjacent to these urban centres.
NEA is also undertaking a regulatory role on behalf of the Independent Consumer and

Competition Commission (ICCC). These responsibilities include approving licenses for electrical contractors, providing certification for models of electrical equipment and appliances to be sold in the country and providing safety advisory services and checks for major installations.
PNG Power Limited (Company No 1-44680) was corporatized under Section 3 (1) of the Electricity Commission (Privatisation) Act 2002 as the successor company to the Papua New Guinea Electricity Commission (ELCOM). All of ELCOM's assets, liabilities, rights, titles and personnel were transferred to PPL. This role has been transferred to the National Energy Authority.

Company Ownership and Reporting
PPL is a State Owned Entity (SOE). The Kumul Consolidated Holdings Limited (KCHL) holds the shares for corporatized state entities as trustee of the General Business trust. The KCHL acts as the sole shareholder on behalf of the Government. The Minister for Public Enterprise and State Investments appoints a Board who report to KCHL. PPL, through the Board provides regular financial and operational reports and a Five-year Business Plan to KCHL on an annual basis.

PNG Power Ltd Board
The PPL Board consists of 8 Directors appointed through KCHL. The Directors come from a diverse professional background whose task is to make policy decisions for the operations of PNG Power.

PNG Power Ltd Constitution
PPL was established under the Electricity Commission (Privatisation) Act of 2000 to be the successor company taking over all assets, liabilities and personnel of the Papua New Guinea Electricity Commission (ELCOM). PNG Power is also governed by another Act of Parliament, the Electricity (Amendment) Act which established a regulatory regime for the Electricity Industry.
PPL as a corporatized entity operates in accordance with the Companies Act 1997. The Constitution of PPL has been established in compliance with this Act. The Constitution establishes the functions and responsibilities of the Board to the shareholders and the general administrative and reporting requirements.

ELECTRICAL LICENSING
ELECTRICAL LICENSES – NEA
AS AN INDEPENDENT STATE, ELECTRICAL WORK AND PRACTICE IN PAPUA NEW GUINEA IS SUBJECT TO LEGISLATION, REGULATION & GOVERNMENT POLICY THAT CHANGE FROM TIME TO TIME.
.
It is important to note that though Independent Consumer & Competition Commission (ICCC) is the Regulator it however has delegated the Function of Electrical Licensing to NEA.

ELECTRICIANS LICENSE
This is a permit issued:
· To a qualified/certified electrical trade person following successful passing of the set Electricians Licensing Examination.
· The Electricians Licensing Examination is conducted quarterly in a year and may be conducted at other times at the discretion of the Regulator.
· Under the Regulation (Licensing of Electrical Contractors and Electricians) all foreign licensed electricians must be licensed by PNG Power through the office of the

Regulatory Service Group to operate in PNG.
Note:
1. Holders of Australia and New Zealand Electricians License must apply to be issued a PNG Electricians License without further testing.
2. Other nationalities will have to sit the Electricians Licensing Examination to qualify (due to adaptation of Wiring Standards – AS/NZS 3000 Wiring Rules). This standard can be purchased from National Institute of Standards & Industrial Technology (NISIT).
3. It is a 'must' that Applicant holds 'valid work permit'.

ELIGIBILITY
The Applicant must:
· Be 19 years and above
· Have Completed Apprenticeship,
· Holder of an Electrical Trade Certificate.
· Electrical Engineering graduates must possess at least 5 years work experience.
· Hold a 'valid work permit' for foreign applicants.

ELECTRICAL CONTRACTORS LICENSE
This is a permit issued to an IPA (Investment Promotion Authority) registered company in Papua New Guinea whether Sole or Corporate who intend to carry out electrical work as its business or part thereof in the country.

ELIGIBILITY
The Applicant must:
1. Have a PNG Licensed Electrician in their employment ('valid work permit' a 'must' for overseas applicant).
2. Have a valid PNG based postal address.
3. Ensure that the Licensed Electrician at all times be on worksites.
4. Ensure that the Licensed Electrician is not employed elsewhere.

NOTE:
a) UMBRELLA LICENSING is only possible when one major electrical company is awarded contract for all electrical works.
b) COMPLIANCE to wiring standards and applicable inspections for all anticipated project work in isolated location in Papua New Guinea will be the responsibility of the major Electrical Company.
c) FINAL INSPECTION of all wiring work in the country must be certified by an authorised Electricity Inspector of the Regulator. The authorised Electricity Inspector reserves the right of final inspection on completion & certification.
d) If eligible, one can collect and complete required Form.
e) Pay the applicable fee.
f) Return completed Form with other applicable documents & receipt of payment and lodge them with the Licensing Clerk.
g) The normal turn-around time for applications - assuming the applications meet all requirements can be processed within ten (10) working days of receipt.
h) All electrical installation works (including temporary) are subject to periodic inspections by electricity inspectors. Regulatory Service Inspectors reserves the right of inspection and certification.

FINAL INSPECTION & CERTIFICATION.

i) A major project can engage one licensed electrical contractor or multiple to cover all associated electrical works or can subcontract portions of the electrical installation; however, all electrical contractors must be licensed respectively.
j) Licensed Electrician is responsible for providing all electrical plans/drawings and applicable notices to inspectors for assessment, appointment, inspection, approval & certification.
k) Unless reviewed Electrical Licenses are valid for the life time of the Holder.
l) Electrical Contractors Licenses are valid for 12 months.
m) License renewal is the responsibility of the Holder.
Correspondences from PNG Power, Kave J,(2023) Manager Regulatory Services Group Operations & Maintenance Business Unit

Electrical Standards
The practice of the Electrical Industry in Papua New Guinea is as per Standards Australia - AS/NZS 3000 Wiring Rules (PNGS 1022), the current edition.
In Papua New Guinea the standard voltage is 240 V and the frequency is 50 Hz. You can use your electric appliances in Papua New Guinea, if the standard voltage in your country is in between 220 - 240 V (as is in the UK, Europe, Australia and most of Asia and Africa).

Wiring rules (AS/NZS 3000)
The current Wiring Rules are the accepted Australian and New Zealand rules and are incorporated in the regulations in each jurisdiction; they are the minimum legal requirement and their provisions are enforceable by law. Those who directly deal with the design and installation of electrical wiring and equipment must be thoroughly familiar with the use and application of the Wiring Rules to ensure the safety and effectiveness of the electrical system in a building or premises. A competent Electrician regards the Wiring Rules as a tool and keeps up to date with any changes, amendments and revised edition. The Wiring Rules is set out in two parts and eight sections. Part 1 sets the safety and performance standards to which an electrical installation shall comply, whereas Part 2 provides installation practices that achieve certainly of compliance with the standards set out in Part 1.

The Wiring Rules book follows a logical plan, with rules commencing at the supply end of the installation of wiring, equipment and earthing. These are followed by requirements for special types of installations and then verification by inspection and testing. It finishes with appendices for information and guidance in applying the requirements of the standard. The rules are written in the form of clauses designated by a point numbering system, the first number identifies the section under which the clause appears. The Appendices is the help file as the task of using it will become much easier to discover sections of the wiring rules.

Teaching and Learning Strategies
Teachers are encouraged to introduce students to industry personnel and workspace to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to *understand and comprehend electrical licensing, standards and wiring rules used in PNG and also the role of PNG Power Limited.* The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Role of the Statutory Body

Lesson Objective: Students will be able to:

1. Describe the roles of PNG Power Ltd and the National Energy Authority.
2. Explain the regulations that guides electricity distribution in PNG.

Knowledge: Role of the statutory body that governs distribution of electricity in PNG
Skills: Describe and explain the function of the statutory body for electricity in PNG.
Values: appreciate
Attitudes: Value

Teaching Strategies
· Students engage in brainstorming exercise to discover which statutory body regulates electricity distribution in PNG.
· Design guiding questions that will enable them to conduct research on how Electrical licensing is done or obtained in PNG
· Discussions in groups on the research findings and facilitate students' research findings as a class discussion.

Learning Strategies
Activity 1 Brainstorming activity on electrical licenses
Activity 2 Conduct research on how electrical licensing is done in PNG
Activity 3 Discussions and presentation of research findings on electrical licensing in PNG

Teacher	Student
Introduction	
Put forward a question for class discussion, (what is the name of the statutory body that regulates electricity distribution in PNG?) Introduces PNG Power Ltd personnel	Brainstorm name of Electricity regulation in PNG as PNG Power Ltd and the National Energy Authority and design questions to ask the resource person. Welcome the resource personnel with an applause
Body	
The invited guest then speaks to students on this following areas · History of PNG Power Ltd · PNG Power Ltd Hierarchy of departments · Role of PNG Power Ltd · The laws/ regulations used by PNG Power · Who is PNG Power answerable to	Students take note and asks questions relating to PNG power operations
Conclusion	
Conclude lesson with main areas discussed Facilitates appreciation of the resource person.	Respond with the main areas discussed Present a token of appreciation to the resource person.
Assessment	
Prepare a questionnaire based on the resources person's speech and conduct it for assessment.	Complete assessment task by answering the questionnaire.

Resources

PNG Power Ltd personnel

Lesson 2: Electrical Licensing

Teaching Strategies
Teachers guide students to prepare to do research questions based on electrical licensing. statutory body that governs distribution of electricity in PNG
Conducts a general discussion on what electrical licensing is and why licensing is done and its importance?
Invite Personnel from the Regulatory Services Group Operations & Maintenance Business Unit in PNG Power Limited. Or invite a licensed electrician to discuss the process he or she has taken to obtain electrical license.

Learning Strategies
Students listen and take note.
Activity 1: Construct questions to ask the resource personnel
Activity 2: Take note of the points mentioned by the invited guest regarding licensing.

Resources
A PNG Power Personnel or a Licensed Electrician or Contractor

Lesson 3: Electrical Standards

Teaching Strategies
Teachers guide students to prepare to do research questions based on electrical standards.
Conducts a general discussion on what electrical standards are used in PNG and why?
Invite a PNG Power Personnel or invite a licensed electrician to discuss electrical standards that PNG are guided with for any electrical work

Learning Strategies
Students listen and take note.
Activity 1: Construct questions to ask the resource personnel
Activity 2: Take note of the points mentioned by the invited guest regarding Electrical standards.

Resources
A PNG Power Personnel or a Licensed Electrician or Contractor

Lesson 4: Wiring Rules AS/NZS 3000

Teaching Strategies
Presents students with the wiring rules section and students work in groups to discuss and interpret what each section is all about. Then facilitates students presentation. Follow up with a summary PowerPoint presentation from the trainer.

Learning Strategies
Students work in groups discussing and interpreting a section of the wiring for the group. Then present it to the class as a class discussion**.**

Activity 1: Discuss in groups a section of the Wiring Rules given by the instructor. Interpret and describe the section and what it covers.

Activity 2: Students present in groups the section of the *Wiring Rules* assigned to them.

Resources
Wiring Rules (3000:2007) edition or the updated version.

STEAM Activity Teacher to decide and provide a safe practical activity for students to apply the sections of the wiring rule books in a real life situation(s). Students will then explain the STEAM concepts involved.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to describe the roles of PNG Power Ltd, the licensing types, their functions and their requirements, the Electrical Standards used in PNG and the *Wiring Rules (3000:2007)* Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Describe the role of PNG Power limited and how it regulates electricity.
2. Define and state the different types of electrical licensing and their requirement.
3. Discover electrical standards in Papua New Guinea
4. Describe the purpose of the wiring rules and interpret and apply the sections of the wiring rule books in real life situations

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. 1. Describe the role of PNG Power limited demand how it regulates electricity.	Confidently describes in detail the role of PNG Power Ltd and how it regulates electricity in PNG	Briefly outlines the roles of PNG Power and its electricity regulation	Describes the role of PNG Power Ltd but cannot further explain the electricity regulation in PNG	Cannot describe the role of PNG Power Ltd nor its electricity regulations
2. Define and state the different types of electrical licensing and their requirement.	Confidently defines electrical licensing and state the different types, their uses and requirements to obtaining them.	Briefly explains electrical licensing requirements	Defines electrical licensing but does not state the types and requirements in obtaining them.	Cannot define or even state the types of licensing and requirements to obtain one.
3. Discover and state electrical standards in Papua New Guinea	Discover and state correctly and confidently the standards that are used in PNG	Discover electrical standards used in PNG	Not sure of the standards used in PNG and sort to guessing	Cannot discover and state the electrical standards

				used in PNG
4.Describe the purpose of the wiring rules, interpret and apply the sections of the wiring rule books in real life situations	Describes the purpose of the wiring rules clearly and always keep referencing *Wiring Rules* in real life electrical situations such as wirings systems or equipment.	Describes the purpose of *Wiring Rules* and at times reference it in real life situations	Describes the role of the *Wiring Rules* only.	Cannot describe the purpose or reference it in real life situations.

UNIT 2. Electrical Technology

Content Standard 3.2. Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.

Benchmark 11.3.2.2. Assess and apply standard safety, health and environmental practices.

Topic 2: Safety Practices

Learning Objectives
By the end of this topic, the students will be able to;

1. Define electrical accidents and state the types and causes
2. Explain how risks are assessed and are managed.

Essential Questions:
1. What is an electrical accident?
2. What is risk?
3. How do we identify and assess risks?
4. Howdo we manage risks?

Essential Knowledge, Skills, Values and Attitudes:
Knowledge: standard safety, health and environmental practices
Skills: Assess and apply safety practices to prevent electrical accidents.
Values: Appreciate, responsible and careful observation and application
Attitudes: Responsible and aware of the safety, health and environmental issues associated with Electrical Technology.

Content Background

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Electrical Accidents
An electrical accident is an undesired event caused by electric current resulting in injury to a person or damage to property. Injury means suffering, discomfort/inconvenience, bodily or psychological injury or death that is caused by electric current.
According to the Health and Safety Executive (HSE) in the UK, who collect and analyse data on electrical accidents, among other things, there are 12 common causes of electrical accidents that happen while the equipment is being maintained which is in some way similar to Papua New Guinea context:
1. Unsafe system of work
2. Inadequate information
3. No training
4. Inadequate isolation
5. Unsafe Rules
6. Poor control of work activities
7. Working Live
8. Unsuitable test equipment

9. Poor maintenance
10. Failure to manage work
11. Person not competent
12. Uninsulated electrical wiring

RISK ASSESSMENT

Risk assessment is a term used to describe the overall process or method where you:
Identify hazards and risk factors that have the potential to cause harm (hazard identification).
Analyse and evaluate the risk associated with that hazard (risk analysis, and risk evaluation).

RISK ASSESSMENT STEPS

Step 1: Identify the hazard (Hazard is anything that has the potential to harm you)
Step 2: Decide who might be harmed and how
Step 3: Evaluate the risk and decide on the precaution
Step 4: Record your findings and implement them
Step 5: Review your assessment and update if necessary.

RISK MANAGEMENT

Risk management is the identification, evaluation, and prioritization of risks followed by coordinated and economical application of resources to minimize, monitor, and control the probability or impact of unfortunate events or to maximize the realization of opportunities.

RISK MANAGEMENT PROCESS

Figure 2.2a Risk management process
Source: https://www.google.com/search?q=flow%20chart%20risk%20management%20process

RISK ASSESSMENT AND MANAGEMENT PROCESS CHART

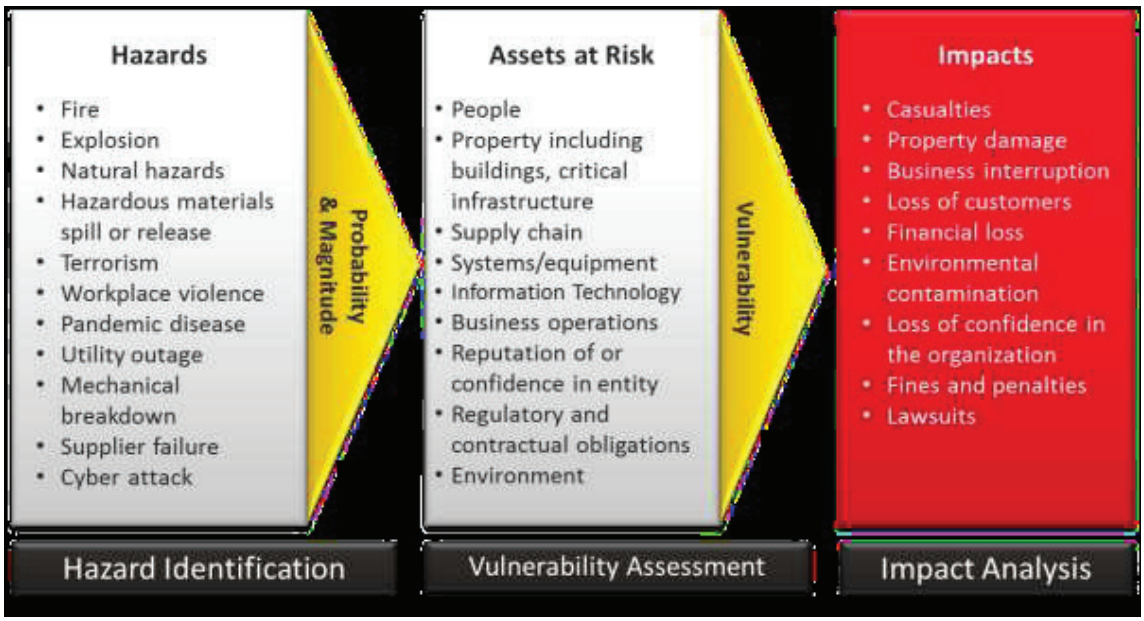

Figure 2.2b Risk management process chart
Source: https://www.google.com/search?q=flow%20chart%20risk%20management%20process

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations and case studies to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of types and causes of electrical accidents and work and how the risks can be assessed and managed. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Electrical Accidents

Teaching Strategies

Students engage in brainstorming exercise to discover what electrical accidents are and the different types and causes as well as how to prevent them from happening. Students
Are then guided on how to do case study and how to analyse findings on the case study and reporting. They then are given a role to demonstrate how electrical accidents are caused.

Learning Strategies

Students do brainstorming for ideas on electrical accidents. They then are allowed to do case studies based on Electrical accidents, the types, causes and ways to prevent Discussions in groups on the case study and present views of each case study that is looked at. Put on a role play demonstrating how electrical accidents are caused.
Activity 1 Brainstorming activity
Activity 2 Do case Study
Activity 3 Discussions and presentation of Case study analysis and evaluations.
Activity 4 Demonstrate role play on how electrical accidents are caused.
Resources

Different case studies on Electrical Accidents.

Lesson 2: Risk Assessment

Teaching Strategies
Students engage in brainstorming exercise to discuss how to assess risks. Students are then guided on how to do case study and how to analyse findings on the case study and reporting.

Learning Strategies
Students do brainstorming for ideas on Risk assessment. They then are allowed to do case studies based on how to assess risk of electrical accidents. Discussions are then done in groups on the case study and present views of each case study that is looked at.
Activity 1 Brainstorming activity
Activity 2 Do a case Study
Activity 3 Discussions and presentation of Case study analysis and evaluations.
Resources
Case study on Electrical accidents and how to assist risks.

Lesson 3: Risk Management

Teaching Strategies
Students are now guided to work on a project after knowing electrical accidents and the risks involved. They are guided to work in groups of to identify potential hazards in the electrical workshop or around school ground, their further are guided to assess their risks and identify and apply control measures to reduce or control their risks. Guide them to do a presentation on the project carried out.

Learning Strategies
Students work on a project implementing risks assessment and management. They carry out a real project in a workshop or in the school ground.
Activity 1 Put in groups to decide a project to carryout.
Activity 2 Implement risks assessments and management
Activity 3 Do a presentation on the project undertaken.

Resources
Workshop set-up or school campus, computers, projector

STEAM Activity Download pictures depicting electrical hazards in the work place or at home. State safety measures to avoid hazards and calculate the maximum safe amount of current that can be used in a circuit that has 20Amp circuit breaker and if the National Electrical Code & Outlet states that is up to 80% of the capacity of the circuit breaker can be used at any one point in one time.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to identify electrical accidents and hazards, assess and manage risk. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Explore the social application of electricity to improve quality of human life
2. Identify solutions to electrical problems to improve social application of electricity

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Define Electrical accidents and state the types and causes	Defines electrical accidents and identifies the different types and causes confidently and in detail	Briefly explains electrical accidents with types and causes	A progressive explanation of electrical accidents, the types and causes	Cannot explain electrical accidents, the types or causes
2. Explain how risks are assessed	Clearly outlines the procedures on how risk are accessed in detail	Briefly outlines how risks are assessed	Explanation not very clear on risks assessment.	Cannot assess risks
3. Explain how risks are managed	Clearly explains and apply control measures to manage risks step by step.	Explains risk managements strategies only .	Explanation not too clear	Cannot explain how to manage risks

Unit 2: Electrical Technology

Content Standard 3.2. Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.

Benchmark 11.3.2.3. Explore the concepts and principles used in the electrical field with a relevant knowledge of motors, generators and transformers and their use in the power generation and distribution system.

Topic 3: Concepts and Principles of Motors

Learning Objectives

By the end of this topic, the students will be able to;

1. Define and explain the operation of motors.
2. Explain functions of generators and transformers.
3. Explain the generation, transmission and distribution of electricity in PNG.

Essential Questions:

1. What is a motor?
2. What is the function of transformers and generators?
3. What is electricity generations, transmission and distribution?
4. How is electricity generated, transmitted and distributed?

Essential Knowledge, Skills, Values and Attitudes:

Knowledge: Concepts, principles and uses of motors, generators and transformers
Skills: Investigate, explore and discover
Values: Appreciate, value, considerate and responsible
Attitudes: Open-minded and appreciative of understanding the operational principles of electric motors.

Content Background

Introduction to motors

An electric motor is an electrical machine that converts electrical energy into mechanical energy. Most electric motors operate through the interaction between the motor's magnetic field and electric current in a wire winding to generate force in the form of rotation of a shaft. One of the fundamental elements of an Electrician is knowing about the different types of electric motors. Without electric motors, we would not have power tools, household appliances, or even cars.

DC Motors

DC stands for “direct current,” and they were the first type of motors that were commonly used because they could be powered from a pre-existing power distribution system. The speed in a DC motor can be adjusted through the intensity of its current. The current is carried through an armature or stator. The armature contains the coiled (star-formation for astator) copper or aluminum wiring (commonly referred to as “windings”), and they both provide points for the wire to connect to the rest of the motor so that the electricity can continue to flow properly.

AC Motors

A motor that reverses the direction of an electrical current at regular times is called an alternating current motor, or more commonly known as an AC motor. This type of motor uses opposing and attracting magnetic forces to propel the AC through the motor. There are magnets attached to both an external stationary stator, and an internal rotor. The rotor is able to move because the current is reacting to the magnetic poles, creating a rotating magnetic field.

Generators and transformers

Generators are useful appliances that supply electrical power during a power outage and prevent discontinuity of daily activities or disruption of business operations. Generators are available in different electrical and physical configurations for use in different applications. An electric generator is a device that converts mechanical energy obtained from an external source into electrical energy as the output.
It is important to understand that a generator does not actually ‘create’ electrical energy. Instead, it uses the mechanical energy supplied to it to force the movement of electric charges present in the wire of its windings through an external electric circuit. This flow of electric charges constitutes the output electric current supplied by the generator. This mechanism can be understood by considering the generator to be analogous to a water pump, which causes the flow of water but does not actually ‘create’ the water flowing through it.

The modern-day generator works on the principle of electromagnetic induction discovered by Michael Faraday in 1831-32. Faraday discovered that the above flow of electric charges could be induced by moving an electrical conductor, such as a wire that contains electric charges, in a magnetic field. This movement creates a voltage difference between the two ends of the wire or electrical conductor, which in turn causes the electric charges to flow, thus generating electric current.

Main components of a generator
(1) Engine
(2) Alternator
(3) Fuel System
(4) Voltage Regulator
(5) Cooling and Exhaust Systems
(6) Lubrication System
(7) Battery Charger
(8) Control Panel

(9) Main Assembly / Frame

Another very useful and common device that exploits magnetic induction is called a transformer. Transformers do what their name implies—they transform voltages from one value to another; the term voltage is used rather than emf because transformers have internal resistance. For example, many cell phones, laptops, video games, power tools, and small appliances have a transformer built into their plug-in unit that changes 120 V or 240 V AC into whatever voltage the device uses.

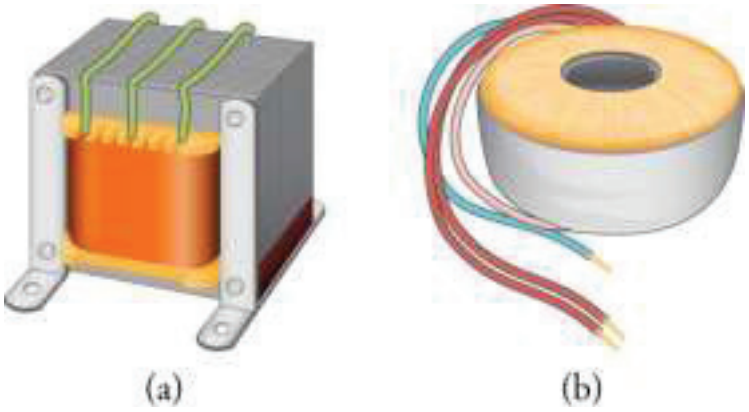

Figure 2.3a is a common laminated-core transformer. b. toroidal transformer
Source: https://circuitdigest.com/tutorial/different-types-of-transformers-and-their-applications

On the left (a) is a common laminated-core transformer, which is widely used in electric power transmission and electrical appliances. On the right (b) is a toroidal transformer, which is smaller than the laminated-core transformer for the same power rating but is more expensive to make because of the equipment required to wind the wires in the doughnut shape.

Generation, Transmission and Distribution of electricity

There are three stages of electric power supply; generation, transmission and distribution. Each of these stages involves distinct production processes, work activities and hazards. Most electricity is generated at 13,200 to 24,000 volts. After electrical power is generated, it is transmitted over distances using transmission lines. Transmission lines are constructed between transmissions substations located at electric generating stations. Transmission lines may be supported overhead on towers or they may be underground. They are operated at high voltages. They send out large amounts of electrical power and extend over considerable distances. When electricity comes out of a generating station, the transmission substation located there steps up the voltages to the range of 138,000–765,000 volts. Within the operating area, transmission substations reduce the transmitted voltage to 34,500–138,000 volts. This power is then carried through lines to the distribution systems located in the local service territory.

The distribution system connects the transmission system to the customer's equipment. The distribution substation reduces the transmitted electrical voltage to 2,400–19,920 volts. A distribution transformer further reduces the voltage.

Transmission and distribution substations are installations where the voltage, phase or other characteristics of the electrical energy are changed as part of the final distribution process.

A distribution substation is located near or inside city/town/village/industrial area. It receives power from a transmission network. The high voltage from the transmission line is then stepped down by a step-down transformer to the primary distribution level voltage.

Electrical distribution systems are an essential part of the electrical power system. In order to transfer electrical power from an alternating current (AC) or a direct current (DC) source to the place where it will be used, some type of distribution network must be utilized.

Distribution systems usually employ such equipment as transformers, circuit breakers, and protective devices. The original electrical distribution system developed by Thomas Edison was an **underground direct current (DC) system**. In general, the distribution system is the electrical system between the substation fed by the transmission system and the consumer end. It generally consists of feeders, distributors. Basically we can say, that part of power system which distributes electric power for local use is known as distribution system.

A feeder is a conductor which connects the substation (or localized generating station) to the area where power is to be distributed. Generally, no tapings are taken from the feeder so that current in it remains the same throughout. The main consideration in the design of a feeder is the current carrying capacity.

A distributor is a conductor from which tapings are taken for supply to the consumers. The current through a distributor is not constant because tapings are taken at various places along its length. A service maim is generally a small cable which connects the distributor to the consumers' terminals.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to understand how motors work, describe functions of transformers and generators and explain how electricity is generated, transmitted and distributed. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving,

which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Introduction to Motors

Teaching Strategies
Students engage in brainstorming exercise to discover what motors are.
They then are shown a video on how motors function and basic practical application of motors.
Then discuss in groups on the video.

Learning Strategies
Students do brainstorm on motors and watch a tutorial video on motors then a discussion on video analysis.
Activity 1 Brainstorming activity
Activity 2 Watch a tutorial on motors
Activity 3 Discussions in groups and presentation of ideas on motors.

Resources
Video tutorial on motors

Lesson 2: Generators and Transformers

Teaching Strategies
Students are guided to write up guiding questions to do research on generators or transformers. They then discuss in groups and do a presentation. After the presentation, they are given some identification activities on parts of generators and transformers and do more activities on problem solving with transformers.

Learning Strategies

Students write up research guiding questions, do research and discussion in groups ending with a presentation. They then proceed to identification and problem solving activities in pairs to do with transformers and generators.

Activity 1 Design guiding questions to do research
Activity 2 Discussion in groups
Activity 3 Presentation of group discussion
Activity 4 Do problem-solving and identify activities in pairs.

Resources
Identification and Problem-solving worksheet on Generators and Transformers.

Lesson 3: Generation, Transmission and Distribution of Electricity

Teaching Strategies
Teachers are encouraged to organise a field trip or excursion to PNG Power Ltd facilities to see how power is generated, transmitted and distributed throughout the city and country.
They then are asked to write up a report on the field trip on how they have understood the topic and facilitate their presentation.

Learning Strategies
Students go on a field trip or excursion to discover how electricity is generated, transmitted and distributed in Port Moresby from Rouna Power Stations. They then compile a report based on their experience and share as a class discussion.
Activity 1 Students go on a field trip or excursion
Activity 2 They should compile a report and share a presentation.

Resources

STEAM Activity Students work in groups to create an activity incorporating the concept of the operating principles of motors.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to discover how electricity is generated, transmitted and distributed in Port Moresby and Country. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Define and explain the operation of motors
2. Explain functions of generators and transformers
3. Explain the generation, transmission and distribution of electricity in PNG

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Define and explain the operation of motors	Confidently defines and explains the basic operation of a motor	Briefly explains the operation of a motor	Defines motors but Explanations are not too clear on the operation of a motor or vice versa	Cannot define or explain the operation of a motor.
2. Explain functions	Confidently explains and	Briefly explains functions of	Explanations not too clear on	Cannot explain the

of generators and transformers	distinguishes the functions of generators and transformers in detail	generators and transformers	function of generators and transformers	functions of generators and transformers
3. Explain the generation, transmission and distribution of electricity in PNG	Confidently explains generation, transmission and distribution of electricity in PNG.	Briefly explains generations, transmission and distribution of electricity	Explanations not too clear on generation, transmission and distribution of electricity in PNG	Cannot explain the generation, transmission and distribution of electricity.

UNIT 2. Electrical Technology

Content Standard 3.2. Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.

Benchmark 11.3.2.4. Distinguish between single phase and three phase systems

Topic 4: Distinguish between single-phase and three-phase system

Learning Objectives

By the end of this topic, the students will be able to;

1. Explain single phase and three phase.
2. Distinguish single phase from three phase describing components and functions in installations.

Essential Questions:

1. What is an Alternating Current (AC)?
2. What is the difference between single phase and three phase systems?

Essential Knowledge, Skills, Values and Attitudes:

Knowledge: single phase and three phase
Skills: distinguish
Values: Appreciate, value, considerate and responsible
Attitudes: Critical and open-minded when assessing single-phase and three-phase systems.

Content Background

Alternating Current

Alternating current, abbreviation AC, flow of electric charge that periodically reverses. It starts, say, from zero, grows to a maximum, decreases to zero, reverses, reaches a maximum in the opposite direction, returns again to the original value, and repeats this cycle indefinitely. The interval of time between the attainment of a definite value on two successive cycles is called the period, the number of cycles or periods per second is the frequency, and the maximum value in either direction is the amplitude of the alternating current. Low frequencies, such as 50 and 60 cycles per second (hertz), are used for domestic and commercial power, but alternating currents of frequencies around 100,000,000 cycles per second (100 megahertz) are used in television and those of several thousand megahertz in radar or microwave communication. Cellular telephones operate at frequencies of about 1,000 megahertz (1 gigahertz).

In electricity, the phase refers to the distribution of a load. What is the difference between single-phase and three-phase power supplies? Single-phase power is a two-wire alternating current (ac) power circuit. Typically, there is one power wire—the phase wire—and one neutral wire, with current flowing between the power wire (through the load) and the neutral wire. Three-

phase power is a three-wire AC power circuit with each phase ac signal 120 electrical degrees apart.
Residential homes are usually served by a single-phase power supply, while commercial and industrial facilities usually use a three-phase supply. One key difference between single-phase vs. three-phase is that a three-phase power supply better accommodates higher loads. Single-phase power supplies are most commonly used when typical loads are lighting or heating, rather than large electric motors. (Fluke Resource Centre,2022)

Single Phase
In electrical engineering, **single-phase electric power** is the distribution of alternating current electric power using a system in which all the voltages of the supply vary in unison. Single-phase distribution is used when loads are mostly lighting and heating, with few large electric motors. A single-phase supply connected to an alternating current electric motor does not produce a rotating magnetic field; single-phase motors need additional circuits for starting (capacitor start motor), and such motors are uncommon above 10 kW in rating.
Because the voltage of a single phase system reaches a peak value twice in each cycle, the instantaneous power is not constant. (Wikipedia,2022)

A single-phase load may be powered from a three-phase distribution transformer in two ways: by connection between one phase and neutral or by connection between two phases. These two give different voltages from a given supply. For example, on a 120/208 three-phase system, which is common in North America, the phase-to-neutral voltage is 120 volts and the phase-to phase voltage is 208 volts. This allows single-phase lighting to be connected phase-to-neutral and three-phase motors to be connected to all three phases. This eliminates the need of a separate single phase transformer.

Standard frequencies of single-phase power systems are either 50 or 60 Hz. Special single phase traction power networks may operate at 16.67 Hz or other frequencies to power electric railways. (Wikipedia,2022)

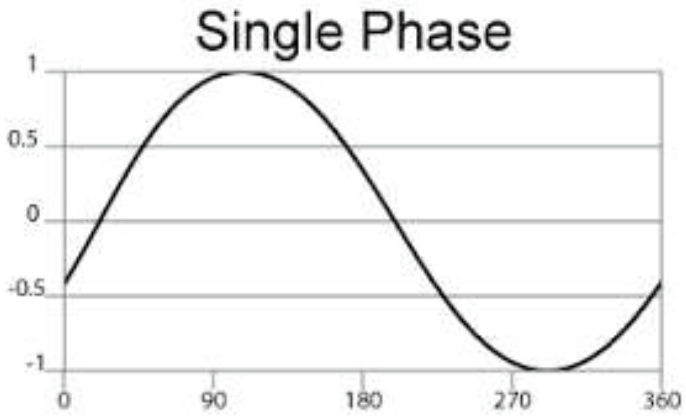

Figure 2.4a Single-phase power graph
Source: https://www.ukfrs.com/promos/17145

Three Phase
One other important difference between 3-phase power vs. single phase power is the consistency of the delivery of power. Because of the peaks and dips in voltage, a single-phase power supply simply does not offer the same consistency as a three-phase power supply. A three-phase power supply delivers power at a steady, constant rate.

Comparing single-phase vs. three-phase power, three-phase power supplies are more efficient. A three-phase power supply can transmit three times as much power as a single-phase power supply, while only needing one additional wire (that is, three wires instead of two). Thus, three phase power supplies, whether they have three wires or four, use less conductor material to transmit a set amount of electrical power than do single-phase power supplies.

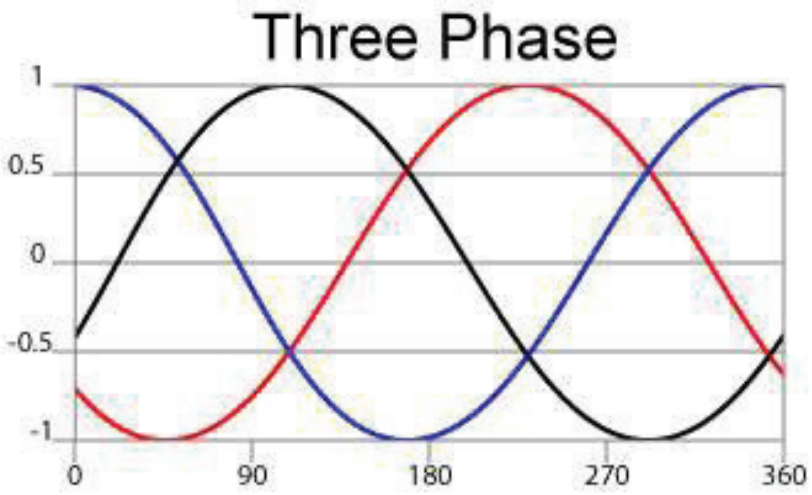

Figure 2.4b Three-phase power graph
Source: https://www.ukfrs.com/promos/17145

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students differentiate between single-phase and three-phase. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Single-Phase

Teaching Strategies

Students are guided to write up guiding questions to do research on single phase. They then discuss in groups and do a presentation. After the presentation, they are then given some problem solving activities to solve regarding single-phase system.

Learning Strategies

Students write up research guiding questions, do research and discussion in groups ending with a presentation. They then proceed to problem solving activities in pairs with single phase activities.

Activity 1 Design Guiding questions to do research
Activity 2 Discussion in groups
Activity 3 Presentation of group discussion

Activity 4 Do problem-solving activities in pairs.

Resources
Problem-solving worksheet on Single-phase.

Lesson 2: Three-Phase

Teaching Strategies
Students are guided to write up guiding questions to do research on single phase. They then discuss in groups and do a presentation. After the presentation, they are then given some problem solving activities to solve regarding three-phase system. They further on facilitate and experiment using electrical instruments to measure three-phase system.

Learning Strategies
Students write up research guiding questions, do research and discussion in groups ending with a presentation. They then proceed to problem solving activities in pairs with three-phase activities. They further on experiment using electrical instruments to measure three-phase system.
Activity 1 Design Guiding questions to do research
Activity 2 Discussion in groups
Activity 3 Presentation of group discussion
Activity 4 Do experiment using electrical instruments to measure three-phase system.

Resources
Problem-solving worksheet on three-phase and oscilloscope, multimeters

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STEAM Activity Students work in groups to create an activity incorporating the concepts of single and three phase systems.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to differentiate single-phase and three-phase. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Explain single phase and three phase.
2. Distinguish single phase from three phase.

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing .	Not Yet
1. Explain single phase and three phase	Confidently explains single phase and three phase with practical examples	Briefly explains single phase and three phase	Not too confident in explaining single phase and three phase	Cannot explain single phase or three phase
2. Distinguish single phase from three phase.	Confidently distinguishes single phase from three phase using their wave forms	Briefly distinguishes single phase from three phase	The distinction made for single and three phases is not too clear.	Cannot distinguish single phase from three phase

UNIT 2. Electrical Technology

Content Standard 3.2. Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.

Benchmark 11.3.2.5. Compare and analyse electronic and electrical drawings and illustrations according to engineering standards manually and with the use of technology..

Topic 5: Circuit Diagrams

Learning Objectives

By the end of this topic, the students will be able to;
1. Define technical drawing.
2. Demonstrate functions of each drawing equipment.
3. Design and create sketches and 3D models.
4. Define and differentiate schematic, pictorial and wiring diagrams.

Essential Questions:
1. What is technical drawing?
2. What is a circuit diagram?
3. How do we describe a schematic circuit diagram?
4. What is a pictorial diagram?
5. What is a wiring diagram?
6. What is an electrical floor plan?

Essential Knowledge, Skills, Values and Attitudes:
Knowledge: Circuit diagrams, floor plans
Skills: Investigate, explore and discover
Values: considerate and responsible
Attitudes: Open-minded and critical when analysing technical drawings.

Content Background

Circuit Diagrams
A circuit diagram (electrical diagram, elementary diagram, electronic schematic) is a graphical representation of an electrical circuit.

Technical Drawing
Technical Drawing is the main method of communication between all tradespersons. A sound knowledge and understanding in technical drawing by a trades-person is considered to be literate. Technical Drawing is not only a way of communicating ideas but is also an essential part of any design process.

The following should be always be considered;
i. Legibility – each drawing should be clear and legible and care should always be taken.

ii. Neatness – each drawing must be clean and neat.
iii. Accuracy – each drawing should convey ideas of shape and proportion and be accurate for any use. This depends on the condition of the instruments and the manner in which they are used.
iv. Speed – speed in executing a drawing comes with the practise of good techniques and thorough understanding of the process involved.
The basic drawing equipment are;

- Drawing board
- T-Square
- Set Squared (triangles)
- Protractor
- Pencils
- Compass
- Erasers
- Radius Curve
- Templates (Circular, Ellipse)
- French curves
- Scales

Important Areas to consider in technical Drawing

- The Alphabet of lines
- Drawing sheets
- Dimensioning
- Scaling
- Lettering
- Assembly drawing
- Detail Drawing
- Electrical Drawing
- Abbreviations
- Orthographic drawing
- Isometric drawing
- Electrical Floor Plans

Types of Electrical Diagrams or Schematics
There are three ways to show electrical circuits. They are wiring, schematic, and pictorial diagrams. The two most commonly used are the wiring diagram and the schematic diagram. The uses of these two types of diagrams are compared in Table 1.

Wiring Diagram	Schematic Diagrams
1. Emphasise connections between elements of a circuit or system.	1. Emphasise 'flow' of system.
2. Use horizontal and vertical lines to represent the wires.	2. Use horizontal and vertical lines to show system flow.
3. Use simplified pictorials that clearly resemble circuit/system components.	3. Use symbols that indicate function of equipment, but the symbols do not look like the actual equipment.
4. Place equipment and wiring on drawing to approximate actual physical location in real circuit.	4.Drawing layout is done to show the 'flow' of the system as it functions, not the physical layout of the equipment.

The pictorial diagram is usually not found in engineering applications for the reasons shown in the following example. Figure 9 provides a simple example of how a schematic diagram compares to a pictorial equivalent.
As can be seen, the pictorial version is not nearly as useful as the schematic, especially if you were trying to obtain enough information to repair a circuit or determine how it operates.

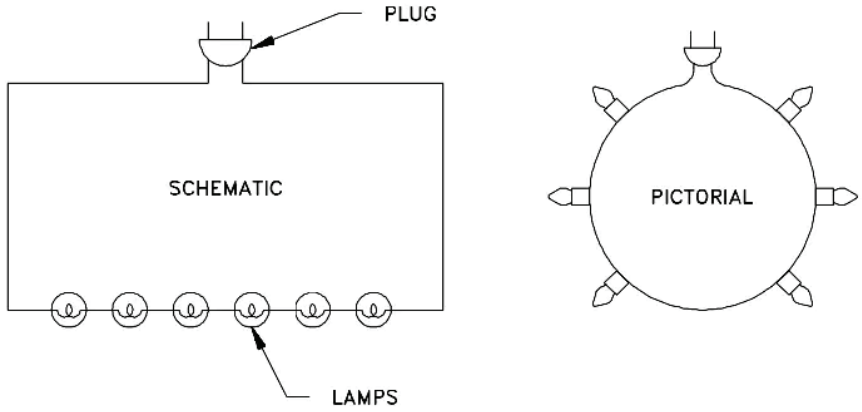


Figure 2.5a Comparison of an Electrical Schematic and a Pictorial Diagram
Source:https://instrumentationtools.com/electrical-diagrams-and-schematics/#:~:text=They%20are%20wiring%2C%20schematic%2C%20and%20pictorial%20diagrams.

Schematic diagrams

A schematic, or schematic diagram, is a representation of the elements of a system using abstract, graphic symbols rather than realistic pictures. A schematic usually omits all details that are not relevant to the information the schematic is intended to convey, and may add unrealistic elements that aid comprehension. The following illustration shows a simple schematic circuit diagram.

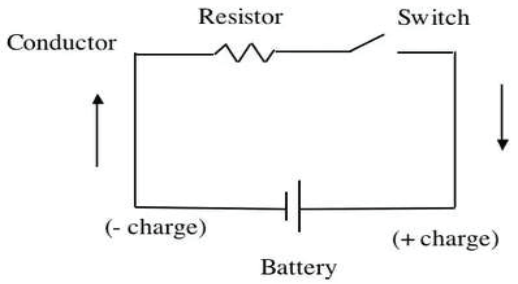


Figure: Schematic circuit diagrams
Source: https://instrumentationtools.com/electrical-diagrams-and-schematics/#:~:text=They%20are%20wiring%2C%20schematic%2C%20and%20pictorial%20diagrams.

A schematic diagram is a circuit which shows the connections in a clear and standardised way. It shows the components and their values and connections in an understandable manner. It is usually used to communicate or intended to convey the connections and working of the circuit to other engineers.

Pictorial diagrams

A pictorial circuit diagram uses simple images of components, while a schematic diagram

shows the components and interconnections of the circuit using standardised symbolic representations. The simplest of all diagrams is the pictorial diagram. It shows a picture or sketch of the various components of a specific system and the wiring between these components. This simplified diagram provides the means to readily identify the components of a system, even if you are not familiar with their physical appearance. This type of diagram shows the various components without regard to their physical location, how the wiring is marked, or how the wiring is routed. It does, however, show you the sequence in which the components are connected.

Wiring diagrams

A wiring diagram is mainly intended to convey the wiring or connection between the components in a proper way without any confusion, so that one can create a prototype easily using that. It usually gives information about the relative position and arrangement of devices and terminals on the devices, to help in building or servicing the device. It furthermore uses ma more symbolic notation to emphasize interconnections over physical appearance.

Wiring diagrams show the approximate locations and interconnections of receptacles, lighting, and permanent electrical services in a building. Interconnecting wire routes may be shown approximately, where particular receptacles or fixtures must be on a common circuit. Wiring diagrams use standard symbols for wiring devices, usually different from those used on schematic diagrams. The electrical symbols not only show where something is to be installed, but also what type of device is being installed. For example, a surface ceiling light is shown by one symbol, a recessed ceiling light has a different symbol, and a surface fluorescent light has another symbol. Each type of switch has a different symbol and so do the various outlets. There are symbols that show the location of smoke detectors, the doorbell chime, and thermostat. On large projects symbols may be numbered to show, for example, the panel board and circuit to which the device connects, and also to identify which of several types of fixture are to be installed at that location.

A set of wiring diagrams may be required by the electrical inspection authority to approve connection of the residence to the public electrical supply system. Wiring diagrams will also include panel schedules for circuit breaker panel boards, and riser diagrams for special services such as fire alarm or closed circuit television or other special services.

Electrical Floor plans

Any electrical working drawing consists of "lines, symbols, dimensions, and notations to accurately convey an engineering's design to the workers, who install the electrical system on the job. Floor plans show the location of electrical systems on every floor of a building. It outlines how connections are carried on electrical wiring systems and equipment.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to understand concepts of technical drawing, design or create different circuit diagrams such as schematic, pictorial and wiring diagrams. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Electrical Circuit Drawing

Teaching Strategies

Students engage in brainstorming exercise to discover basic aims of technical drawing and equipment and a few basic concepts of it. The teachers then facilitate students' findings as a class discussion. Teachers then further demonstrate the use of the drawing equipment and how students should work towards achieving the aims of technical drawing. Students are also guided to design and create sketches and 3D designs of electrical concepts and systems. The students work are then submitted for marking.

Learning Strategies
Students brainstorm to discover aims, equipment used and basic concepts of technical drawing. They then discuss their findings as a class discussion. They observe the teacher on how drawing equipment are used and follow how the demonstration was done and also take note of how drawing aims are targeted to be achieved. Students then move forward with designing and creating sketches and 3D design manually first then use technology.

Activity 1 Brainstorming activity.
Activity 2 Discussion and presentation of findings.
Activity 3 Observe and demonstrate the correct use of drawing equipment.
Activity 4 Use drawing equipment and technology to design sketches and 3D designs both manually and using technology.

Resources
Drawing handouts, Drawing equipment, Computers and AutoCAD or 3D CAD software

Lesson 2: Schematic Diagrams

Teaching Strategies
Students are guided with a brainstorm activity on components of circuits, circuit symbols and how schematics are drawn ending with a short discussion. Teachers then demonstrate steps to design a schematic and students follow through. Then put students in pairs to work out a worked circuit problem into schematic diagrams. Finally conduct correction by each pair to present their schematic diagrams on the board for the class to see with solutions of missing circuit quantities.

Learning Strategies
Students do a brainstorm activity on component of circuits, circuit symbols and schematic diagrams. Observe steps to drawing a schematic demonstrated by a teacher then work in pairs to solve worded problems into schematics circuit diagrams and solve for circuit quantities.

Activity 1 Do brainstorm activity.
Activity 2 Observe teacher's example or demonstration.
Activity 3 Work in pairs to solve worded problems into schematic circuit diagrams and solve for missing circuit quantities.

Resources
Worksheets on worded problems of circuits.

Lesson 3: Pictorial Diagrams

Teaching Strategies
Engage students in the discussion on pictures of components and how they can draw pictorial circuit diagrams. Each is given a worded problem and a schematic circuit to convert to pictorial diagram and sketch it. They then put on a chart to present it in class.

Learning Strategies
Discover pictures of components and how they can be used to draw up a pictorial circuit diagram. They then use a chart to present their drawing and explain to the class.

Activity 1 Discussion.
Activity 2 Sketching of pictorial circuit diagram on a chart.
Activity 3 Presentation and explanation.

Resources
Chart, markers and worksheet on pictorial circuit diagrams.

Lesson 4: Wiring Diagrams

Teaching Strategies
Introduce students to how wiring symbols of switches and lights and socket outlets so as the cable types and how to read colours of the cable. They are then given a description of a switching circuit and students are guided to draw out the wiring diagram in pairs then use a simulation software to design and test the circuit that has been drawn to find out if it is functional. They then are facilitated to compile an evaluation report.

Learning Strategies
Students discover wiring symbols of switches, lights and socket outlets and the cable types and colours. They then use a description to draw out a wiring diagram of a switching circuit. Then use a simulation software to design the circuit drawn and run a test to see if it is functional. Then compile an evaluation report.
Activity 1 Discover wiring symbols.
Activity 2 Use description to draw out a wiring diagram of a switching circuit.
Activity 3 Use a simulation software to design and test the circuit drawn and write up an evaluation report.

Resources
Drawing equipment and template, handouts and Multi-Sim software or other wiring software.

STEAM Activity Teacher to provide a list of electrical components and a building floor plan with descriptions of where he/she wants the particular component is to be installed. The voltage, current, resistance and power values of the components must be provided for correct placing of components in the circuit diagram. This activity can be modified.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to understand concepts of technical drawing, design or create different circuit diagrams such as schematic, pictorial and wiring diagrams. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Define technical drawing.
2. Demonstrate functions of each drawing equipment.
3. Design and create sketches and 3D models.
4. Define and differentiate Schematic, pictorial and wiring diagrams.

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Define technical drawing	Define technical drawing in detail with examples	Briefly define technical drawing	Briefly defines Technical drawing but ideas are not in full	Cannot define Technical drawing or provide any example.
2. Demonstrate functions of each drawing equipment.	Confidently demonstrates function of each technical drawing equipment	Briefly demonstrates the function of a few drawing equipment.	Demonstrate functions of only one or two drawing equipment.	Cannot demonstrate the function of any drawing equipment.
3. Design and create sketches and 3D models.	Confidently designs or creates sketches using drawing equipment and 3D models using technology	Briefly designs and creates sketches and not too confident in design 3D models using technology	Can create sketches but not able to handle 3D designs using technology	Is not able to produce sketches or 3D designs.
4. Define and differentiate Schematic,	Confidently define and differentiate schematic, pictorials and wiring diagrams using drawings and examples	Define and differentiate schematic, pictorial and wiring diagrams without examples	Define but not too confident in differentiating schematics, pictorials and wiring diagrams.	Cannot define or differentiate schematics from pictorial and wiring diagrams.

UNIT 2. Electrical Technology

Content Standard 3.2. Analyse and apply the technological processes, concepts, principles and practices related to Electrical Technology and its social contribution with regard to economic growth, entrepreneurship, sustainability and as a tool for change, improving the quality of life responsive to individual, community and industrial needs.

Benchmark 11.3.2.6. Explore and analyse materials, tools, components and accessories used in the electrical installation process.

Topic 6: Parts and Components

Learning Objectives

By the end of this topic, the students will be able to;

1. Explain the installation process
2. List electrical accessories, materials and tools used in the installation process.

Essential Questions:

1. What are the materials and accessories used in electrical installation process?
2. What are the tools used in installation?
3. What are the procedures or processes of installation?

Essential Knowledge, Skills, Values and Attitudes:

Knowledge: Electrical Installation, Electrical materials, accessories and tools,
Skills: Explain steps of installation process and the electrical accessories
Values: Appreciate, value, the process of installation
Attitudes: Responsible, critical and attentive to important safety and process details when doing electrical instaaallations.

Content Background

Introduction to parts and components of the installation process.

Electrical wiring needs expertise attention to every building project. It directly related to the safety of human beings and utilities / equipment people handle. The scope of electrical wiring shall cover supply, installation, testing and commissioning of all conduits and accessories, wiring, switches, socket outlets, spur outlets, junction boxes / pull boxes, GI pull wires, ceiling roses making connections etc. Unless otherwise indicated wiring shall consist of PVC insulated, copper conductor wires installed in heavy gauge steel galvanized conduits.

Electrical Installation materials and accessories,

These are the following installation materials and accessories

- Conduits (galvanized, PVC, rigid or flexible PVC)

Separate conduits and runways shall be used for:

- Lighting system.
- Power outlets.
- Emergency light.

- Telephone system.
- Fire alarm system.
- Sound / public address system.
- Television system.
- Computer system.
- Wiring for short extensions to outlets in hung ceiling or to equipment,
- motors etc. shall be installed in flexible conduits. Otherwise rigid conduits
- shall be used.
- Conduit fittings (saddles, cable ties, couplings, connectors, elbow, bends)
- Wires, Cables and Cords
- Wring fittings (junction boxes, brackets, mounting boxes, grounding terminals)
- Lighting switches and circuit breakers
- Socket outlets (GPOs)
- Telephone outlets

Electrical tools

Tools include basic

- Philips and flats screw driver sets.
- Pliers (combination, side cutter and long nose pliers)
- Tinsnips
- Conduit cutter
- Drills (cord and cordless drills)
- Hole saws
- Hammers
- Wire strippers
- Clamps

Electrical Installations process

Before starting an Electrical installation, there are some important procedures to carryout.

i. There should be a detailed Electrical Wiring Diagram to start with. This is normally prepared by an Electrical Engineer.

ii. First, the Electrical Loads, Currents, Cable sizes and the Protective devices for the Electrical Installation are calculated. Once these information are obtained Electrical Drawings based on this information is done on a CAD or by a Draftsman on paper. Later the engineer incorporates these details into a Diagram with Electrical Symbols and text details so that referring these Electrical Diagrams, the Installer[s] can carry out the installation job.

iii. Based on this information, the quantities of material and components needed for the job also is worked out.

iv. There are specifications for carrying out Electrical Installation Work so that the completed installation will abide to rules and regulations of the Electrical Industry.

v. One needs to be familiar with Electrical Symbols appearing in Electrical Drawings These symbols can be different from a region to region so one has to be familiar with the symbols used in that part of the world he is living.

vi. The Electrical Wiring Diagram will indicate the areas or locations of a building where Lighting, Socket Outlets [receptacles], Small Appliances or other machinery will be positioned.

vii. The Electrical Conductors [cables or wires] needed to be selected according to the current rating [Capacity] and Voltage Drop when the rated current flows in the conductors. This selection of the conductor is called Conductor Sizing.

viii. The conductors can be of Copper or Aluminium. Copper is the material used mostly for indoor installations and Aluminium for mostly Power Transmission.

ix. The outer Insulation of the conductors are selected according to the Temperature, the conductors are used for when carrying current.

x. There are cables for heavy duty activities such as laid under soil in trenches which are called armored cables.

xi. The over current protection for conductors are very important and there are Fuses and Circuit Breakers incorporated to safeguard current carrying conductors. Ground Fault Circuit Interrupters or Earth Leakage Circuit Breakers or Residual Current Circuit Breakers will safeguard people from getting Electric Shock from Live or Hot Circuit conductors or equipment.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to understand and analyse installation process and list accessories, materials and tools used in the installation process. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Electrical accessories, tools and materials

Teaching Strategies

Teachers are encouraged to engage students with the use of catalogues to list and name electrical accessories, tools and materials. They then are allowed to identify physical accessories, materials and tools used in the installation process. They go on

further to demonstrate the basic steps of installation the accessories and how to use correct tools and materials while installation equipment or electrical wiring system. They are also guided to work out cost of accessories, materials and tools needed in an installation task.

Learning Strategies
Students bring along catalogues to class to work in groups to identify and name electrical accessories, materials and tools. They also demonstrate the basic steps of installing the accessories and materials and how to use tools correctly and for the correct task in installation. Students also calculate the cost of the accessories, materials and tools for a basic installation for instance a room wiring.

Activity 1 Work in groups to identify electrical accessories, tools and materials.
Activity 2 Demonstrate correct handling techniques of using tools for installation
Activity 3 Demonstrate basic steps for installation accessories and materials.
Activity 4 Demonstrate ability in calculating cost of a basic installation using the catalogues.

Resources
Catalogues from electrical wholesalers

Lesson 2: Installation Process

Teaching Strategies
Students are taken to inspect an installation in a building (the circuit breaker, the switches and lighting and others) and take note of how they presume the installation process that had been undertaken. They are then taken back to class to sit in groups and discuss what they have observed. Then the teacher presents a model and wraps up the discussion on how installation process proceeds.

Learning Strategies
Students go out to inspect an installation in a building and then go back in groups to discuss findings. And then observe to see if their findings have gone in line with the teacher wiring installation model. Then they evaluate their findings.

Activity 1 Inspection of an installation in a building
Activity 2 Group discussion
Activity 3 Observe wiring model presentation
Activity 4 Evaluate findings.

Resources
One-way switching model

STEAM Activity Students work in groups to create an activity incorporating concepts of power installation processes

Assessment

The main purpose of assessment is to find out if students can use the skill of synthesis to explain the installation process and list electrical accessories and functions of each material and tools used in the installation process. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Explain the installation process
2. List electrical accessories, materials and tools used in the installation process.

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Explain the installation process	Explains the installation process in detail and with examples	Gives a brief explanation of the installation process	Provides half explanation of the installation process	Very poor explanation of the installation process
2. List electrical accessories, materials and tools used in the installation process.	List correctly all the accessories, materials and tools used in the installation process and further identify in physical appearance	Lists only the requested accessories, materials and tools	List only a few while still processing the rest of the accessories, materials and tools	Cannot identify or list accessories, materials and tools

Unit 3: Plumbing Technology

Units	Topics	Lesson Titles
3. Plumbing Technology	1. Topic 1. Fundamental Concept of Plumbing System	2. Plumbing System 3. Types of Plumbing System 4. Water Distribution System 5. Drain, Waste, Vent System
	Topic 2. Hazard Communication in Plumbing Trade	1. Hazard Communication 2. Types of Hazard Communication 3. Common Hazards in Workplace 4. Methods of Minimising Hazard in Workplace
	Topic 3. Plumbing Corrugated Stainless steel Tubing, Fixtures and Faucets	1. Types of Corrugated Stainless Steel Tubing 2. Types of Faucets and Fittings 3. Methods of Stainless Steel Tubing 4. Methods of Stainless Steel Faucets and Fitting, polly Pipes, PVC, Copper, Cast Iron, Galvanised Steel, Flexible Hose
	Topic 4. Introduction to Blueprint and Sketches of Pipe System	1. Blue Print and Pipe System 2. Method of Manual Sketching Blueprint and Pipe System 3. Methods of Sketching Blueprint and Pipe System using CAD Program 4. Methods of Downloading CAD Program

UNIT 3. Plumbing Technology

Content Standard 3.3. Investigate and analyse fundamental concepts of plumbing and theories, Occupational Health and Safety Regulations and standards ,trade drawing, demonstrations and applications of tools and materials specifications, installation of plumbing fittings and accessories in Drain, waste, vent system, and water (DWV) distribution system.

Benchmark 11.3.3.1 Explore and analyse fundamental concept on water distribution system, drain, waste, vent system in Plumbing

Topic 1: Fundamental concept of plumbing system

Learning Objectives

By the end of this topic, the students will be able to;

1. Analyse and describe the types of plumbing system, and the water distribution system.
2. Describe and connect the drainage, waste, vent system.

Essential Questions:

1. What is fundamental concept of plumbing system?
2. What are the types of plumbing system?
3. How does water distribution system work?
4. What is drainage, waste, vent system?
5. How do we connect DWV system to the existing piping system?

Essential Knowledge, Skills, Values and Attitudes:
Knowledge: Plumbing system
Skills: Apply
Values: safe practise is paramount
Attitudes: Appreciative of understanding the different types of plumbing systems and their concepts.

Content Background

The Fundamental concept of the plumbing system is the introductory part of the plumbing trade. And that is to learn how the plumbing piping system is connected from the new building/project to the existing system. It is vital for plumbers to do piping system before dry wall is completed in that stage.

The Types of Plumbing System in new residential buildings;
There are three types of Plumbing systems. **Potable water, sanitary, and storm water system**. Each of these plays a vital role in keeping the city clean and hygienic. All the residential, industrial, and commercial buildings have each of these plumbing systems installed. Each system has its main function but ultimately brings water to a building and removes it and waste from it. Potable brings in water, sanitary removes wastage and stormwater transfers rainwater from the building.

Potable Plumbing Systems

A potable water system is responsible for bringing in water from local community water mains into a building. A water valve on the water main is there so the water can be shut off if needed. Similarly, a water meter is installed to keep a record of how much water is used in the building. The potable system transfers water that is used for drinking, cleaning and alike, meaning it is safe for people. In the specific building, there are various different pipes and fixtures which are used to divert water to each appliance. These include:

- Straight Pipes – these are the more common pipes in the potable plumbing system. Either long or short, the straight pipes quickly direct water to where it needs to be.
- Tee Section – the shape of these are of a right-angle.
- Elbows – these are used for directional changes in the plumbing system.
- Brass and Gate Valves – controlling the flow of water is the main function of these appliances.

Figure 3.1a Pipe fittings for Piping and Plumbing Industries
Source: https://whatispiping.com/types-of-pipe-fittings/

Sanitary Plumbing Systems

The sanitary plumbing systems are what remove all wastage from a building. This wastage includes human wastage and wastewater, such as from cooking and washing. Furthermore, the wastage is transferred to the local community sewage. They are connected on the ceiling to ventilate gases and allows the system to work at atmospheric pressures. With sanitary plumbing systems, there are three main types which can be installed:

- Gravity Systems – The more common type of sanitary system are the gravity systems. Using the natural slope of the ground, these easily collect the wastewater and bring it to the sewage network. Also, these are used mainly in places where flooding is not common and where the water table is relatively low.
- Low Pressure Systems – These are a low-head pressure system which is an alternative to the gravity system. An interceptor tank with a chamber unit is within the system which holds a small electrical pump. Installed belowground, the waste is transported to the main sewage plant by using small pressure lines.
- Vacuum Systems – Another alternative to gravity systems, this system uses electricity and are mainly installed in specific areas. These include areas that have reclaimed ground, charged ground, seasonal areas or in flat areas. Using a central vacuum station, the sewage fittings are connected through vacuum valves. Also, the central vacuum station has vacuum pumps, discharge pumps, a collection chamber and associated controls.

Storm water Plumbing Systems

The main function of the storm water plumbing systems is to have rainwater removed from the building. They are installed with specific characteristics to ensure that the water it successfully transferred away. The water can be collected and travelled away from the following:

- Roof – The roof is designed to ensure that the water travels down into the pipes and removed from the area. Depending on how much rainfall is received, the design and the size of the downpipes and roof will be influenced.
- Surface – Paved or unpaved areas have the water from remaining there removed through the angle of the surface. Adjacent drains can be included, but the water should be transferred away before pooling up quickly on the flat surface.
- Subsoil – In regards to water that is trapped below ground, subsoil drains are needed. These underground drains collect the stormwater to then go to a drain before it runs-off to other properties and alike.

With transferring the water away, there are a few systems which then transport the water to the next point, including:

- Gravity-Fed Systems – Pipes are angled in a way so that the water can go straight down through the drainage systems. The size of the pipes is determined from the amount/ intensity of rainfall and the size of the area.
- Pump-Based Systems – When the slope of the land is not suitable for gravity-fed systems then pumps may be needed. These often incorporate rainwater tanks and also pump the water where it needs to go.

- Stormwater Discharge and Harvesting – Larger pipes and channels may be installed to transport water to local rivers, lakes the sea. Mainly in more populated areas, however, this type of system often leads to pollution going into the native waterways.

Each type of plumbing system is designed, installed, maintained and repaired by professional plumbers to ensure efficiency.

There are three different types of plumbing systems that are vital in mechanical planning for the building. It mainly involves creating the water system for an excellent drainage and sanitation system. It includes sewer pipes, pipe sloping, water pressure design, and overhead and underground piping. It also involves incorporating safe access to the water system components like installing specialty roof hatches if the central water system control is on the rooftop of the building.

- **WATER DISTRIBUTION IN BUILDINGS-**

Cold and hot water may be conveyed to plumbing fixtures under the pressure of a water source, such as a public water main, by pumps, or by gravity flow from elevated storage tanks. The water-distribution system should be so laid out that, at each plumbing fixture requiring both hot and cold water, the pipes at the outlets for both supplies should be nearly equal.
This is especially desirable where mixing valves may be installed, to prevent the supply at a higher pressure from forcing its way into the lower-pressure supply when the valves are opened to mix hot and cold water. Pipe sizes and types should be selected to balance loss of pressure head due to friction in the hot and cold-water pipes, despite differences in pipe lengths and sudden large demands for water from either supply.

Care should be taken to assure that domestic water piping is not installed in a location subject to freezing temperatures. When piping is installed in exterior walls in cold climate areas, the piping should be insulated and should be installed on the building side of the building wall insulation. Piping installed in exterior cavity walls or chases may require heat tracing, although the installation of high and low wall mounted grilles, which allow heated air from the building to naturally flow through the cavity, will usually prevent the temperature in the cavity from falling below a temperature where water in the piping will freeze. Designers should thoroughly Investigate local climatic conditions and building methods to assure proper installation. Designers should also specify freeze-proof-type hydrants (hose bibs) for Exterior applications.

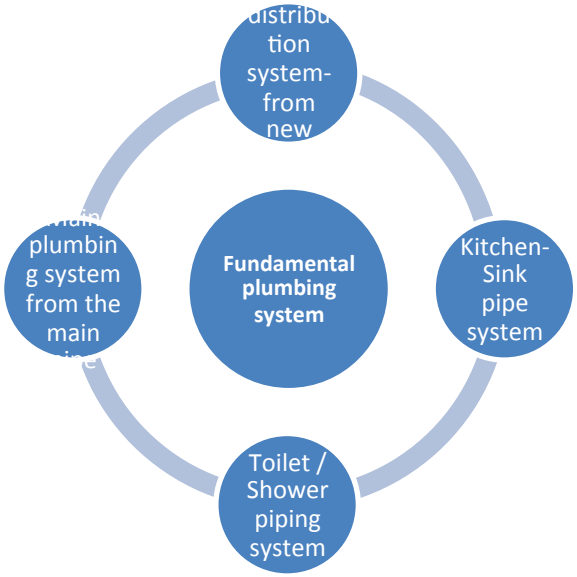


Fig. 3.1b. Diagram shows the flow of Plumbing Piping system.

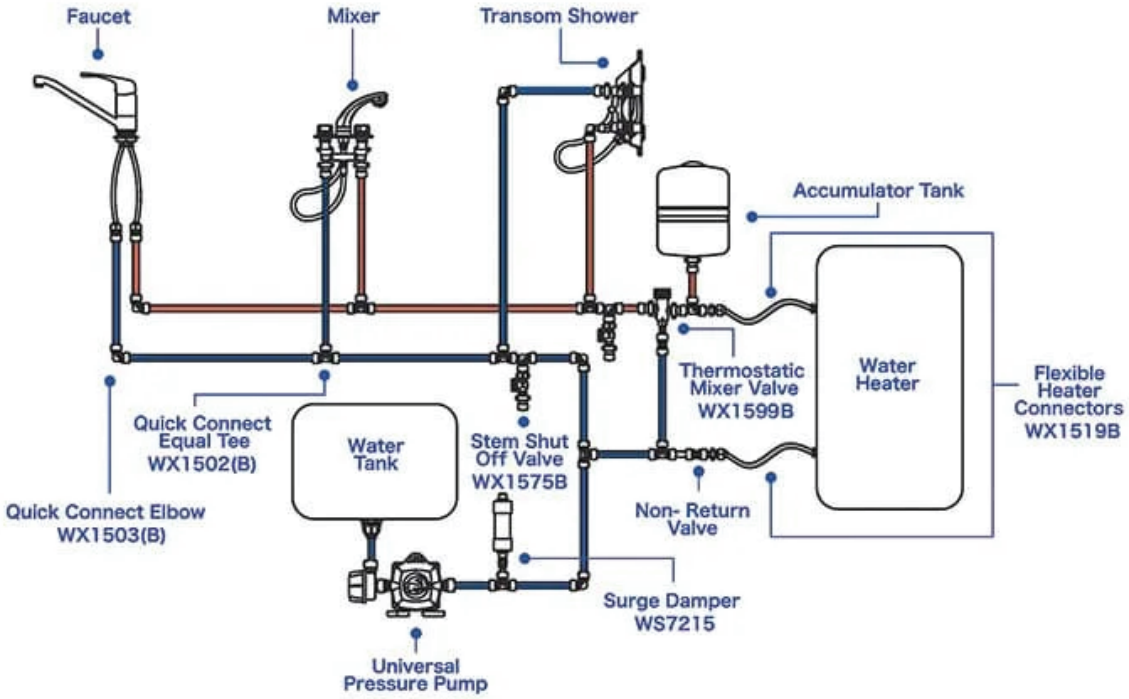


Fig. 3.1c. Plumbing Piping system.
Source: https://danikaplumbing.com/types-of-plumbing-systems/

This plumbing system must be able to cope with backpressure hazards or back siphonage, and the line should not be in contact with some other plumbing system that might transmit contamination. The plumbing material on this line should meet the performance and quality specifications set by the authorities or an accepted certification organisation.

This drinking water plumbing fixtures and piping system require adequate maintenance and repairs from professional plumbers to minimise wastage and leakage. A sound installation of these fixtures also prevents leakages and protects the pipeline from accidental damage and corrosion.

Sewage plumbing system

A sewage system is a network of pumps, mains, and pipes used to collect wastewater and have a compartment inside for separation of sewage and sludge. Sewage systems have two main types: industrial and domestic. In some cases, they combine both methods into one.

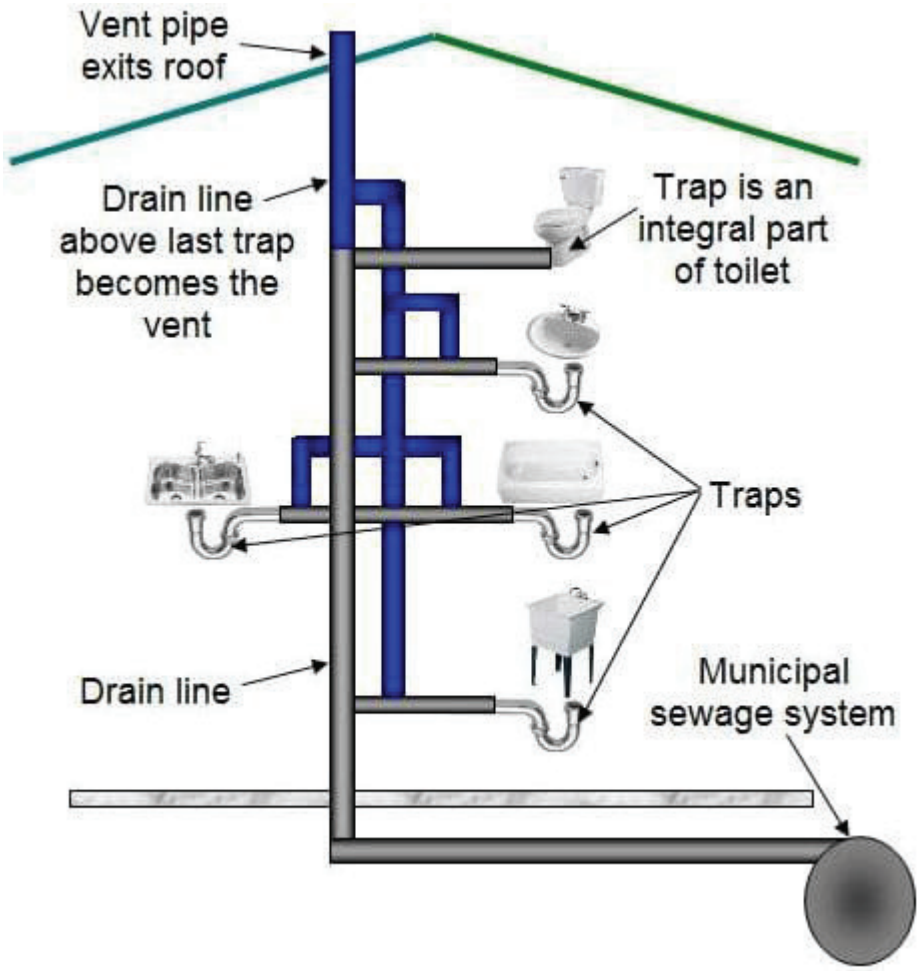


Figure 3.1d. Sewage system
Source: https://danikaplumbing.com/types-of-plumbing-systems/

Sewage systems are beneficial in every building structure for the disposal of wastewater. This system requires proper maintenance from professional plumbers as they can bring problems to the environment. This sewage system contains many substances that can be harmful to human beings and other living creatures.

It is vital to understand that this system needs proper management and periodic inspection and maintenance from professional plumbers to prevent those sewage issues.

Drainage plumbing system

Drainage is a vital part of every building design. The main objective of the drainage system is to systematically remove those excess waters from the surface to maintain the healthy condition of the building. It includes all the piping that moves rainwater and other excess liquids to the point of disposal. Its design is to depose water as quickly as possible to avoid entering those excess water in residential or commercial buildings.

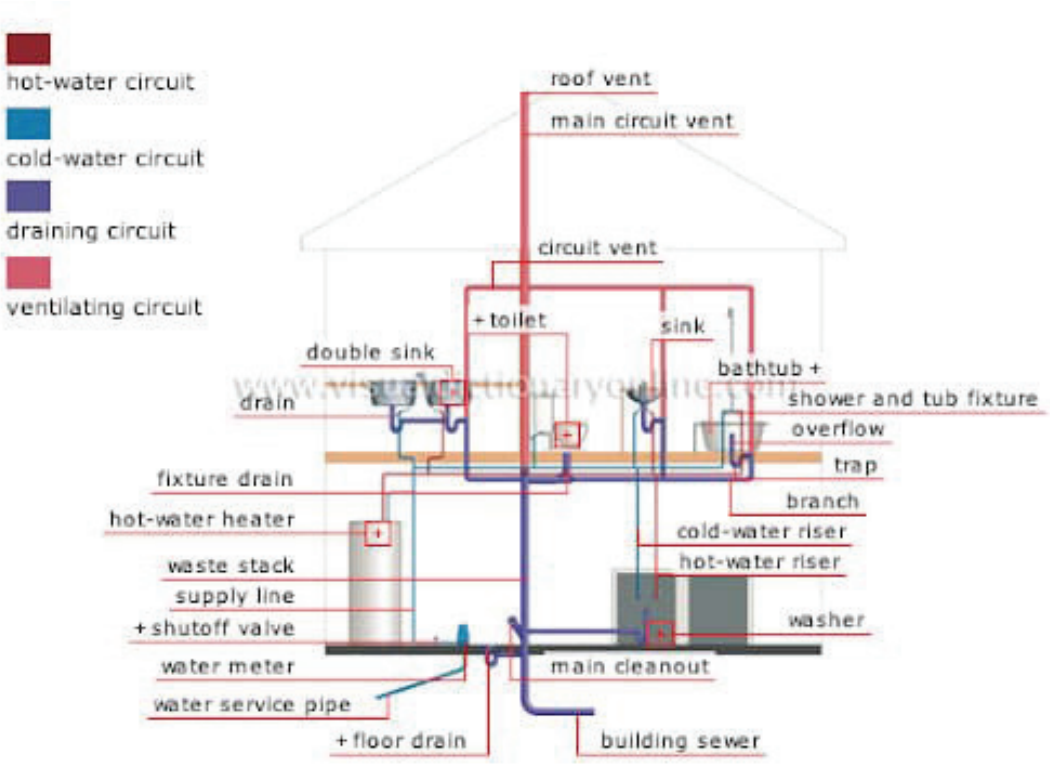


Figure 3.1e drainage system
Source: https://danikaplumbing.com/types-of-plumbing-systems/

A proper drainage system works to avoid excess water from damming in your surroundings or underground surfaces that can damage your property. Without an appropriate drainage system, rainwater will quickly build up.

This system helps whisk water from driveways, roofs, walkways, and underground spaces to avoid flooding. It is imperative in residential areas to prevent structural damage, mildew, mold, and rotting in residential structures due to flooding.

It doesn't matter how efficient your drainage system is. The drainage system will experience clogs, hiccups, or tears over time like any other plumbing system. Drainage systems require periodic property inspection and maintenance from a professional plumber to ensure it is working efficiently. Failing to maintain the drainage system properly can cause severe problems and property damage during heavy rains.

It is essential to note that the plumbing system is necessary for our daily life. The professional plumber plays a vital role in keeping the plumbing system efficient in the building. Whether residential or commercial, all plumbing systems require maintenance and repairs of their

components as time goes by to prevent serious clogs, and fixture damage and keep all the plumbing systems functional every day.

1. **Drain, Waste, Vent system-**

In modern plumbing, a **drain-waste-vent** (or DWV) is a system that allows air to enter the plumbing system to maintain proper air pressure to enable the removal of sewage and greywater from a dwelling. Drain refers to water produced at fixtures such as sinks, and showers; waste refers to water from toilets. As the water runs down, proper venting is required to allow water to flow freely, and avoid a vacuum from being created. As the water runs down air must be allowed into the waste pipe either through a roof vent (external), or an internal vent.

DWV systems maintain neutral air pressure in the drains, allowing free flow of water and sewage down drains and through waste pipes by gravity. It is critical that a sufficient downward slope be maintained throughout the drain pipes, to keep liquids and entrained solids flowing freely towards the main drain from the building. In some situations, a downward slope out of a building to the sewer cannot be created, and a special collection pit and grinding lift "sewage ejector" pump are needed. By contrast, potable water supply systems operate under pressure to distribute water up through buildings, and do not require a continuous downward slope in their piping.

Every fixture is required to have an internal or external trap; double trapping is prohibited by plumbing codes due to its susceptibility to clogging. Every plumbing fixture must also have an attached vent. Without a vent, negative pressure from water leaving the system can cause a siphon which empties the trap. The top of stacks must be vented too, via a stack vent, which is sometimes called a stink pipe.

All plumbing waste fixtures use traps to prevent sewer gases from leaking into the house. Through traps, all fixtures are connected to waste lines, which in turn take the waste to a "soil stack", a.k.a. "soil stack pipe", "soil vent pipe" or "main". At the building drain system's highest point, the drain-waste vent is attached, and rises (usually inside a wall) to and out of the roof. Waste exits from the building through the building's main drain and flows through a sewage line, which leads to a septic system or a public sewer.

The venting system, or plumbing vents, consists of a number of pipes leading from waste pipes to the outdoors, usually through the roof. Vents provide a means to release sewer gases outside instead of inside the house. Vents also admit oxygen to the waste system to allow aerobic sewage digestion, and to discourage noxious anaerobic decomposition. Vents provide a way to equalize the pressure on both sides of a trap, thereby allowing the trap to hold the water which is needed to maintain effectiveness of the trap, and avoiding "trap suckout" which otherwise might occur.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of plumbing system. The knowledge prescribed must be taught. It is not only about

teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Plumbing system

Teaching Strategies
Students engage in brainstorming exercise to define plumbing system.
They then are allowed to design guiding questions that will enable them to conduct research on definition of plumbing system.
Discussions in groups on the research findings on definition of plumbing system.

Learning Strategies
Activity 1 Brainstorming activity definition of plumbing system.
Activity 2 Conduct research on different terminologies used in plumbing system.
Activity 3 Discussions and presentation of research findings of the different terminologies used in plumbing system.

Resources

Building Design & construction process

Lesson 2: Types of plumbing system

Teaching Strategies
Students engage in brainstorming exercise the types of plumbing system.
They then are allowed to design guiding questions that will enable them to conduct research on the types of plumbing system.
Discussions in groups on the research findings of the types of plumbing system.

Learning Strategies
Activity 1 Brainstorming activity the types of plumbing system.
Activity 2 Conduct research on different types of plumbing system
Activity 3 Discussions and presentation of research findings the types of plumbing system

Resources

Building Design & construction process

Lesson 3: Water Distribution system

Teaching Strategies
Students engage in brainstorming exercise water distribution system.
They then are allowed to design guiding questions that will enable them to conduct research on the water distribution system. .

Discussions in groups on the research findings the water distribution system.

Learning Strategies
Activity 1 Brainstorming activity water distribution system. .
Activity 2 Conduct research on different water distribution system.
Activity 3 Discussions and presentation of research findings on the water distribution system.

Resources

Building Design & construction process

Lesson 4: Drain, waste, vent system
Teaching Strategies
Students engage in brainstorming exercise Drain, Waste, Vent system
They then are allowed to design guiding questions that will enable them to conduct research on the Drain, waste, Vent system
.Discussions in groups on the research findings on the Drain, Waste, Vent system
.
Learning Strategies
Activity 1 Brainstorming activity Drain, Waste, Vent system
Activity 2 Conduct research on different Drain, Waste, Vent system
Activity 3 Discussions and presentation of research findings Drain, Waste, Vent system

Resources
Building Design & construction process

STEAM Activity Students work in groups to create plumbing system from the house to the main supply or they can work in groups to design a drainage system (stormwater drainage) for their school and estimate the project costs).

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to Fundamental concept of plumbing system. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Define Plumbing system
2. Analyse and describe the types of plumbing system
3. Analyse and demonstrate the Water Distribution system
4. Describe and connect the Drainage, Waste, Vent system

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1.Define Plumbing system	Accurately define Plumbing system	Correctly define Plumbing system	Partially define Plumbing system	Cannot define Plumbing system

2.Analyse and describe the types of plumbing system	Accurately analyse and describe the types of plumbing system	Correctly analyse and describe the types of plumbing system	Partially analyse and describe the types of plumbing system	Cannot analyse and describe the types of plumbing system
3.Analyse and demonstrate the Water Distribution system	Accurately analyse and demonstrate the Water Distribution system	Correctly analyse and demonstrate the Water Distribution system	Partially analyse and demonstrate the Water Distribution system	Cannot analyse and demonstrate the Water Distribution system
4.Describe and connect the Drainage, waste, Vent system	Accurately describe and connect the Drainage, waste, Vent system	Correctly describe and connect the Drainage, waste, Vent system	Partially describe and connect the Drainage, waste, Vent system	Cannot describe and connect the Drainage, waste, Vent system

UNIT 3. Plumbing Technology

Content Standard 3.3. Investigate and analyse fundamental concepts of plumbing and theories, Occupational Health and Safety Regulations and standards ,trade drawing, demonstrations and applications of tools and materials specifications, installation of plumbing fittings and accessories in Drain, waste, vent system, and water (DWV) distribution system.

Benchmark 11.3.3.2 Identify and analyse Hazard communication in plumbing

Topic 2: Hazard communication in Plumbing Trade

Learning Objectives

By the end of this topic, the students will be able to;

1. Define hazard communication in plumbing.
2. Analyse and describe the types of hazard communication in plumbing and demonstrate ways of minimising them.

Essential Questions:

1. What is hazard communication?
2. What are the types of hazard communications?
3. What are the common hazards in workplace?
4. How do we demonstrate the methods of minimizing hazard in workplace?

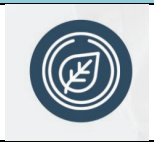
Essential Knowledge, Skills, Values and Attitudes:
Knowledge: Hazard communication in plumbing
Skills: Demonstrate
Values: Safe Practice
Attitudes: Responsible and considerate of hazard communication in plumbing trade.

Content Background

Hazard communication is all about identifying chemical hazards in the workplace and communicating these hazards to ensure a safe and healthy work environment.

The common way to classify hazards is by category.

The six main categories of hazards are:

Symbol	Category	Description
	Biological	Bacteria, viruses. Insects, plants, birds, animals, and humans

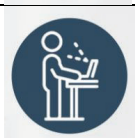
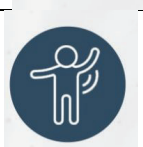
	Chemical	Depends on the physical, chemical and toxic properties of the chemical
	Ergonomic	Repetitive movements, improper setup of workstation, poor design of equipment, workstation design
	Physical	Radiation (ionizing and non-ionizing) high exposure to sunlight and ultraviolet rays, temperature extreme, and constant loud noises
	Psychological	Shift work, workload, dealing with the public, harassment, discrimination, threat of danger
	Safety	Slipping/tripping hazards, inappropriate machine guarding, equipment malfunctions or breakdowns

Figure: 3.2a Hazard Classification
Ref: https///storage/1A35-900B/Download/

The words '**hazard**' and '**risk**' are used often to describe dangers in the workplace. A lot of the time, they are used interchangeably and, while it might be thought they mean the same thing, they actually have very different meanings. The distinction between hazards and risks are explained.

What is a Hazard in the Workplace?
Hazards are anything that can cause harm, damage or adverse health effects to people in the workplace. Depending on the workplace, these could include:
Biological. Biological hazards include viruses, bacteria, insects, animals, etc., that can cause harm. For example, mould, dust, blood and other bodily fluids, vermin and other parasites.
Chemical. The nature of a chemical hazard will depend on the properties of the chemicals used and stored on the premises. It includes both health and physical hazards, such as skin irritation, carcinogenicity, flammability and radiation.
Ergonomic. Ergonomic hazards are a result of physical factors that can lead to musculoskeletal injuries. These hazards include workstation setup, poor posture and manual handling.
Physical. Physical hazards are a result of environmental factors and include heights, vibration, radiation and pressure.
Psychosocial. Psychosocial hazards include hazards that can have an adverse effect on an individual's mental health or wellbeing including stress, bullying and workplace violence.
Safety. Safety hazards are hazards that create unsafe working conditions. For example, melting ice could cause a spill hazard or exposed wires might result in a tripping hazard.

Potential hazards must be accurately identified in the workplace to create a thorough risk assessment.

First, assess the workplace and consider any activities, processes or substances that may result in injury, fatality or adverse health effects.

The type of hazard depends on the nature of the work and the type of work environment. For example, working in an office will pose different hazards to working in a confined space or working at height. There is not a 'one-size-fits-all' for hazards, so it's important that this is carefully considered so all the hazards in the workplace are identified. Measures should be installed to protect workers from them.

Factors of consideration

- Consider if chemicals are stored on site. Not all chemicals stored on site will pose the same hazards to workers. Therefore, its important material safety data sheets are formulated and checked for every chemical stored on site.
- The manufacturer's instructions for all on-site equipment and machinery must be checked for additional hazards.
- Review your accident log and ill-health records should be reviewed. These can be a good source of information for hazards you might not have considered.
- Consider the long-term health hazards employees are exposed to, such as noise and vibration.
- Think about any hazards posed by non-routine operations. These include maintenance processes and cleaning operations.

What is a Risk in the Workplace?

A risk, on the other hand, is the likelihood of a person being injured or receiving an adverse health effect due to a hazard.

When the degree of risk that a hazard poses is considered, one must bear in mind the following factors that can influence risk:

1. The frequency of exposure. *Are workers exposed to the hazard once a day or once a year?*
2. The route of exposure. *How are workers exposed? Do they breathe in vapours or is it through skin contact?*
3. How severe the injury or adverse health effect of exposure is. *Is the health affected lung irritation or lung cancer?*

It's the responsibility of employers to determine the hazards, measure the risks and install controls to protect the workforce.

What is meant by hazard communication?

All employers are required by law to provide information and training to their employees about the hazardous chemicals to which they may be exposed to at the time of their initial assignment and whenever a new hazard is introduced into their work area.

Hazard Communication may include an inventory of chemicals on site, chemical labeling, a safety data sheet, written work plans and employee training.

The management of health and safety in the workplace is the responsibility of employers. It is important to know the difference between them. If the responsibility of protecting workers in the workplace is neglected, the employer could face financial and custodial penalties. Therefore, it is vital to properly manage all workplace hazards.

How to Manage Hazards in the Workplace

1. Carry out an appropriate risk assessment for the nature of the work and hazards

2. Introduce appropriate control measures. Once completed risk assessment, introduce controls to reduce or eliminate the identified hazards. For example, you may be able to avoid work at height completely when window cleaning by using extension poles or, if those are inappropriate, you could reduce the risks by installing fall prevention equipment.

3. Appropriately train all employees in their duties. All employees should have appropriate Health and Safety Training or Office Safety Training, in addition to training for any specific workplace hazards.

What are the Occupational Health Risks in Construction?

Occupational ill health describes all health problems in the work environment. This includes health problems that workers bring to the workplace as well as health issues that are caused or made worse by work. In the construction injury, there are many hazards that can contribute to occupational ill-health. Some of these are:

- **Exposure to harmful materials,** including asbestos, lead, dusts containing silica, chemicals, sunlight, gases, and exhaust emissions. This can lead to skin problems, dermatitis, occupational asthma, occupational cancer, and lung disease, if they are not properly controlled.
- **Frequent loud noise.** In time, this may contribute to noise induced hearing loss and tinnitus.
- **Excessive use of vibrating tools**, which may lead to Hand Arm Vibration Syndrome and vibration white finger.
- **Frequent material and manual handling of heavy loads**. This may give rise to musculoskeletal disorders and upper limb disorders, particularly if you adopt incorrect manual handling procedures.
- **Stress and fatigue.** This can contribute to a range of mental health conditions, including depression and anxiety.
- **Lone working.** This presents risks such as accidents not receiving urgent assistance if nobody is nearby and if communication methods are insufficient. It may also result in accidents arising from the inability to immediately ask someone for help.
- Potential for **falls from height, electric shocks, being struck by a moving vehicle, and working in a confined space**. The dangers from these can range from a broken bone to death.
- **Inadequate working conditions**, including insufficient lighting, uncomfortable temperatures, and long working hours.

As an employer, it's your responsibility to minimise these risks and protect your construction workers' health.

Mental Health and the Construction Industry

Suicide is the leading cause of death for men aged 20-49. Suicide kills more construction workers than falls do.

Clearly, mental health in the construction industry is something that needs our attention. Promoting good mental health in construction is just as important as promoting physical safety.

The construction industry lends itself to a challenging and stressful environment; working hours are long and demanding, the risk of injury is high, work often needs to be carried out miles from home for weeks at a time, and lone working is common.

The construction industry is predominantly male, and the idea of the strong, macho man is widespread. This 'tough guy' image, however, makes it difficult for men to communicate their struggles for fear of ridicule and being seen as 'weak'. The belief that construction site workers are too tough to struggle with mental health is damaging and results in many just keeping silent about their struggles.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of health hazards. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Hazard Communication

Teaching Strategies
Students engage in brainstorming exercise and define of hazard communication

They then are allowed to design guiding questions that will enable them to conduct research on Hazard communication.

Discussions in groups on the research findings of hazard communication.

Learning Strategies
Activity 1 Brainstorming activity on hazard communication.

Activity 2 Conduct research on hazard communication.

Activity 3 Discussions and presentation of research findings on hazard communication.

Resources

Building Design & construction process

Lesson 2: The Types of Hazard communication

Teaching Strategies
Students engage in brainstorming exercise on the types of hazard communication

They then are allowed to design guiding questions that will enable them to conduct research on the types of hazard communication.

Discussions in groups on the research findings the types of hazard communication.

Learning Strategies
Activity 1 Brainstorming activity on the types of hazard communication.

Activity 2 Conduct research on different the types of hazard communication.

Activity 3 Discussions and presentation of research findings on the types of hazard communication.

Resources

Building Design & construction process

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Lesson 3: The Common Hazards in workplace

Teaching Strategies
Students engage in brainstorming exercise on the common hazards in the workplace.

They then are allowed to design guiding questions that will enable them to conduct research on the common Hazards in workplace.

Discussions in groups on the research findings on the common Hazards in workplace.

Learning Strategies
Activity 1 Brainstorming activity on the common Hazards in workplace.

Activity 2 Conduct research on different the common Hazards in workplace.

Activity 3 Discussions and presentation of research findings on the common Hazards in workplace.

Resources

Building Design & construction process

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Lesson 4: The Methods of Minimising Hazard in Workplace

Teaching Strategies
Students engage in brainstorming exercise on the methods of minimising hazard in workplace

They then are allowed to design guiding questions that will enable them to conduct research on the methods of minimising hazard in workplace.

Discussions in groups on the research findings the methods of minimising hazard in workplace

Learning Strategies
Activity 1 Brainstorming activity on the methods of minimising hazard in workplace.

Activity 2 Conduct research on different the methods of minimising hazard in workplace.

Activity 3 Discussions and presentation of research findings on the methods of minimising hazard in workplace.

Resources

Building Design & construction process

STEAM Activity Students work in groups, research identify and do presentations explaining the plumbing –related hazards and their solutions.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to hazard communication in plumbing trade .Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Define hazard communication
2. Analyse and describe the types of hazard communication
3. State and demonstrate the common hazards in workplace
4. Analyse and demonstrate the methods of minimising hazard in workplace

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1.Define hazard communication	Accurately define hazard communication with examples	Correctly define hazard communication	Partially define hazard communication	Poorly define hazard communication
2.Analyse and describe the types of hazard communication	Accurately analyse and describe the types of hazard communication	Correctly analyse and describe the types of hazard communication	Partially analyse and describe the types of hazard communication	Poorly analyse and describe the types of hazard communication
3.State and demonstrate the common hazards in workplace	Accurately state and demonstrate the common hazards in workplace	Correctly state and demonstrate the common hazards in workplace	Partially state and demonstrate the common hazards in workplace	Poorly state and demonstrate the common hazards in workplace
4.Analyse and demonstrate the methods of minimising hazard in workplace	Accurately analyse and demonstrate the methods of minimising hazard in workplace	Correctly analyse and demonstrate the methods of minimising hazard in workplace	Partially analyse and demonstrate the methods of minimising hazard in workplace	Poorly analyse and demonstrate the methods of minimising hazard in workplace

UNIT 3. Plumbing Technology

Content Standard 3.3. Investigate and analyse fundamental concepts of plumbing and theories, Occupational Health and Safety Regulations and standards ,trade drawing, demonstrations and applications of tools and materials specifications, installation of plumbing fittings and accessories in Drain, waste, vent system, and water (DWV) distribution system.

Benchmark 11.3.3.3 Explore and categorise corrugated stainless steel tubing, fixtures and faucets

Topic 3: Plumbing Corrugated Stainless Steel Tubing, Fixtures and Faucets

Learning Objectives

By the end of this topic, the students will be able to;

1. Analyse and describe the types of corrugated stainless steel tubing, fixtures and faucets.
2. State and demonstrate the methods of categorising and installing stainless steel faucets and fitting.

Essential Questions:

1. What are the types of corrugated stainless steel tubing?
2. What are the types of faucets and fittings?
3. What are the methods of stainless steel tubing?
4. How do we demonstrate methods of stainless steel faucets and fitting?

Essential Knowledge, Skills, Values and Attitudes:
Knowledge: corrugated stainless steel tubing
Skills: Apply, inquiry
Values: Values the importance
Attitudes: critical, open-minded and confident in demonstrating the concepts of plumbing with corrugated stainless steel tubing, fixtures and faucets.

Content Background

Our water sources vary according to where we live. Cities get their water from civically or privately owned water companies that treat and purify water collected from lakes, rivers, and reservoirs.
Pipes and other plumbing materials must be strong, durable, and non-corrosive. Supply pipes must withstand the high pressures inherent in water supply systems. They are made from materials that will match or exceed the expected life of the homes in which they are installed. The array of pipes found in the home may seem complex when you first look at them; but it's really quite simple once you know the basics. Once you are able to identify the specific parts and understand what they do, you're on the road to having the skills to install and maintain a home plumbing system. Water is provided by a municipal water company or by a well. In cities and towns, water runs through main supply lines under the street. A pipe branching off the main supply line enters the house and passes through a water meter and main shut-off valve. The water meter monitors the amount of water being used. The pipe then branches off to a water heater and from there, to all the fixtures and appliances in the house. Drain lines collect water from sinks, showers, and bathtubs. A strainer is used to prevent a sink or tub drain from clogging. Waste lines carry wastes from toilets. Because the drain and waste lines rely on gravity, they slope slightly downward, allowing the waste to run down and out to the municipal sewer or septic tank. Vent pipes allow sewer gases to escape and also allow wastes to flow freely by maintaining the necessary air pressure. Vent pipes are vital to drain and waste systems.

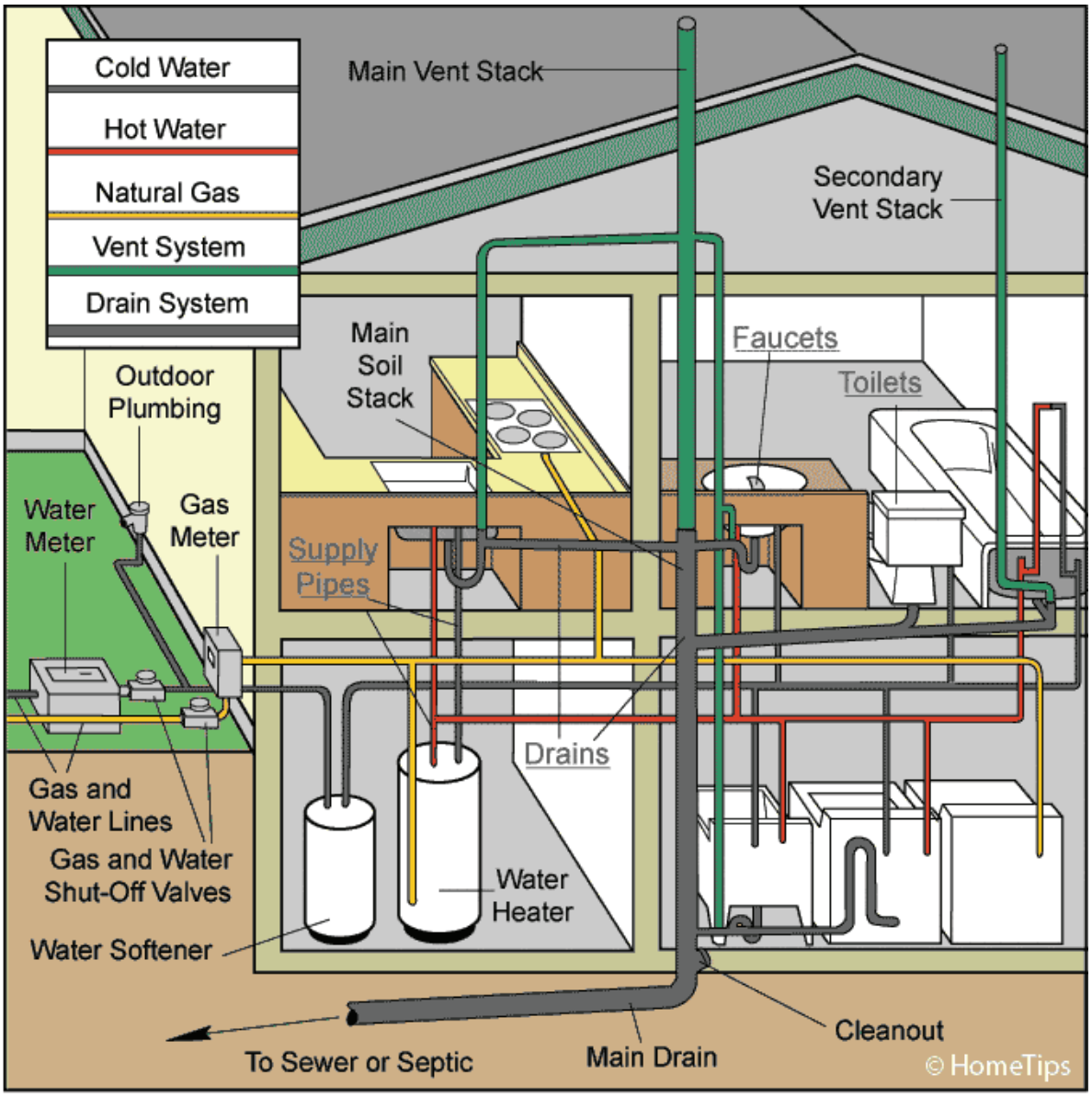


Figure 3.3a Piping system
Source:https://www.google.com/search?q=house%20drainage%20system%20diagram&tbm=isch&rlz=1C1GCEU_enPG1032PG1032&hl=en&sa=X&ved=0CB4QtI8BKABqFwo

Pipe Comparison Chart

This chart shows the various types of pipe that are available from plumbing supply stores or home centers.
Before using any of these pipes, you should check your local plumbing codes. The people who are very knowledgeable and can give good advice.
All diameters refer to the inside diameter (ID).

General Info Lengths Common

General Information	Lengths	Common Uses	Diameters	Fitting Methods	Cutting Tools
Cast Iron	5'' – 10''	main DWV pipe	3"- 4"	banded neoprene couplings	soil pipe cutter or hacksaw
ABS	10' – 20' or	DWV pipes,	1¼" – 1½" -	solvent glue,	tubing cutter,

(acrylonitrile butadiene styrene)	by linear ft.	traps	2" – 3"- 4"	ABS fittings	hacksaw
PVC (polyvinyl chloride)	10' – 20' or by linear ft.	DWV pipes, traps	1½" – 2"- 3" and 4"	solvent glue, PVC fittings	tubing cutter, hacksaw mitre saw
Galvanized Iron*	various	hot and cold water, drains	½" - ¾" – 1" – 1½" - 2'	galvanized threaded fittings	pipe cutter, tubing cutter
CPVC (chlorinated polyvinyl chloride)	10'	hot and cold water 100psi	3/8" – ½" – ¾" – 1"	solvent glue, CPVC fittings, grip fittings	tubing cutter, hacksaw, miter saw
PB (polybutylene)	25' – 100' coils or by linear ft.	hot and cold water (where permitted)	3/8" - ½" - ¾"	plastic grip fittings	tubing cutter, hacksaw, sharp knife
Rigid Copper	10' – 20' or by linear ft.	hot and cold water supply	3/8" - ½" - ¾" and 1"	solder , copper fittings or compression fittings	tubing cutter, hacksaw
Chromed Copper	12' – 20' –30'	tubing for fixture water supply (visible when installed)	3/8"	brass compression fittings	tubing cutter, hacksaw
Flexible Copper Tubing .	30' – 60' coils or by linear ft	hot and cold water supply, natural gas	¼ - 3/8" – ½" – ¾" – 1"	brass compression fittings, flare fittings, solder	tubing cutter, hacksaw
Chromed Brass	various	valves, shutoffs, traps	¼" – ½" – ¾" for traps 1¼"– 1½"	compression fittings	tubing cutter, hacksaw

Uses Diameters Fitting
Methods Cutting Tools
**Not recommended for new installations.*
Lab-Volt (2005) Tech0Design Residential Plumbing Module Guide, Introduction to Residential Plumbing, Edition 1

The 5 Types of Plumbing Pipes
Different types of plumbing pipes can be used in a number of ways, from carrying water to the kitchen faucet to delivering waste to the sewage system. These kinds of drainage and delivery systems have been around since ancient times. The Greeks used clay pipes to transport water to homes and public buildings. Moving into the early twentieth century, materials like cast iron, terra-cotta, copper, and galvanised steel became more popular. As knowledge and understanding of lead poisoning developed, things evolved further. Today, there are many different types of pipe available, each used to serve a specific purpose.

The 5 main types of plumbing pipes are;
1. PVC Pipes

Polyvinyl chloride pipes (PVC) are commonly used as part of the a sink, toilet, or shower drain line. Its plastic tubing is ideal for this kind of usage because it protects the water from rust and corrosion better than any other types of pipes. This capability also makes PVC pipe very durable. Unless they are subject to some kind of damage, the PVC will last indefinitely. It can handle high water pressure and is lightweight making it easier to work with than the more traditional galvanised steel piping options.

2. PEX Pipes
PEX, or cross-linked polyethylene, piping also refers to affordable plastic tubing commonly used for water supply lines. Similar to PVC piping, it prevents rust or corrosion from leaching into the water. Professional remain drawn to PEX lines because they are flexible and easy to weave through walls, ceilings, basements, and crawl places. At the same time they are strong enough to withstand the pressure of water supply. Cross-linked polyethylene pipe is also colour coded for hot and cold water, making it easy for plumbers to identify and organise when on the job.

3. ABS Pipes
Acrylonitrile butadiene styrene (ABS) pipe is similar to PVC in nature but easy to identify based on their black colour. Acrylonitrile butadiene styrene is also particularly resilient to cold temperatures. It is predominantly used for vent and drain lines. Though this kind of plumbing pipe is easy to easy to install, it can warp when exposed to direct sunlight, causing disturbances among some home owners.

4. Copper Pipes
Copper pipe has been a staple within the plumbing industry for decades. This type of plumbing pipe can last upwards of 50 years and is commonly found in sinks, showers, tubs, and other fixtures in new and old homes. Copper pipes remain popular among plumbers and homeowners alike because they are corrosion-resistant and best suited to protect the quality of the water.

Different pipe sizes can be used for water supply lines
Copper pipes are able to handle high water pressure and are tolerant of both hot and cold water temperatures. It's also able to be recycled, making it a somewhat environmentally-friendly option. That said, there are a few drawbacks to consider. Because it is so rigid, plumbers cannot use copper piping in tight spaces. It is also the most expensive type of plumbing pipe. As the price of copper continues to rise, so will the costs of any project involving copper pipe.

5. Cast Iron and Galvanised Steel Pipes
Cast iron pipe and galvanized steel pipe are rarely included in new construction, though they are commonly found in homes built in the early 20th century. Still, cast iron plumbing pipes are incredibly durable and remain in use for parts of water distribution systems today.

Cast iron pipes were typically used as sewer pipes or other drainage purposes. Their popularity largely stemmed from the fact that they are heat-resistant and reduce the sound of moving water.

Unfortunately, cast-iron pipe is prone to rust and corrosion. Over time, this will affect its ability to maintain a clean water supply. These types of pipes have largely been replaced by copper or PEX pipes in residential plumbing repairs

Different plumbing pipe types are reserved for different purposes.
Pipes and fixtures

1. Pipes

Pipes are the Plumbing fixtures provided for carried water. Several types of pipes are used for carrying the water in plumbing systems. Such as cast iron pipes, wrought iron pipes, steel pipes, concrete pipes, galvanized iron pipes, copper pipes, etc.

1. Hose Bib (Connections for Water Hoses

Hose bibs are the Plumbing fixtures provided in the exterior of the house. Hose bibs are outdoor faucets that carry water from indoor systems outside.

3. Tapware

Tapware is the plumbing fixtures provided in an industry. The plumbing fixtures consist of tap valves, also called water taps or faucets, and their accessories, like water spouts and showerheads.

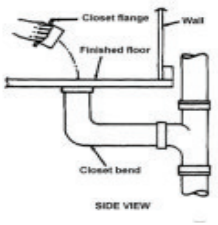
4. Terminal Valves

Terminal valves are the Plumbing fixtures provided in the pipeline to control water flow. Terminal valves are used for dishwashers, ice makers, humidifiers, etc.

5. Washbasins

Washbasins are the plumbing fixtures for washing hands and face and brushing teeth in a standing position. These are generally made of glazed earthenware or vitreous china. Occasionally these are also made of iron, stainless steel, or plastic.

6. Water Closet



A water closet is a visage-like water flushed plumbing fixture designed to admit human excreta directly from the user. It is made of vitreous china or porcelain and is connected to the soil pipe utilizing a trap. The water closet's inside face and the trap is made smooth by glazing to ensure an effective flush.

7. Bidets

A bidet is a plumbing fixture installed as a separate unit in the bathroom besides the toilet, shower, and sink.

8. Kitchen Sinks

Sinks are the plumbing fixtures handed in kitchens for cleaning utensils.

9. Bathtubs

Bathtubs are the plumbing fixtures handed in the bathrooms for taking a bath. These are generally made of glazed earthenware cement concrete finished with terrazzo or glazed porcelain tiles or marble titles and enameled iron. For draining, the bathtubs are handed with an indirect waste hole at the bottom.

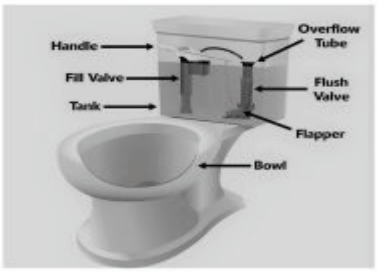
10. Showers

Showers are the Plumbing fixtures provided in the bathrooms.

11. Urinals

Urinals are the plumbing fixtures handed to urinate.

12. Flush Cisterns



Flushing cisterns are the plumbing fixtures for flushing out water closets and urinals. These are cast iron, glazed earthenware or vitreous china, or plastic.

Figure 3.3b Plumbing fixtures
Source: https://civiljungle.com/water-pipe-sizing-charts/

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to plumb corrugated stainless steel tubing, fixtures and faucets. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Types of Corrugated Stainless Steel Tubing

Teaching Strategies

Students engage in brainstorming exercise on the types of corrugated stainless steel tubing
They then are allowed to design guiding questions that will enable them to conduct research on the types of corrugated stainless steel tubing. .
Discussions in groups on the research findings on the types of corrugated stainless steel tubing.

Learning Strategies

Activity 1 Brainstorming activity on the types of corrugated stainless steel tubing.
Activity 2 Conduct research on different types of corrugated stainless steel tubing.
Activity 3 Discussions and presentation of research findings on the types of corrugated stainless steel tubing.

Resources

Building Design & construction process

Lesson 2: Types of Faucets and Fittings

Teaching Strategies

Students engage in brainstorming exercise on the types of faucets and fittings.
They then are allowed to design guiding questions that will enable them to conduct research on the types of faucets and fittings.
Discussions in groups on the research findings on the types of faucets and fittings.

Learning Strategies

Activity 1 Brainstorming activity on the types of faucets and fittings.
Activity 2 Conduct research on different types of faucets and fittings.
Activity 3 Discussions and presentation of research findings on the types of faucets and fittings.

Resources

Building Design & construction process

Lesson 3: Methods of Stainless Steel Tubing

Teaching Strategies
Students engage in brainstorming exercise on the methods of stainless steel tubing.
They then are allowed to design guiding questions that will enable them to conduct research on the methods of stainless steel tubing.
Discussions in groups on the research findings on the methods of stainless steel tubing.

Learning Strategies
Activity 1 Brainstorming activity on the methods of stainless steel tubing.
Activity 2 Conduct research on different methods of stainless steel tubing.
Activity 3 Discussions and presentation of research findings on the methods of stainless steel tubing.

Resources

Building Design & construction process

Lesson 4: Methods of Stainless Steel Faucets and Fitting

Teaching Strategies
Students engage in brainstorming exercise on methods of stainless steel faucets and fittings.
They then are allowed to design guiding questions that will enable them to conduct research on the methods of stainless steel faucets and fittings.
Discussions in groups on the research findings on the methods of stainless steel faucets and fittings.

Learning Strategies
Activity 1 Brainstorming activity on the methods of stainless steel faucets and fittings.
Activity 2 Conduct research on different methods of stainless steel faucets and fittings.
Activity 3 Discussions and presentation of research findings on the methods of stainless steel faucets and fittings.

Resources

Building Design & construction process

STEAM Activity Students work in groups to create a piping system using bamboo sticks and their fittings.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to understand plumbing corrugated stainless steel tubing, fixtures and faucets Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Analyse and describe the types of corrugated stainless steel tubing.

2. State and describe the types of faucets and fittings.
3. State and demonstrate the methods of stainless steel tubing
4. State and demonstrate the methods of stainless steel faucets and fittings.

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Analyse and describe the types of corrugated stainless steel tubing	Accurately analyse and describe the types of corrugated stainless steel tubing	Correctly analyse and describe the types of corrugated stainless steel tubing	Partially analyse and describe the types of corrugated stainless steel tubing	Cannot analyse and describe the types of corrugated stainless steel tubing
2. State and describe the types of faucets and fittings	Accurately state and describe the types of faucets and fittings	Correctly state and describe the types of faucets and fittings	Partially state and describe the types of faucets and fittings	Cannot state and describe the types of faucets and fittings
3.State and demonstrate the methods of stainless steel tubing	Accurately state and demonstrate the methods of stainless steel tubing	Correctly state and demonstrate the methods of stainless steel tubing	Partially state and demonstrate the methods of stainless steel tubing	Cannot state and demonstrate the methods of stainless steel tubing
4. State and demonstrate the methods of stainless steel faucets and fitting	Accurately state and demonstrate the methods of stainless steel faucets and fitting	Correctly state and demonstrate the methods of stainless steel faucets and fitting	Partially state and demonstrate the methods of stainless steel faucets and fitting	Cannot state and demonstrate the methods of stainless steel faucets and fitting

UNIT 3. Plumbing Technology

Content Standard 3.3. Investigate and analyse fundamental concepts of plumbing and theories, Occupational Health and Safety Regulations and standards ,trade drawing, demonstrations and applications of tools and materials specifications, installation of plumbing fittings and accessories in Drain, waste, vent system, and water (DWV) distribution system.

Benchmark 11.3.3.4 Read and analyse blue prints and sketches of pipe system using CAD program

Topic 4: Introduction to Blueprint and Sketches of Pipe System

Learning Objectives

By the end of this topic, the students will be able to;

1. Analyse and demonstrate the method of manual sketching blue print and pipe system.
2. Analyse and demonstrate the methods of downloading CAD program.
3. Analyse and demonstrate the methods of sketching blue print and pipe system using CAD program.

Essential Questions:

1. What is a Blueprint and pipe system?
2. What are the method of manual sketching blue print and pipe system?
3. How do we demonstrate the methods of sketching blue print and pipe system using CAD program?
4. What are the methods of downloading CAD program?

Essential Knowledge, Skills, Values and Attitudes:
Knowledge: Blueprint of Pipe system
Skills: Apply
Values: Appreciate the importance
Attitudes: Appreciative of sketching the piping system manually and using the CAD program confidently.

Content Background

Plumbing blueprints detail everything from the type and size of sinks to the location of gas lines, drains and vents. Most times plumbers must take extensive courses to learn how to read all the details of a plumbing blueprint. There are two main types of plumbing sketches/ drawings used by plumbers and mechanical designers to illustrate proposed plumbing layouts, which are orthographic and isometric sketches.

Orthographic sketches
Orthographic sketches is best described as a two dimensional drawing drawn from a vantage point such as an underground piping for example. In building plans these can be described as someone looking down (top view) , this is called a plan view and best describes horizontal features. Another common orthographic view is a front view; also called an elevation view. An

elevation view is from the perspective of a person standing in front of structure and best describes vertical features such as the plumbing stack.

Isometric Sketching

An Isometric sketch is a two dimensional drawing that creates the illusion of three dimensions using angular lines. This is the preferred drawing method for plumbers as it show the most information about the piping layout.

Blueprints are the technical plans that illustrate any kind of construction, from the foundation to the electrical wiring to the plumbing. Plumbing blueprint schedules note everything from the size of the sinks to the location of drains. Blueprints are drawn to scale. Symbols on the blueprint are drawn to scale as it is important to know how much space is being worked with. Symbols and abbreviations so anyone can interpret them. Plumbing blueprints also include the buildings water supply and drain piping which may be represented by dashes, solid lines, dotted lines and or coloured lines. Lines and pipes will often be enclosed within walls, which themselves are usually represented by double ines with space in between. F blueprints are drawn in multiple colours (not just blue) this would mean that cold water lines are drawn in blue and hot water lines are drawn in red. Many abbreviations and symbols are quite logical. Hence, for clarity and consistency, plumbing plan layouts should use detailed, industry standard schematic symbols. In many instances a plumbing diagram will be colour coded to distinguish certain processes

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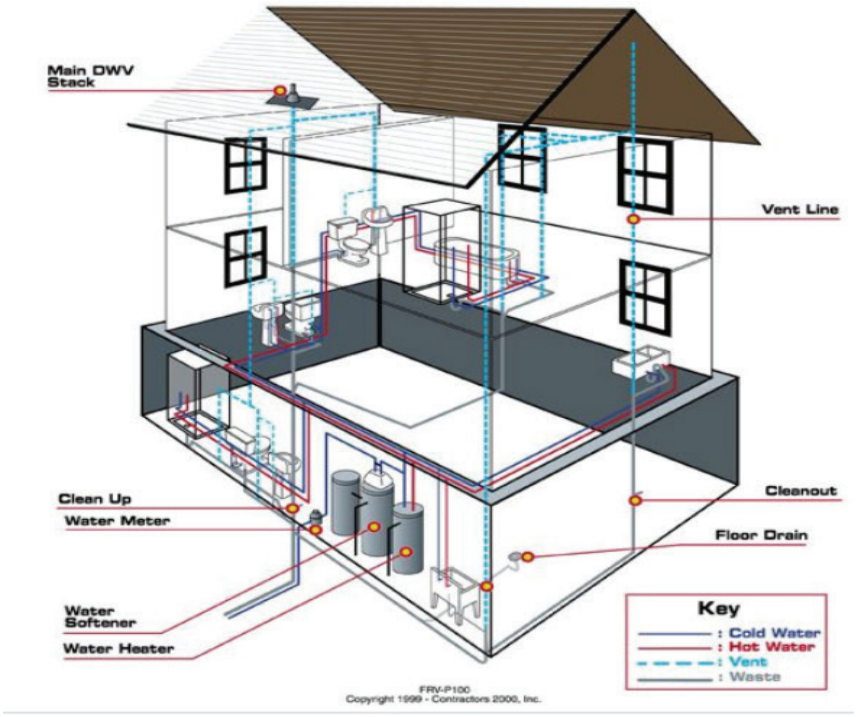

Figure 3.3a. AutoCAD blueprint of a piping system.

Source: https://www.plumbinghelp.com/sketching

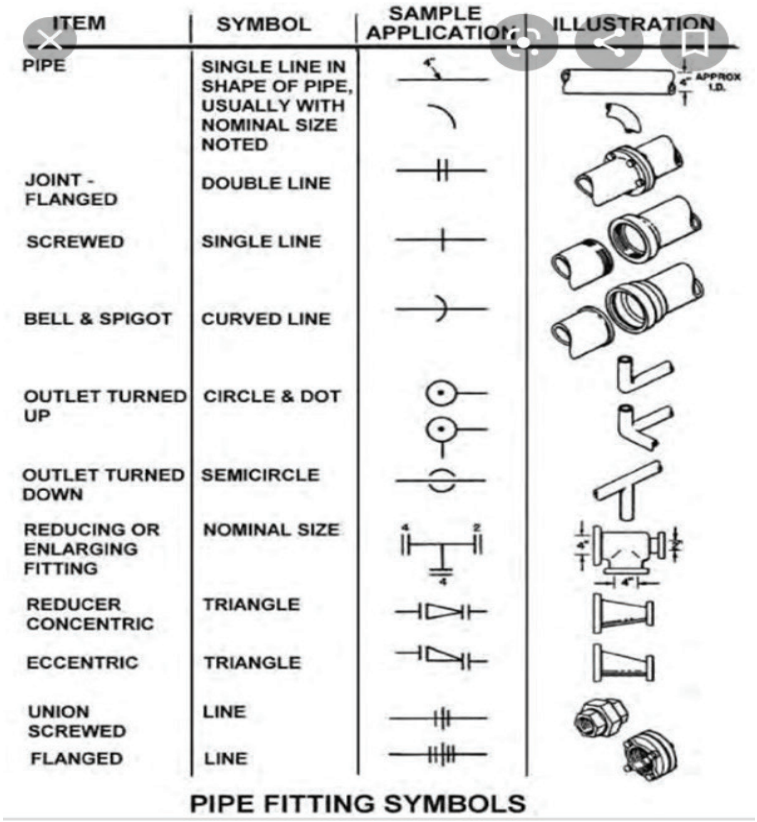

Figure 3.3b; Blue print- Plumbing symbols and fittings.
Source: https://draftingmanuals.tpub.com/14276/css/Common-Plumbing-Symbols-257.html

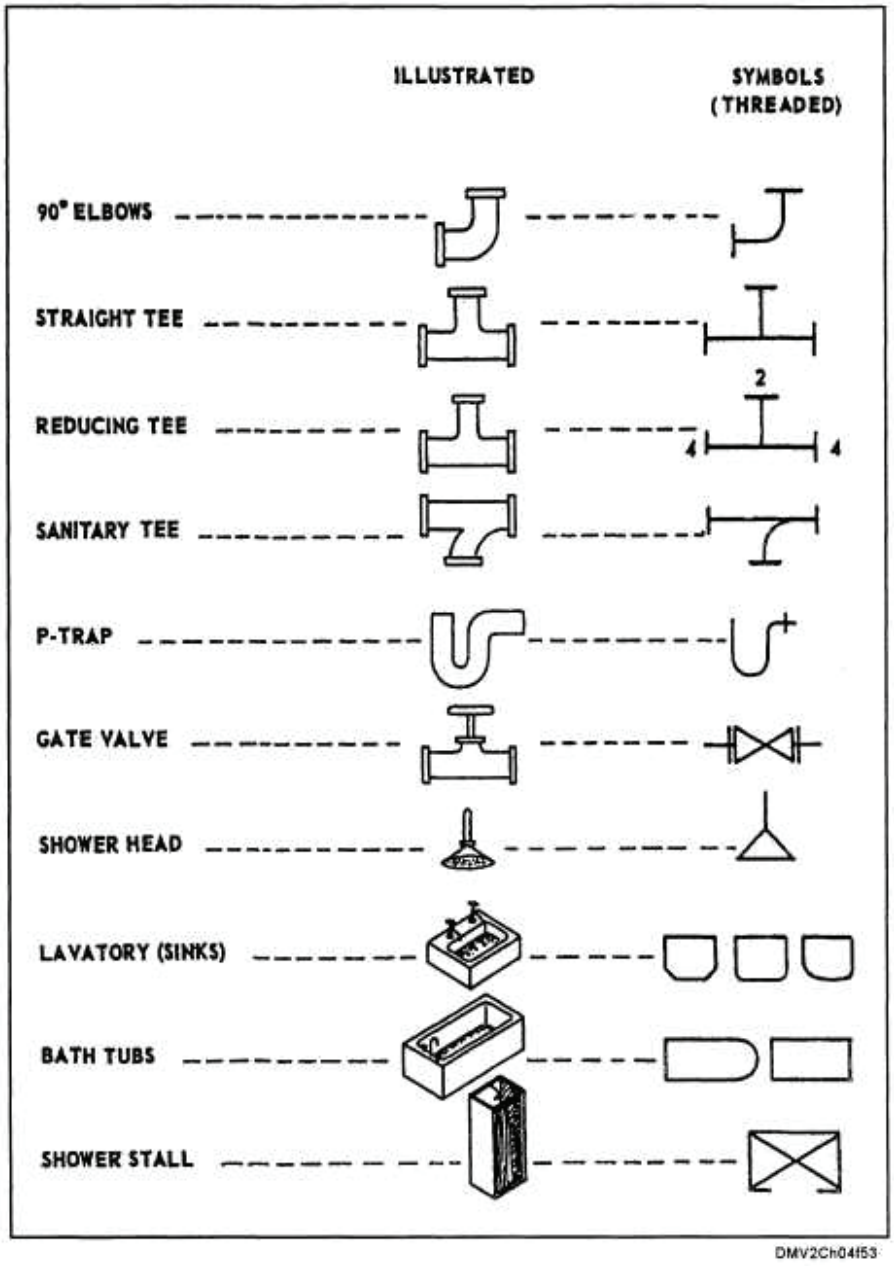

Figure 3.3c The Cycle of the Blue print Sketches are shown above.
Source: https://draftingmanuals.tpub.com/14276/css/Common-Plumbing-Symbols-257.html

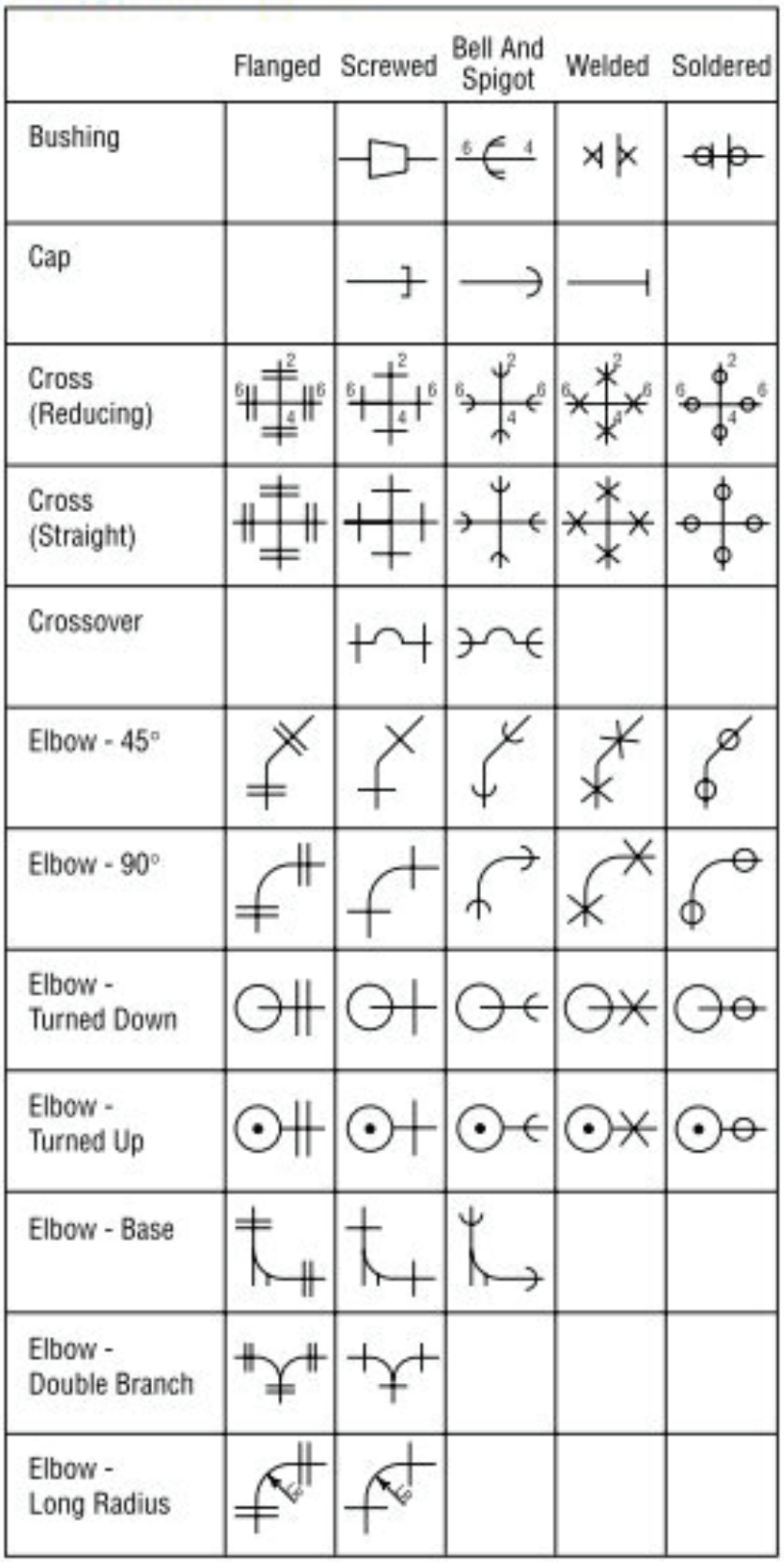

Figure 3.3d Symbols for pipe fittings
Source: https://www.yumpu.com/en/document/view/32338459/symbols-for-pipe-fittings

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to learn the Introduction to Blue Print and sketches of Pipe system. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Blue print and pipe system-

Teaching Strategies

Students engage in brainstorming exercise on definition of blueprint and pipe system-
They then are allowed to design guiding questions that will enable them to conduct research on the definition of blueprint and pipe system.
Discussions in groups on the research findings on the definition of blueprint and pipe system.

Learning Strategies

Activity 1 Brainstorming activity on the definition of blueprint and pipe system.
Activity 2 Conduct research on different definition and terminologies of blueprint and pipe System.
Activity 3 Discussions and presentation of research findings on definition and terminologies of blueprint and pipe system.

Resources

Building Design & construction process

Lesson 2: Method of Manual Sketching Blueprint and Pipe System-

Teaching Strategies

Students engage in brainstorming exercise on method of manual sketching blueprint and pipe system.
They then are allowed to design guiding questions that will enable them to conduct research on the method of Manual sketching blueprint and pipe system.
Discussions in groups on the research findings on the method of manual sketching blueprint and pipe system.

Learning Strategies

Activity 1 Brainstorming activity on the method of manual sketching blueprint and pipe system
Activity 2 Conduct research on different method of manual sketching blueprint and pipe System.
Activity 3 Discussions and presentation of research findings on the method of manual sketching blueprint and pipe system.

Resources

Building Design & Construction process
AutoCAD software manual Books
Autodesk software e- Book
Autodesk software 2020 version

Lesson 3: Methods of Sketching Blueprint and Pipe System Using CAD program-

Teaching Strategies
Students engage in brainstorming exercise on methods of sketching blueprint and pipe system using CAD program.
They then are allowed to design guiding questions that will enable them to conduct research on the methods of sketching blueprint and pipe system using CAD program-
Discussions in groups on the research findings on the methods of sketching blueprint and pipe system using CAD program.

Learning Strategies
Activity 1 Brainstorming activity on the methods of sketching blueprint and pipe system using CAD program.
Activity 2 Conduct research on different methods of sketching blueprint and pipe system using CAD program.
Activity 3 Discussions and presentation of research findings on the methods of sketching blue print and pipe system using CAD program.
Resources

Building Design & construction process
AutoCAD software manual Books
Autodesk software e- Book
Autodesk software 2020 version

Lesson 4: Methods of Downloading CAD Program-

Teaching Strategies
Students engage in brainstorming exercise on methods of downloading CAD program-
They then are allowed to design guiding questions that will enable them to conduct research on methods of downloading CAD program- .
Discussions in groups on the research findings the methods of downloading CAD program-

Learning Strategies
Activity 1 Brainstorming activity on the methods of downloading CAD program.
Activity 2 Conduct research on different methods of downloading CAD program.
Activity 3 Discussions and presentation of research findings on methods of downloading CAD program.

Resources
Building Design & construction process
AutoCAD software manual books
Autodesk software e- Book
Autodesk software 2020 version

STEAM Activity Students work in groups to construct a building plan using Auto CAD/ FreeCAD Program.

Assessment

The main purpose of assessment is to find out if students can use the skill of synthesis to Introduction to Blueprint and sketches of Pipe system .Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Define Blueprint and pipe system
2. Analyse and demonstrate the method of Manual sketching blueprint and pipe system
3. Analyse and demonstrate the methods of sketching blueprint and pipe system using CAD program
4. Analyse and demonstrate the methods of downloading CAD program

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Define blueprint and pipe system	Correctly and accurately define blueprint and pipe system	Correctly define blueprint and pipe system	Partially define blueprint and pipe system	Cannot define blueprint and pipe system
2.Analyse and demonstrate the method of Manual sketching blueprint and pipe system	Accurately and correctly analyse and demonstrate the method of Manual sketching blueprint and pipe system	Correctly analyse and demonstrate the method of Manual sketching blueprint and pipe system	Partially analyse and demonstrate the method of Manual sketching blueprint and pipe system	Cannot analyse and demonstrate the method of Manual sketching blueprint and pipe system
3.Analyse and demonstrate the methods of sketching blueprint and pipe system using CAD program	Accurately and correctly analyse and demonstrate the methods of sketching blueprint and pipe system using CAD program	Correctly analyse and demonstrate the methods of sketching blueprint and pipe system using CAD program	Partially analyse and demonstrate the methods of sketching blueprint and pipe system using CAD program	Cannot analyse and demonstrate the methods of sketching blueprint and pipe system using CAD program
4.Analyse and demonstrate the methods of downloading CAD program	Accurately and correctly analyse and demonstrate the methods of downloading CAD program	Correctly analyse and demonstrate the methods of downloading CAD program	Partially analyse and demonstrate the methods of downloading CAD program	Cannot analyse and demonstrate the methods of downloading CAD program

Unit 4: Welding Technology

Unit	Topics	Lesson Titles
4. Welding Technology	Topic 1. Workplace Health & Safety	1. Risk assessment 2. Risk management 3. Safe operational procedure of machines
	Topic 2. Lathe and Milling Machines	1. Lathe Machines 2. Milling Machines 3. Elements of Metals and Material Properties in Machining
	Topic 3. Engineering Drawings	1. Engineering Drawing 2. Engineering Blueprints
	Topic 4. Welding Techniques in Accordance to Safety Standards	1. Welding Techniques 2. Cutting Processes in Welding 3. Standard Metals for Welding Projects
	Topic 5. Forms of Welding	1. Material Selection for Welding and Machining 2. Types of Joints
	Topic 6. Machinery Safety	1. Lathe Machine Safety 2. Milling Machine Safety

UNIT 4 Welding Technology

Content Standard 3.4. Investigate and analyse safety procedures, print reading, measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing principles and apply fundamentals of fabrication codes, inspections, testing principles and apply fundamentals of fabrication.

Benchmark 11.3.4.1 Identify and apply fundamental principles of OHS when working with materials, tools and machines.

Topic 1: Workplace Health and Safety

Learning Objectives

By the end of this topic, the students will be able to;

1. Identify workplace health and safety practices when working with materials, tools and machines
2. Apply workplace health and safety practices when working with materials, tools and machines.

Essential Questions:

1. What are the workplace health and safety practices?
2. What is risk assessments and management?
3. Why do we apply safe practices in the workplace?
4. What are the safe operational procedures of handling machines?

Essential Knowledge, Skills, Values and Attitudes:

Knowledge: Principles of OHS
Skills: Identify and apply
Values: Appreciate
Attitudes: Aware of health and wellbeing standards.

Content Background

RISK ASSESSMENT

Risk assessment is a term used to describe the overall process or method where you: Identify hazards and risk factors that have the potential to cause harm (hazard identification). Analyse and evaluate the risk associated with that hazard (risk analysis, and risk evaluation).

RISK ASSESSMENT STEPS

Step 1: Identify the hazard (Hazard is anything that has the potential to harm you).

Step 2: Decide who might be harmed and how.
Step 3: Evaluate the risk and decide on the precaution.
Step 4: Record your findings and implement them.
Step 5: review your assessment and update if necessary.

RISK MANAGEMENT

Risk management is the identification, evaluation, and prioritization of risks followed by coordinated and economical application of resources to minimize, monitor, and control the probability or impact of unfortunate events or to maximise the realisation of opportunities.

RISK MANAGEMENT PROCESS

Figure 4.1a Risk Management
Source: https://www.worksafe.qld.gov.au/data/assets/pdf_file/0010/82783/guidetomachinery-equipmentsafety

Safe Operational procedures for tools, equipment and machines

Key principles of machinery and equipment safety

Mechanical hazards

Machinery and equipment have moving parts. The action of moving parts may have sufficient force in motion to cause injury to people.

When assessing machinery and equipment for possible mechanical hazards, consider:

- Machinery and equipment with moving parts that can be reached by people.
- Machinery and equipment that can eject objects (parts, components, products or waste items) that may strike a person with sufficient force to cause harm.
- Machinery and equipment with moving parts that can reach people, such as booms or mechanical appendages (arms).

- Mobile machinery and equipment, such as forklifts, pallet jacks, earthmoving equipment, operated in areas where people may gain access.

Common mechanical hazards and associated risks for machinery and equipment are shown below.

- Hazard Risk.
- Rotating shafts, pullies, sprockets and gears entanglement.
- Hard surfaces moving together crushing.
- Scissor or shear action severing.
- Sharp edge – moving or stationary cutting or puncturing.
- Cable or hose connections slips, trips and falls (e.g. oil leaks).

Non-mechanical hazards

Non-mechanical hazards associated with machinery and equipment can include harmful emissions, contained fluids or gas under pressure, chemicals and chemical by-products, electricity and noise, all of which can cause serious injury if not adequately controlled. In some cases, people exposed to these hazards may not show signs of injury or illness for years. Where people are at risk of injury due to harmful emissions from machinery and equipment, the emissions should be controlled at their source.

When assessing machinery and equipment for possible non-mechanical hazards, consider how machinery and equipment can affect the area (environment) around them.

Common non-mechanical hazards are shown below.

- Non-mechanical hazards.
- Dust Mist (vapours or fumes).
- Explosive or flammable atmospheres Noise.
- Heat (radiated or conducted) Ignition sources (flame or spark).
- High intensity light (laser, ultraviolet) Molten materials.
- Heavy metals (lead, cadmium, mercury) Chemicals.
- Steam Pressurised fluids and gases.
- Ionising radiation (x-rays, microwaves) Electrical.

Access hazards

People must be provided with safe access that is suitable for the work they perform in, on and around machinery and equipment. A stable work platform, suited to the nature of the work that allows for good posture relative to the work performed, sure footing, safe environment and fall prevention (if a fall may occur), is a basic requirement. For example, cooling towers on building roofs may have poor access, yet must be attended by a service person at predictable times for water treatment, chemical dosing or monitoring of automated dosing equipment. People

performing these tasks must be provided with the means to get themselves and any equipment they require onto the roof with no risk, or minimal risk of fall or injury.

When thinking about safe access to machinery and equipment, consider the following:

- who will be working on or around the machinery and equipment,
- people who are required to work in enclosed areas where the atmosphere could be harmful, such as pits, tanks or storage vessels,
- what equipment or materials need to be carried to undertake the task,
- where and when is access required for operation, maintenance and cleaning,
- how will people gain safe access (walkway, gantry, elevated work platform or ladder),
- what work will be carried out during access,
- will people be near or exposed to an unidentified mechanical or non-mechanical hazard at the time of access,
- has consultation occurred with workers or contractors regarding how they intend to gain access, and what equipment and work platform or structure is best suited for the intended task.

Access

Access needs can be predicted and planning must occur in advance. People need access to machinery and equipment in the workplace (either continually or occasionally) for predictable tasks such as operation, maintenance, repair, installation, service or cleaning. Access may vary during each stage of the machinery and equipment life cycle. For example:

- installation or removal of complete access from every area may be required and involve disconnection or connection of services, such as water, air, pipes, installation of electrical cable to switch board,
- operation or access for set up, operation and adjustment,
- maintenance, repair, cleaning, alteration or adaptation of access to remote areas may be required.

Following are examples of common hazards by type of workplace activity.
People who install or dismantle machinery and equipment could:

- work in isolation,
- work on machinery and equipment at height, or over machinery and equipment to connect services, such as electricity, air or water,
- work in low light, or with bright directional light,
- access machinery and equipment from the top, sides or underneath,
- work with or near cranes, forklifts or rigging to lift machinery and equipment,
- work in confined spaces,
- use power tools, welders, extension leads, which present electrical hazards if damaged or wet.

People operating machinery and equipment could:

- be required to place their hands close to the mechanism of the machinery and equipment that does the work, and may be injured if caught or trapped by moving parts,
- be exposed to constant harmful noise, radiated energy or fumes being emitted from the machinery and equipment being operated, or are close to,
- inadvertently bump or knock poorly placed control levers or buttons,
- be required to make adjustments to the mechanism of machinery and equipment while the machine is in motion,
- be required to clear away scrap,
- make minor adjustments, or reach into the moving mechanism of the machinery and equipment being operated.

People providing maintenance or repair services could:

- work alone,
- work on machinery and equipment at height, or over machinery and equipment to connect services, such as electricity, air or water,
- access machinery and equipment from the rear or sides,
- be required to enter confined spaces of larger machinery and equipment,
- be trapped by the mechanism of the machinery and equipment through poor isolation of energy sources or stored energy, such as spring-loaded or counter-balance mechanisms, compressed air or fluids, or parts held in position by hydraulics or pneumatic (air) rams,
- move heavy parts when changing the setup of machinery and equipment, or repairing failed parts, such as electric motors or gear box assemblies,
- disable or remove normal safety systems to access the mechanism of machinery and equipment.

People providing cleaning services could:

- work alone,
- access machinery and equipment from the rear or sides, or in unexpected ways,
- climb on machinery and equipment,
- enter confined spaces, or larger machinery and equipment,
- become trapped by the mechanism of the machinery and equipment through poor isolation of energy sources or stored energy, such as spring-loaded or counter-balance mechanisms, compressed air or fluids, or parts held in position by hydraulics or pneumatic (air) rams,
- work with chemicals,
- operate electrical equipment in wet areas.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of work[lace health and safety.. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and

problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Risk Assessment
Teaching Strategies
Teachers introduce students to occupational Health & Safety. Highlighting the risk assessment strategies.

Learning Strategies
Conduct a research with guiding questions that will lead to discovering what the terms are.
Occupation
Health
Safety
Risk assessment
Strategy

Activity 1 Issue texts and charts on occupational health and safety with special highlights on risk assessment strategies. Provide guideline questions and points.
Activity 2 Brainstorm on what occupational health and safety is. Signify risk assessment strategies.
Activity 3 Students do research in groups and present their findings.

Resources
Charts and texts on Occupational health and safety

Lesson 2: Risk Management
Teaching Strategies
Teachers introduce students to Occupational Health & Safety highlighting the risk management.

Learning Strategies
Conduct a research with guiding questions that will lead to discovering what the terms are.
Risk Management.
Activity 1 Indicate texts and charts on risk management strategies. Provide guiding questions and points.
Activity 2 Brainstorm on what risk management strategies.
Activity 3 Students do research in groups and present.

Resources
Charts and texts on Occupational health and safety

Lesson 3: Safety Operational Procedures of Machines
Teaching Strategies
Teachers guide students to investigate the safety operational procedures of machines.

Learning Strategies
Conduct a research with guiding questions that will lead to discovering the safety operational procedures of; Tools, Materials, Machines

Activity 1 Highlight texts and charts on safety operational procedures of tools, materials and machines. Provide guiding questions and points.

Activity 2 Brainstorm on what safety operational procedures of tools, materials and machines.
Activity 3 Students do research in groups and present.

Resources
Charts and texts on safety operational procedures of tools, materials and machines.

STEAM Activity Students work in groups to create an activity incorporating the concepts of safety risks, and management.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to identify and apply fundamental principles of OHS when working with materials, tools and machines. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Identify workplace health and safety practices with working with materials, tools and machines
2. Apply workplace health and safety practices with working with materials, tools and machines.

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Identify workplace health and safety practices when working specified with materials, tools and machines.	Identify workplace health and safety practices when working with specified materials, tools and machines competently.	Identify workplace health and safety practices when working with specified materials, tools and machines correctly.	Identify workplace health and safety practices when working with specified materials, tools and machines partially.	Identify workplace health and safety practices when working with specified materials, tools and machines very poorly.
2. Apply workplace health and safety practices when working with materials, tools and machines.	Apply workplace health and safety practices when working with materials, tools and machines competently..	Apply workplace health and safety practices when working with materials, tools and machines correctly.	Apply workplace health and safety practices when working with materials, tools and machines partially.	Apply workplace health and safety practices when working with materials, tools and machines poorly.

UNIT 4 Welding Technology

Content Standard 3.4. Investigate and analyse safety procedures, print reading, measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing principles and apply fundamentals of fabrication codes, inspections, testing principles and apply fundamentals of fabrication.

Benchmark 11.3.4.2. Explain functions and components of lathe and milling machines and describe material properties and elements of metals in lathe machining.

Topic 2: Lathe and Milling machines

Learning Objectives

By the end of this topic, the students will be able to;

1. Explain functions and parts of lathe and milling machines.
2. Describe material properties and elements of metals for machining.

Essential Questions:

1. What are the functions of lathe and milling machines?
2. How would you describe material properties and elements of metals in machining?

Essential Knowledge, Skills, Values and Attitudes:

Knowledge: Lathe and Milling machines, material properties, elements of metals
Skills: Explain, describe
Values: Appreciate and value
Attitudes: Responsible

Content Background

A lathe is a machine tool which is used to rotate a work piece to perform various operations such as turning, facing, knurling, grooving etc., with the help of tools that are applied to the work piece. It is used to shape wooden or metallic products. It furnishes a wooden or metal piece by rotating it about an axis while a stationary cutting tool keeps removing unwanted material from the work piece to form the desired shape.

Working Principle of Lathe Machine

The function of a lathe is to remove metal from a piece of work to give it a desired shape and size. In a lathe machine, the work piece rotates against the tool. The tool is used to remove material from the work piece. The direction of the motion of the tool is called a feed.

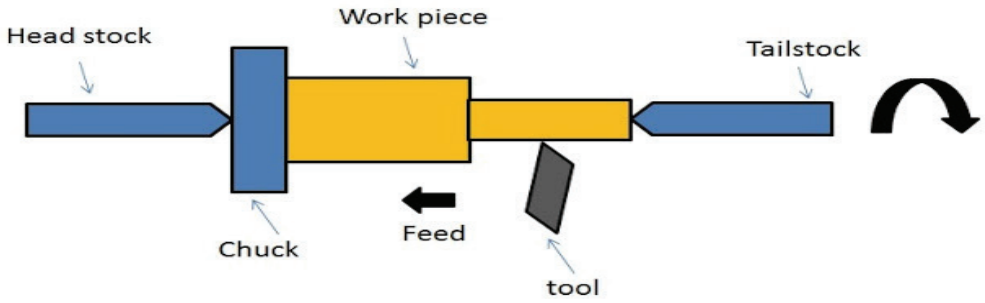

Figure 4.2 a Working principle of lathe machine
Source: https://mechanicalnotes.com/lathe-machine-introduction/

Main Parts of Lathe Machine

The various main parts of lathe machine are

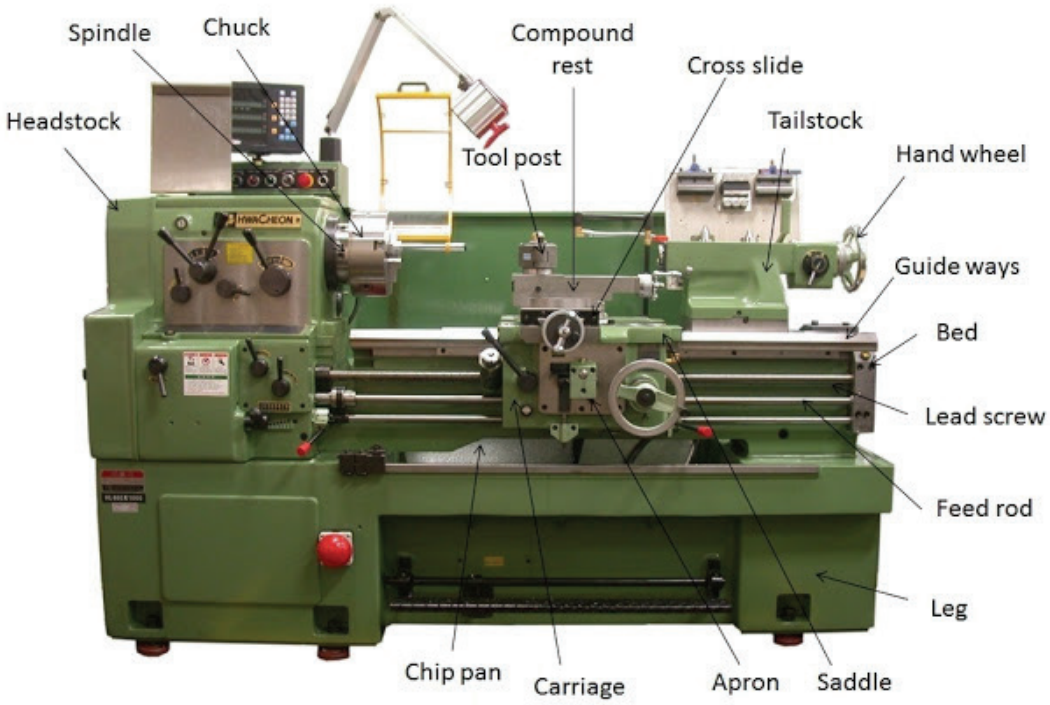

Figure 4.2b Lathe machine
Source:
https://en.wikipedia.org/wiki/Lathe#:~:text=A%20lathe%20(%2Fle%C9%AA%C3%B0,with%20symmetry%20about%20that%20axis.

1. ***Headstock -*** It is present on the left-hand side of the lathe. It holds the gear train, main spindle, chuck, gear speed control levers, and feed controllers. It is aligned with the tailstock. The headstock is made up of cast iron.

(i) Chuck - It is that part of the lathe machine which is used to hold the work piece. It is attached to the main spindle of the headstock. It rotates with the spindle and also rotates the work piece. In the lathe machine, we generally use three-jaw or four-jaw check. The three jaw of the three jaw chuck is made to move simultaneously but the jaws of the four jaw chuck moves independently.

(ii) Main Spindle - This part of the lathe machine is used to hold cylindrical work piece within it. It is a hollow shaft on which the chuck is mounted.

(iii) Feed Selector - It is used to select the direction of the feed i.e. whether we want to move the tool from left to right or right to left. Feed selector is present on the headstock.

2. Tailstock - It is present at the right-hand side of the lathe. It is used to provide supports to the work piece. It supports the work piece from one end i.e. right end.
3. Bed - It is the main part of the lathe. All the parts of the lathe are bolted on the bed. It comprises of headstock, tailstock, carriage guideways and other parts. It is made of cast iron. Guideways are present on the bed. As its name indicates it is used to guide the tailstock and carriage. The tailstock and carriage slide over the guideways. It is an inverted part.
4. Carriage - The carriage is present in between the headstock and tailstock. It carries apron, saddle, compound rest, cross slide and tool post.
    i. Tool Post: It is used to hold the tool. It has T-slot for holding the tool. The tool post is bolted on the carriage.
    ii. Compound Rest: It is used to set the tool at a desired angle for taper turning and other operations.
    iii. Cross Slide: The cross slide is used to move the tool perpendicular to the axis of the lathe.
    iv. Saddle: The top portion of the carriage is called the saddle. Cross slide is mounted on the saddle.
    v. Apron: The front portion of the carriage is called apron. It contains all the moving and control mechanism of the carriage.
5. Lead Screw - The lead screw is used to move the carriage automatically during threading.
6. Feed Rod - It is used to move the carriage from left to right and vice versa.
7. Chip Pan - Chip pan is used to collect the chips that are produced during the lathe operation. It is present at the bottom of the lathe.
8. Hand Wheel - It is the wheel that is operated by hand to move the cross slide, carriage, tailstock and other parts that have hand wheel.

Milling Machines

There are mostly two types of milling machine used in mechanical industries. The first one is horizontal milling machine and the other one is vertical milling machine. The basic parts of these machines are described as follows.

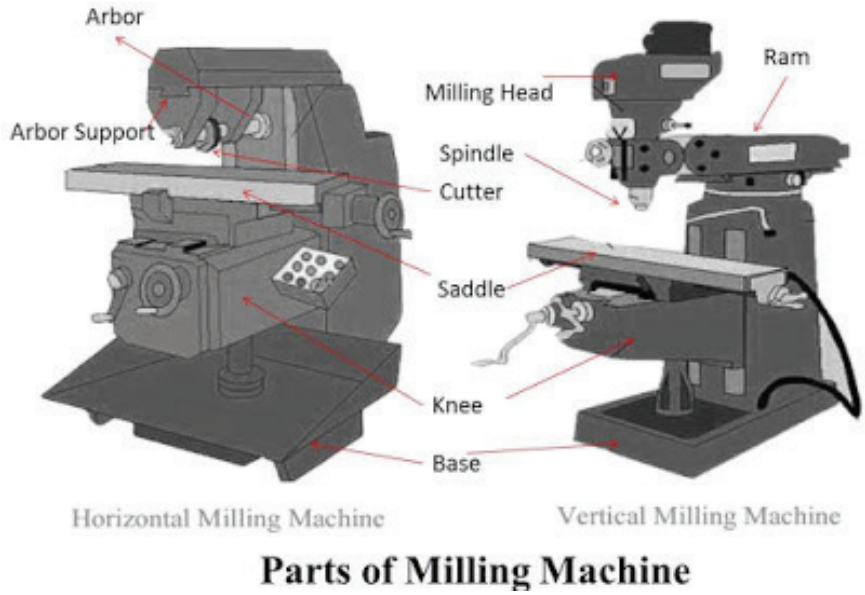

Figure 4.2c Parts of Milling machine
Source: https://themechanicalengineering.com/milling-machine/

Base: It is the foundation part of a milling machine. All other parts are jointed on it. It carries the entire load so it should have high compressive strength so it is made with cast iron. It also works as a reservoir of cutting fluid.

Column: it is another foundation part of milling machine. It is mounted vertically on the base. It supports the knee, table etc. Works as housing for all the other driving members. It is a hollow member which contains driving gears and sometimes motor for spindle and the table.

Knee: is the first moving part of the milling machine. It is mounted on the column and moves along the slide ways situated over the column. It is made by cast iron and moves vertically on sideways. It moves up and down on sideways which changes the distance between tool and work piece It is driven mechanically or hydraulically.

Saddle: It is placed between the table and the knee and works as the intermediate part between them. It can moves transversally to the column face. It slides over the guide ways provided situated on the knee which is perpendicular to the column face. The main function of it is to provide motion in horizontal direction to work piece. It is also made by cast iron.

Table: is situated over the knee. It is the part of machine which holds the work piece while machining. It is made of cast iron and has T slot cut over it. The work piece clamp over it by using clamping bolts. The one end of clamping bolt is fixed into this slot and the other is fixed to the work piece which holds the work piece. It can provide three degree of freedom to work piece. It provides vertical motion by moving the knee up and down. It provides horizontal motion by the feed screw. It provides horizontal (transverse) motion by moving the saddle.

Overhanging arm: It is situated over the column on the horizontal milling machine. It is overhang over the column surface and other end supports the arbor. It is made of cast iron.

Spindle: This is the main part of the machine which holds a tool at the right place in the vertical milling machine and hold arbor in the horizontal milling machine. It is a moving part which is in rotary motion. It is motor driven and drives the tool. It has a slot on the front end of it. The cutting tool is fixed in that slot.

Arbor: It is a mechanical part on which is used as the extension part of the spindle in horizontal milling machine. It is fitted on the spindle whenever required. It holds the tool and moves it in the correct direction.

Arbor Supports: These are used to support the arbor at right place. One end of this support is jointed at the overhanging arm and another is jointed with arbor.

Milling head: It is the upper section of vertical milling machine. It consists of spindle, driving motor and other controlling mechanism.

Ram: Ram works as overhanging arm in vertical milling machine. One end of the arm is attached to the column and other end to the milling head.

Elements of metals and material properties in machining

Types of Metals to Choose for Machining

Categories for types of metals

1. Ferrous Metals are those containing Iron; such as Steel and its many alloys, or Cast Iron. If strength is the most important characteristic wanted, Ferrous Metal is the appropriate.
2. Aluminum is the most commonly used non-Ferrous Metal. It has great strength to weight ratio as well as some resistance to corrosion. Plus, it's relatively easy to work with.
3. Choose brass or copper alloys for their decorative properties, electrical/heat conductivity, excellent corrosion resistance, or because they're easy to work with.
4. Hi-Temp Nickel Alloys - These alloys are the only ones available for the demanding conditions found in the hot sections of turbine engines used for aerospace and marine applications.
5. Titanium
6. Other Non-Ferrous Metals

I. Cast Iron – Ductile

Most of the production of ductile cast iron is aimed at the production of cast iron pipe, used for water and sewer lines. Ductile iron is one of the types of metals specifically useful in many automotive components, where strength must surpass that of aluminum but steel is not necessarily required. Other major industrial applications include off-highway diesel trucks, Class 8 trucks, agricultural tractors, and oil well pumps. In wind power industry nodular cast iron is used for hubs and structural parts like machine frames. Nodular cast iron is suitable for large and complex shapes and high (fatigue) loads.

Various kinds of tooling are often made of ductile cast iron as are machine tool frames. The material has excellent vibration dampening, and is therefore preferred to steel for machine tools.

Pros:
Machines easily and does not require coolant as the graphite is a natural lubricant. Much stronger than grey cast iron. Tensile strength of gray cast iron is 20,000 – 60,000 psi while ductile starts at 60,000 psi and goes to 120,000 psi. Excellent wear resistance due to the graphite. Dissipates heat well.

Cons:
Makes a mess, due to the graphite.

II. Cast Iron – Gray

Most common type of cast iron. In gray cast iron, the graphite is in the shape of flakes rather than in nodules as in grey iron. This encourages cracking, as the flakes are stress risers. As a result, gray cast iron is probably not one of the types of metals to use when wear and durability are important.

Pros:
Machines easily and does not require coolant as the graphite is a natural lubricant. Relatively low cost. Good galling and wear resistance. Often has silicon, which gives good corrosion resistance.

Cons:
Makes a mess, due to the graphite. Impact and shock resistance is almost non-existent.
Cannot be worked (forged, extruded, rolled, etc.) because of tendency to crack.

III. Stainless Steel – 300 Series

Stainless steels are one of the types of metals that resist corrosion and high temperatures, which is the primary reason they're used. The 300-series stainless steels are called *austenitic*. They're non-magnetic, extremely tough, and ductile.
Common applications include cookware, cutlery, medical instruments and devices, major appliances, industrial and chemical equipment.

Pros:
Resists corrosion and high temperatures. Finishes attractively so may not need paint or other surface coatings. Exceptional elongation allows deep drawing to make items such as kitchen sinks.

Cons:
Susceptible to galling: avoid applications where two similar metals rub against each other such as threads. Use dissimilar metals, such as 300 x Stainless and Bronze to minimise galling and susceptible to work hardening. Take care when machining never to dwell the cutter and to take deep enough cuts to get below the work hardening. In fact, 300 series cannot be hardened by heat treating.

IV. Stainless Steel – 400 Series

Swiss Army Knives are commonly made of Martensitic (400 series) stainless steel. The 400 series stainless steels do not resist corrosion as well as the 300 series, but some (Martensitic) can be hardened by heat. The Ferritin members of the 400 series cannot be hardened by heat treatment. The 400 series are also magnetic, unlike the 300 series. 440 is one of the hardest grades of stainless steel.

Common Uses: Automotive Exhaust (409 & 439), Cutlery (420 & 440), Decorative (430, e.g. auto trim).

Pros:

Higher strength and wear resistance than 300 series stainless steels. Often costs less than 300-series stainless.

Cons:

Not as resistant to corrosion as 300 series.

V. Stainless Steel – PH Series

The "PH" stands for "Precipitation Hardening", which is a heat treating process used to increase the strength of malleable materials. PH Stainless Steels can be Martensitic and semi-Austenitic. Uses of PH Stainless Steel: Aerospace, Chemical, Food Processing, Retaining Rings, Springs, Aircraft Bulkheads, Flat Springs.

Pros:

High strength and hardness. These are some of the highest strength stainless steels.
Can be heat treated from annealed condition at relatively low temperatures.
Corrosion resistance is nearly as good as 304 stainless at moderate temperatures.

Cons:

Expensive

VI. Steel – Low Carbon (1020)

Mild or Low Carbon Steel has 0.05 to 0.30% carbon.
Most grades are available as Cold Formed or Hot Rolled. 1018 is more common than 1020, but both have good machinability. Mild Steels are very common types of metals with broad uses.

Used For: Parts that may be case hardened, but whose core strength is not critical. Given the low cost, high volume parts such as screw machine parts are common. Examples include shafts, lightly stressed gears, hard wearing surfaces, pins, and chains.

Pros:

Often chosen for its good machinability and weld ability, Cheap

Cons:

Low hardenability although case hardening through carburization is possible.

VI. Steel – Low Carbon Alloy (8620)

Low alloy steels have elements other than Carbon (they may have small amounts of carbon too) added to improve mechanical properties and resist corrosion. These types of metals are used for: Arbors, Bearings, Bushings, Cam Shafts, Differential Pinions, Guide Pins, King Pins, Pistons Pins, Gears, Splined Shafts, Ratchets, Sleeves and any application that needs a steel that can be readily machined and carburized to controlled case depths.

Pros:

Often chosen for its good machinability and weld ability
Alloy means better mechanical properties and higher resistance to corrosion.

Cons:

Low hardenability although case hardening through carburization is possible.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of lathe and milling machines The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Lathe Machines

Teaching Strategies

Key: What are the functions of lathe machines?

Introduce the students to the lathe machine. Guide the students with charts and texts on parts and uses of the lathe machine. Use guideline points and questions to the part, their uses the machines function.

Show them an actual machine if available. Demonstrate to them on how to use if machine is available.

Observe and describe the parts, uses and functions of the lathe machine.

Learning Strategies

Activity 1 Brainstorm on parts and uses of the machine and observe their functions and how the machine operates.
Activity 2 Research the uses of the different parts and the functions of the machine.
Activity 3 Present the allocated parts and its functions to the rest of the class individually.

Resources
Chart on the lathe machine and or text on lathe machine.

Lesson 2: Milling Machines

Teaching Strategies
Key: What are the functions of milling machines?
Introduce the students to the lathe machine. Guide the students with charts and texts on parts and uses of the milling machine. Use guideline points and questions to the part, their uses the machines function.
Show them actual machine if available. Demonstrate to them on how to use if machine is available.
Observe and describe the parts, uses and functions of the milling machine.

Learning Strategies
Activity 1 Brainstorm on parts and uses of the machine. Observe their functions and how the machine operates.
Activity 2 Research the uses of the different parts and the functions of the machine.
Activity 3 Present the allocated parts and its functions to the rest of the class individually.

Resources
Chart on the lathe machine and or text on milling machine.

Lesson 3: Elements of Metals and Material Properties in Machining

Teaching Strategies
Key: Describe material properties and elements of metals for machining.
Show or guide them to identifying the different material properties and elements of metals for machining.
Provide guideline questions and points to guide the students into identifying them.

Learning Strategies
Activity 1 Students brainstorm material properties and elements of metals for machining.
Activity 2 Students do individual research
Activity 3 Present their research individually

Resources
Text on material properties and elements of metals for machining

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STEAM Activity Students work in groups to create an activity incorporating concepts of machining.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to explain functions and components of lathe and milling machines and describe material

properties and elements of metals in lathe machining. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Explain functions and parts of lathe and milling machines
2. Describe material properties and elements of metals for machining.

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Name the parts of lathe and milling machines	Name all the parts of the lathe or milling machine with correct spelling	Naming more than half of the parts of machines	Name half the parts of the machine	Naming less than half the parts of the machine.
2. Explain functions of lathe and milling machines	In fluent English with correct terminologies describe the functions of both machine	In plain English describe the functions of both machines	Shallow description of both machines	Description of only one machine
3. Describe material properties and elements of metals for machining.	Can describe all material properties and elements of metals for machining.	Can describe more than half the material properties and elements of metals for machining.	Can describe half the material properties and elements of metals for machining.	Can describe less than half the material properties and elements of metals for machining.

UNIT 4 Welding Technology

Content Standard 3.4. Investigate and analyse safety procedures, print reading, measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing principles and apply fundamentals of fabrication codes, inspections, testing principles and apply fundamentals of fabrication.

Benchmark 11.3.4.3. Create and interpret engineering drawings and blueprints with the applications of geometry and trigonometry related to machining.

Topic 3: Engineering drawing

Learning Objectives

By the end of this topic, the students will be able to;

1. Create engineering drawings and blue prints with the application of geometry and trigonometry.

Essential Questions:

1. What is engineering drawing?
2. What are blueprints?
3. How do we create blueprints and engineering drawings?
4. How is an engineering blueprint interpreted?

Essential Knowledge, Skills, Values and Attitudes:

Knowledge: Engineering drawing, blueprints

Skills: Create, Interpret

Values: Appreciate and value

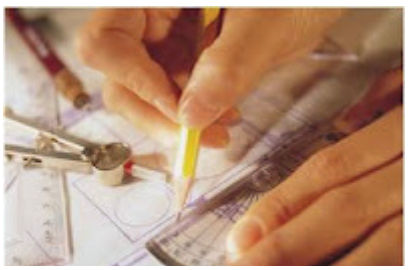
Attitudes: intuitive, open-minded, critical and responsible in learning and producing engineering drawings creatively.

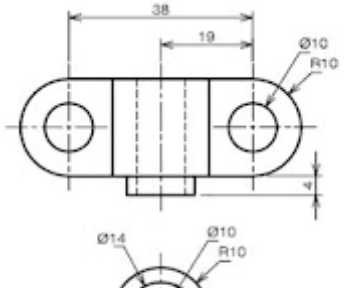
Content Background

Engineering Drawing

Creating a drawing

Drawing instruments are used to draw straight lines, circles, and curves accurately concisely



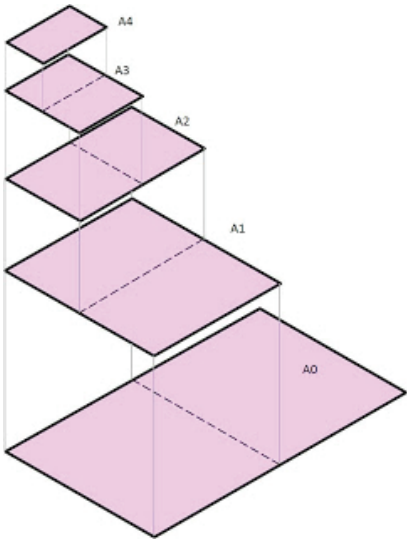


The drawing tools are like drawing board, mini drafter, instrument box containing compass, divider etc. Set squares, protractor, French curves, drawing sheet, pencils, erasers and others.

DRAWING STANDARDS

Drawing standards are set of rules that govern how the technical drawings are represented these are used so that everyone can commonly understand the meaning of drawn picture.
https://1.bp.blogspt.com/

Drawing sheet
We have many types and sizes of drawing sheets. A4, A3, A2, A1,A0 etc.



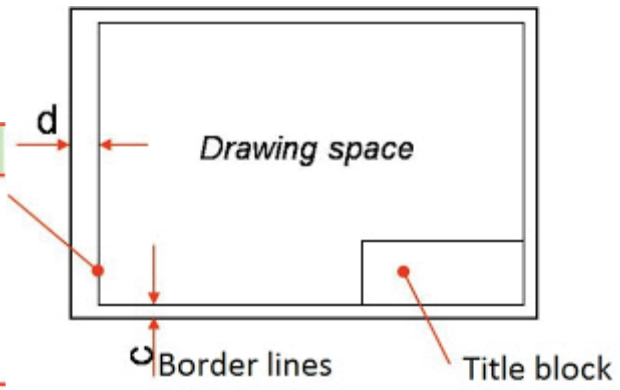
Standard sheet size
(**JIS**)

A4	210 x 297
A3	297 x 420
A2	420 x 594
A1	594 x 841
A0	841 x 1189

Figure 4.3a Drawing sheets
Source: https://1.bp.blogspt.com/

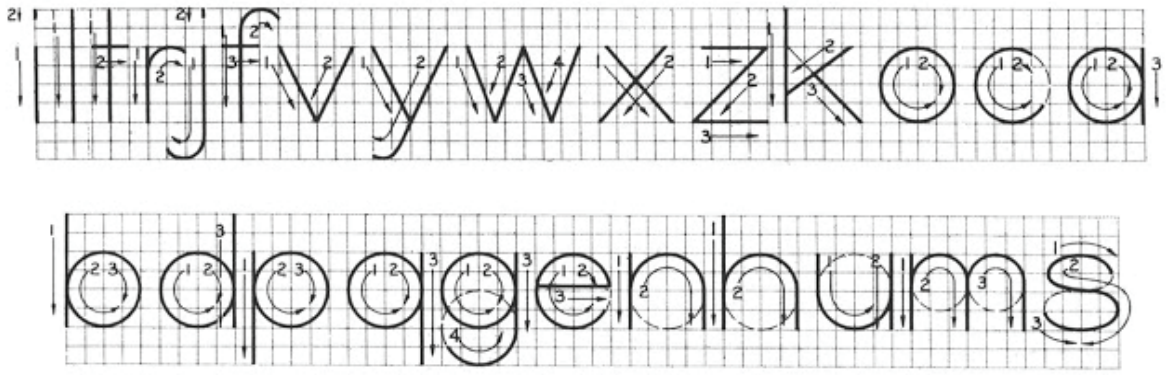
While in the drawing sheet, first we have to draw border lines and title box and then we have to start drawing

Sheet size	c (min)	d (min)
A4	10	25
A3	10	25
A2	10	25
A1	20	25
A0	20	25



Lettering

Lettering and numbering should be in a perfect manner. For example in this figure, the upper and lower case letters are neatly drawn.



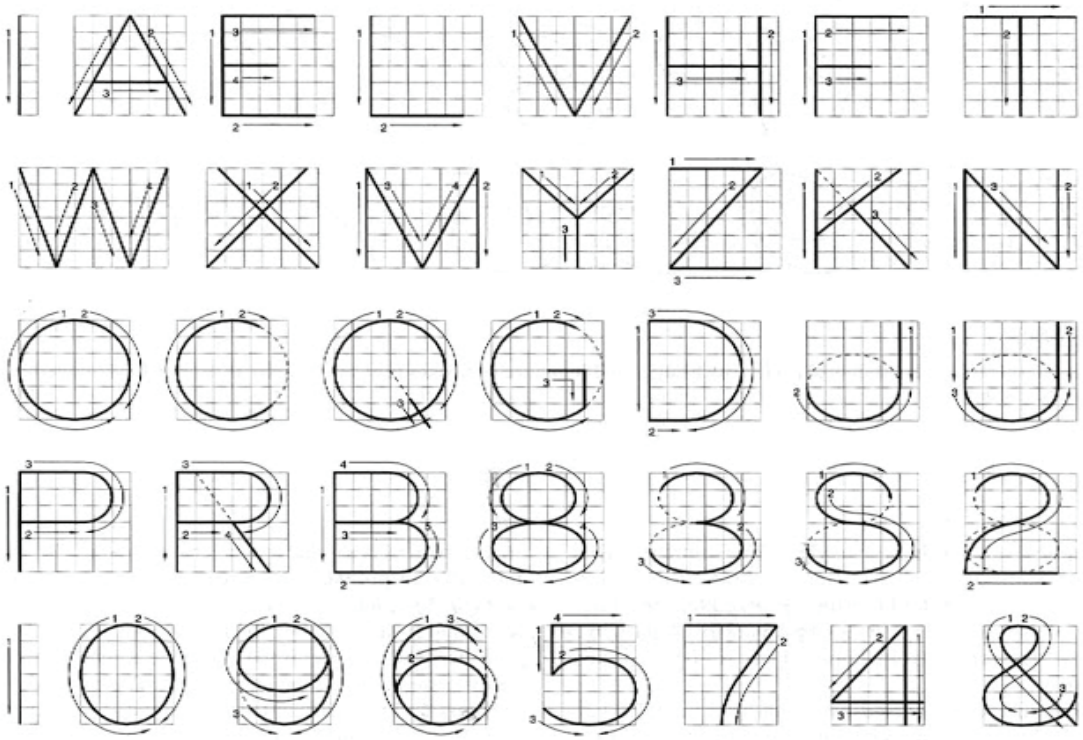


Figure 4.3d Lettering
Source: http://edpstuff.blogspot.com/2010/07/basics-of-engineering-drawing.html

Basically lines which are used in the representation of the diagrams are of mainly four types they are;

- Visible line : represent features that can be seen in the current view.
- Dimension line ;Extension line; Leader line: indicate the sizes and location of features.
- Hidden line : represent features that cannot be seen in the current view.
- Centre line: represents symmetry, path of motion, centres of circles, axis of axisymmetric parts.

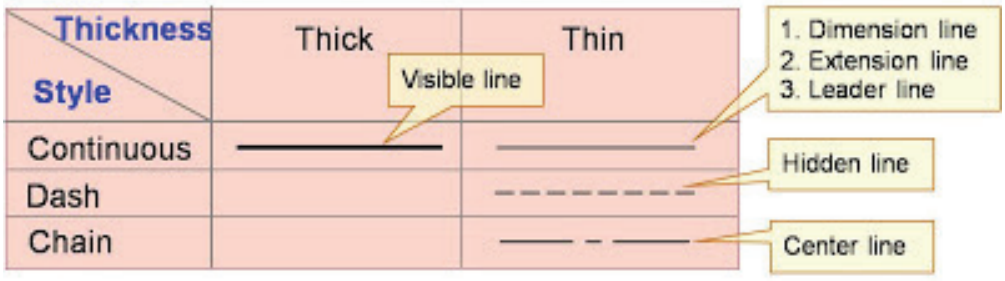


Figure 4.3e Lines and its types
Source: http://edpstuff.blogspot.com/2010/07/basics-of-engineering-drawing.html

Creating engineering drawings is a whole subject area of its own. It is also a time-honoured art form. Drawings are used in all fields of Engineering (Mechanical, Civil, Architectural, Electrical, Aerospace, etc.)

The type of drawings and concepts learnt in this topic are all transferable to the other Engineering fields.

The main purpose of engineering drawings is to **communicate** to other engineers, machinists, etc. Drawings do the communication best merely because *a picture is worth a thousand words*. Giving all of the information needed to make the product and being *accurate* in that information is the main goal. Engineers are very picky about their drawings and must pay attention to detail.

The basics concepts of Engineering Drawings. The attempt here is to take volumes of drafting text material and boil it down to just what is needed. They include:

- Orthographic Views
    - Half Views and Partial Views
    - Line types
    - Dimensions and Notes
    - Half Views and Partial Views
    - Auxiliary Views
- Section Views
    - Full Section
    - Half Section
    - Offset (Sketched) Section
    - Revolved Section
    - Broken Out (Local) Section
- Detailed Views
- Conventional Breaks
- Scaling

Engineering blueprints

Engineering drawings (also sometimes known as blueprints, manufacturing blueprints, prints, manufacturing prints, dimensional prints, drawings, mechanical drawings, and more) are a rich and specific outline that shows all the information and requirements needed to manufacture an item or product. It is more than simply a drawing, it is a graphical language that communicates ideas and information.

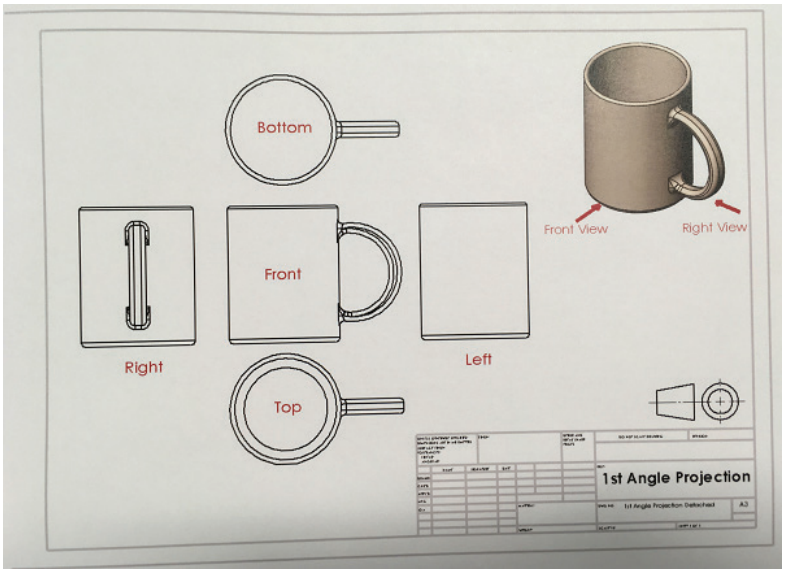


Figure 4.3f Engineering blueprints
Source: https://www.makeuk.org/insights/blogs/how-to-read-engineering-drawings-a-simple-guide

Why not just use a 3D model?

Unlike a 3D model, an engineering drawing offers a lot more specific information and requirements, including:

- Dimensions
- Geometry
- Tolerances
- Material type
- Finish
- Hardware

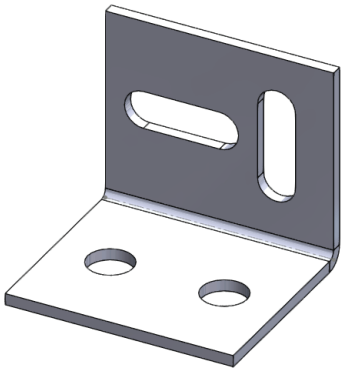


Figure 4.3g 3D Model
Source: https://www.makeuk.org/insights/blogs/how-to-read-engineering-drawings-a-simple-guide

3D models are good to have and are usually (especially nowadays) used in conjunction with drawings. They are a good visual representation of the desired item, but do not contain all the information that drawings do.

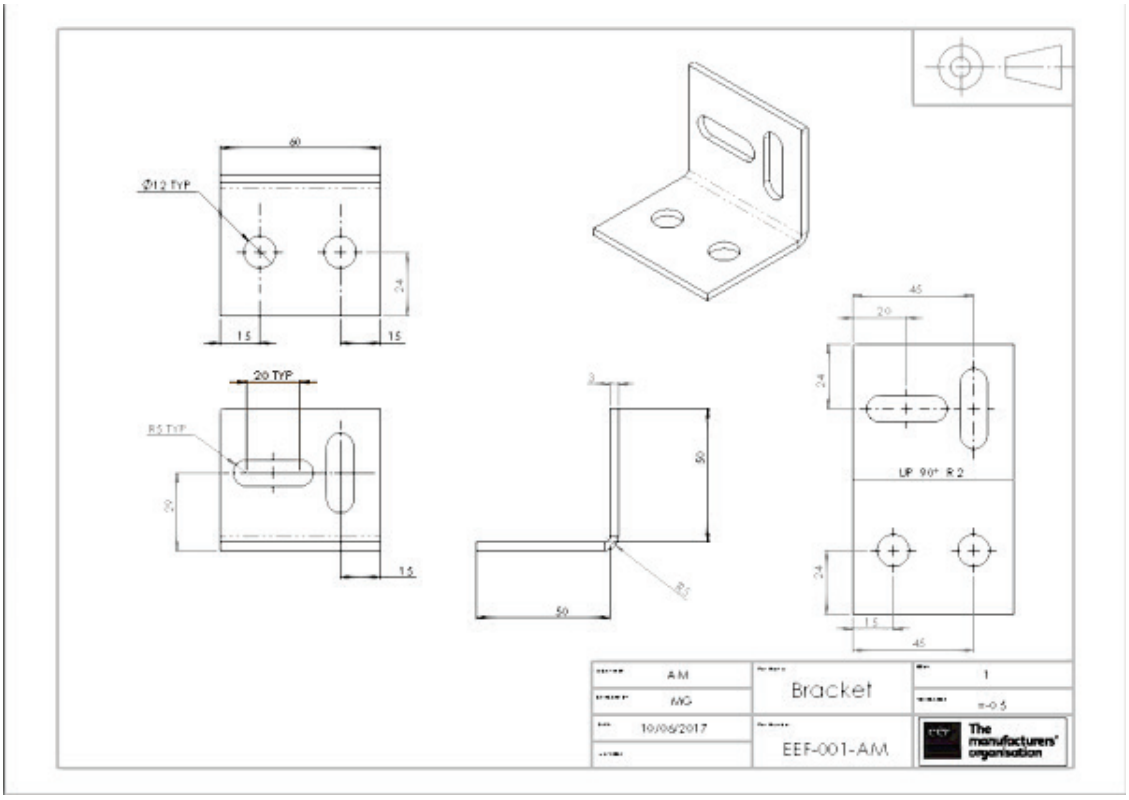


Figure 4.3g Information blocks
Source: https://www.makeuk.org/insights/blogs/how-to-read-engineering-drawings-a-simple-guide

Information blocks

These blocks contain essential information about the assembly. They are usually located in the bottom right-hand corner of the drawing. These blocks provide details about what the drawing is for, for whom, part number and description, as well as information about the material and finish.

These are the main information blocks:

Title block - Start off by reading the title block found at the bottom right-hand corner of the drawing. There are other information blocks like it, but the title block serves as the context in which the drawing should be perceived.

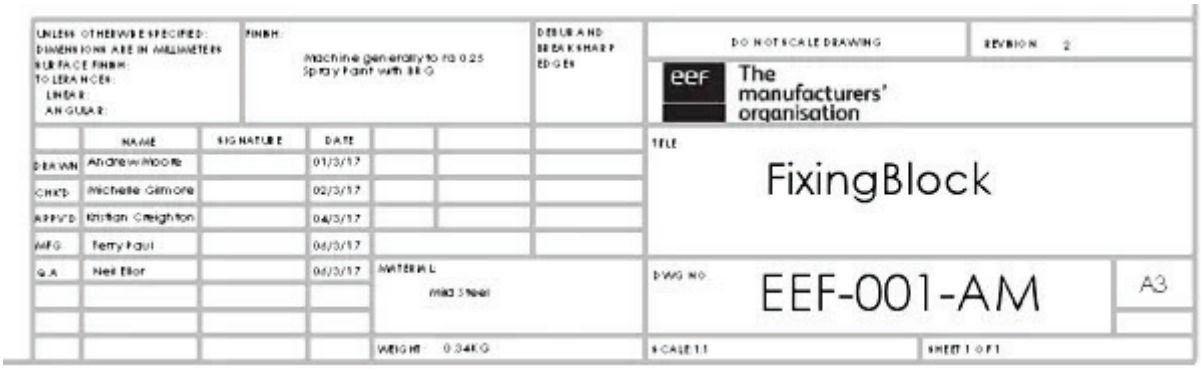


Figure 4.3h Title blocks
Source: https://www.makeuk.org/insights/blogs/how-to-read-engineering-drawings-a-simple-guide

The title block contains information such as:

- Name and address of the company or agency who prepared or owns the drawing
- Part number and description
- Material
- Mass
- Finish
- General tolerances
- Projection details
- Scale used in the drawing
- Revision numbers
- Status of the drawing (Preliminary, Approved, etc.)
- Units used in the drawing

Note that any information in the notes outside the title block that conflicts with the information in the title block should be considered as the right information and supersede the title block information.

Revision block - The revision block, located in the upper right hand corner, shows details about the changes that were made to roll the revision. The Revision Block includes the revision, the description of what changes were made, the date of the revision, and approval of the revision.

Bill of Materials (BOM) Block - Located usually either just above the title block or in the upper left-hand corner, the Bill of Materials block (also known as a BOM, Schedule or Parts List) contains a list of all the items and quantities that are required for the project or assembly. This is used for parts that either require assembly or when hardware should be added to the part.

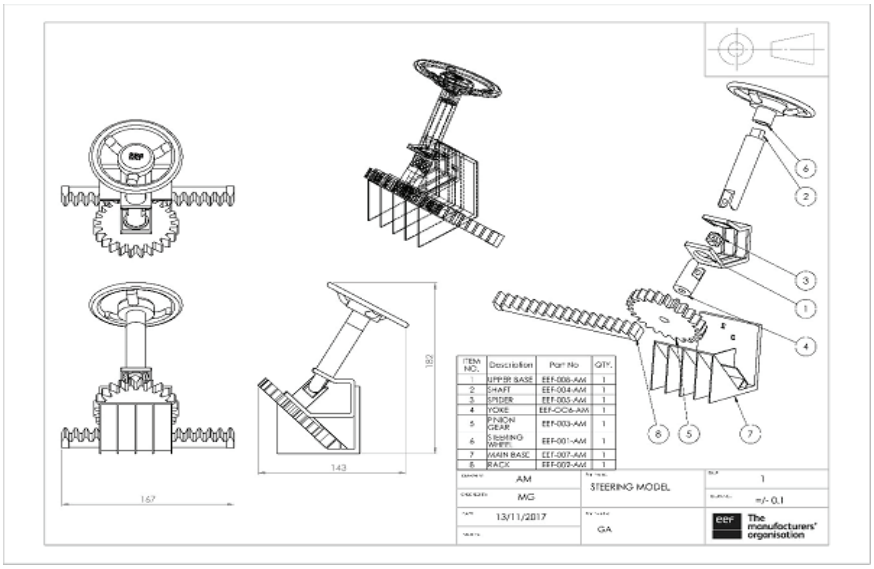


Figure 4.3i Bill of Materials block
Source: https://www.makeuk.org/insights/blogs/how-to-read-engineering-drawings-a-simple-guide

Lines

It is important to understand what each line type is and what they mean. There are three types of lines:

- Visible line: Indicates an edge is visible in relevant view
- Hidden line: Indicates the edge is behind a face
- Phantom line: Mostly used to indicate an alternate position of a moving part. Also used to indicate a break when the nature of the object makes the use of the conventional type of break unfeasible.
- Centre lines: drawn to indicate the exact geometric centre of the assembly. They are made from a series of lighter long and short dashes.

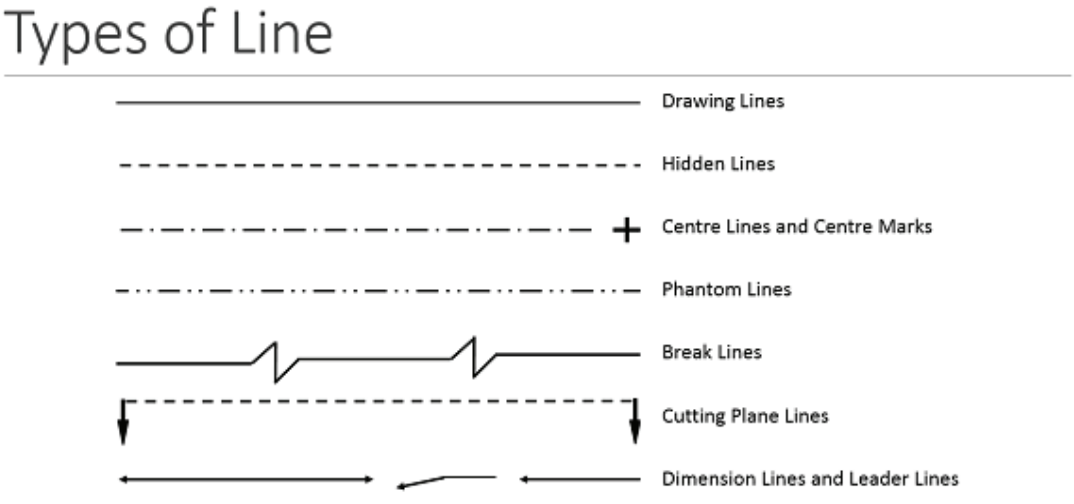


Figure 4.3i Types of lines
Source: https://www.makeuk.org/insights/blogs/how-to-read-engineering-drawings-a-simple-guide

Reading engineering drawings

Now it's time to try to visualise how the assembly is supposed to look like in 3D (for this you can ignore the exact dimensions). Most new drawings will have an isometric view to guide you. You can use the Bill of Materials to find the components in the drawing in order to understand the role they play in the assembly.

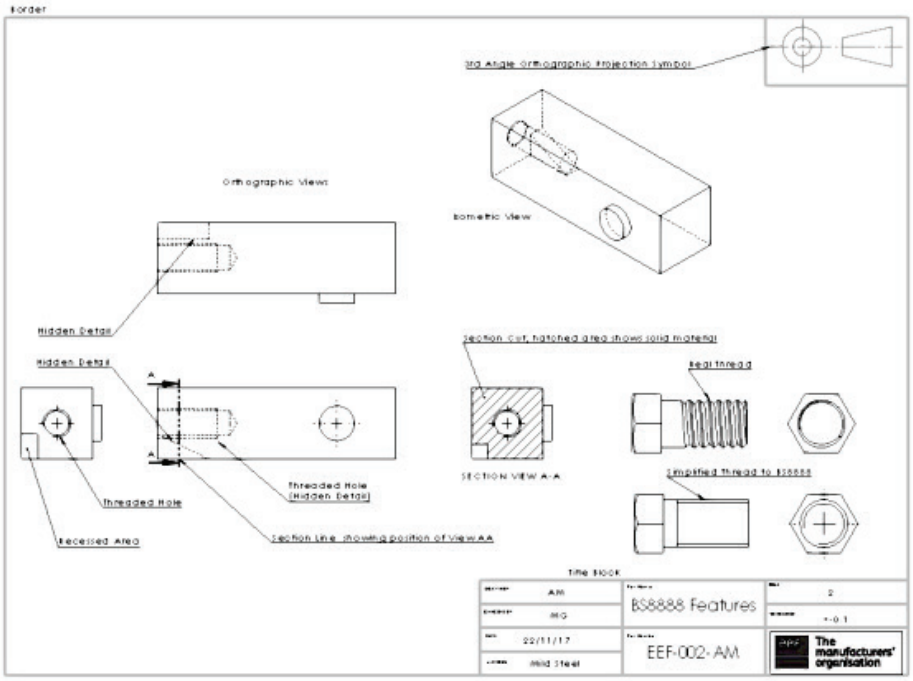


Figure 4.3j Reading engineering drawings
Source: https://www.makeuk.org/insights/blogs/how-to-read-engineering-drawings-a-simple-guide

Remember that reading an engineering drawing can take a long time, depending on the complexity of the assembly and the experience of the reader.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of engineering drawings. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Engineering Drawing

Teaching Strategies

Key: What is engineering drawing?

Provide students with necessary reading information and charts and materials for practice.
Guide and involve students in identifying what an engineering drawing is.
Allow students to practice the basics techniques used in engineering drawing.

Learning Strategies
Activity 1 Brainstorm and research on what an engineering drawing is and the basic techniques involved in creating an engineering drawing.
Activity 2 Present what an engineering drawing is and its techniques and components.
Activity 3 Practice the basics.

Resources
Texts on engineering drawing, paper, mathematical drawing set, pencil

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Lesson 2: Engineering Blueprints

Teaching Strategies
Key: 1.What are blueprints?
2. How do we create blueprints and engineering drawings?

Provide students with necessary reading information and charts.
Guide and involve students in identifying what an engineering blue print is.

Learning Strategies
Activity 1 Read and brainstorm what an engineering blueprint is.
Activity 2 Research in group the engineering blue print and its components.
Activity 3 Present in groups samples of engineering drawing and its components.

Resources
Reading texts on engineering drawing and charts on different types if available.

STEAM Activity Students work in groups to create drawing on concepts to build a bridge beginning with engineering drawing.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to create and interpret engineering drawings and blueprints with the applications of geometry and trigonometry related to machining. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Create engineering drawings and blue prints.

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Create an engineering drawing	Neat and advanced drawing with techniques used to standard	Neat drawing with techniques used to standards	Drawing with techniques used to standards	Drawing with technique used.
2. Identify the different components of the engineering blue print	Can clearly identify the components and interpret the product of the blue print	Can identify most components and the product the blue print is intended for.	Can identify some components and the product	Can identify few components but not the product.

UNIT 4 Welding Technology

Content Standard 3.4. Investigate and analyse safety procedures, print reading, measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing principles and apply fundamentals of fabrication codes, inspections, testing principles and apply fundamentals of fabrication.

Benchmark 11.3.4.4. Analyse the properties of metals and the welding techniques and cutting processes according to safety regulations and standards.

Topic 4: Welding Techniques in Accordance to Safety Standards.

Learning Objectives

By the end of this topic, the students will be able to;

1. Analyse metal properties of metals in accordance with standard metal properties.
2. Analyse welding and cutting processes according to safety standards.

Essential Questions:

1. What is the meaning of standard metal properties?
2. How are metals analysed according to the standard metal properties?
3. What types of welding techniques and cutting processes will meet safety standards?

Essential Knowledge, Skills, Values and Attitudes:
Knowledge: Standard welding techniques and processes
Skills: Analyse
Values: Awareness, appreciation
Attitudes: Creative and responsible in analysing metal properties and what type of welding will be used.

Content Background

Welding techniques
Welding involves a wide range of tasks and hence a wide range of health and safety hazards, which include the following:

- chemical dusts, fumes, vapours and gases
- poor ergonomic working conditions
- electrical hazards
- falls, trips, falling objects
- moving vehicles and cranes
- operating machinery
- arc light radiation, which can expose welders to intense ultraviolet, visible and infrared light
- oxygen displacement, oxygen enrichment or flammable gas mixtures from leaking compressed gas lines and cylinders
- heat, sparks, spatter, open flames and hot surfaces

- noise from metal-on-metal impacts, materials handling, metal working and some welding processes
- confined spaces

MMA (manual metal arc welding) is the most common and diffused way of welding. It functions by using an additional material that fills the gap existing between the 2 parts to be welded. This filling metal is commercialised in the form of electrodes.

Electros have a core of metal, and an external coating, which is the insulating material. When welding with electrodes, the arc generated from the current smelts the internal metal (creating the welding bath), but also the insulating material round on it, letting In this way the procedure be safe from external agents presents in the air, that could damage the welding

TIG (Tungsten inert gas welding) allows the joining of two metal parts, without using any additional material. It functions by heating the parts to be welded with a torch, which is equipped with a special permanent electrode in Tungsten.

The arc generated by this torch allows the two parts be smelted and joined, obtaining a very clean result. For this reason, TIG is used especially when there is the intention to reduce to the minimum the permanent sign left from the welding procedure.

In order to insulate the welding bath is used the gas (normally argon), that comes out from the torch during the welding, round on the tungsten core. TIG welding involves 3 main different modes: HF, LA, Scratch and two different machines: DC and AC/DC

TIG HF is the best way of welding in TIG. You have on the devices all the parameter controls for current and gas, the High Frequency allows starting welding in the exact point wished, without touching the metal. The torch has a special connection to the machine. Once you have settled the machine,
you position the torch near the start point, you push a switch on the torch and the welding starts.

TIG LA. The torch is different from the HF Torch, is very simple, and must be connected to the minus dinse of the machine. There is a tap on the torch to open the gas. The lift-arc-function allows to touch the exact point on which is wished to weld, but without starting immediately the welding. In this way is possible to be more precise. Once you have found the exact point to start, you remove the torch of some millimeters, and the machine starts welding. In this way is also reduced the risk of contamination.

TIG Scratch. The torch is exactly the same as the one seen before, with the gas tap, and must be connected to the minus dinse. The welding starts by touching the metal part. The quality is good, but can't be compared with the HF, because by touching the metal in order to start, is not easy to start exactly in the wished point. But is also to remark that with this kind of welding, some Tungsten rests could remain in the welding.

MIG (Metal Inert gas welding) is the preferred way of welding from people that needs to weld for long time. In fact, the additional material is not in the form of electrodes, but in the form of a wire, that through an electric motor is pulled in a continuous way into the torch, from which it comes out together with the protecting gas round on it (in order to avoid contamination). The wires are available in different metal leagues in order to match the right welding combination, and are stored on rolls. The rolls can be of 5 or 15 Kg.

Welding Machines

The welding machine is in practice a sophisticated generator of current, that functions by transforming the main supply into an arc of current suitable for the welding activity. The tradition and story of welding is represented by the “transformer devices”, now considered primitive machines because of their weight and of the reduced possibility of changing the functioning parameters, also dissipating and wasting a lot of energy into heat.
The new technology, a real revolution in the welding field, is known with the name “inverter technology”. It uses hi-tech very sophisticated electronic elements in order to increase the frequency until very high values, permitting to reduce in an extreme way the weight and dimensions of the machines.

When speaking about inverter technology, the first aspect mentioned is normally the drastic reduction in energy consumption. It is in fact certified that the usage of this technology allows to reduce until 40%, sometimes 50% the consumption. This is but not only an economical aspect. Using less energy means also the possibility to connect equipment with professional features to the normal 220 VAC network, as well as the possibility of using more equipment together in the same working place.

This advantage is reached with a consistent reduction in weight and dimensions that implicated a revolution in the usage and transport of welding equipment in the last years. These aspects are surely interesting in a comparison, especially when speaking without being too professional welders, but represents not yet the biggest advantage of the inverter technology, which is the possibility of setting the welding current as wished, without any predefined step, with an extreme fine range. With inverters, the welder can always find the wished working current, not an ampere less or an ampere more. This is the most interesting aspect, especially for those who makes of welding their main activity.

Duty Cycle

Near the maximum Ampere indicated in the data sheet, there is normally the “%” of the device, called duty cycle, which is an international numerical value indicating the percentage of service from the generator. In a few words, it says how long the machine stays on, without the intervention of the thermostatic protection, which cuts off for some minutes the device.
When for example two devices are giving both 130 A, but one at 20%, the other at 40%, it means that the second will work at 130 A for the double of the time than the first. It represent a big difference, practically the distinction between a low cost machine, and a professional machine.

This parameter, usually indicated as IP, indicates how protected is the device from external agents. In our field the maximum IP to be found in the market is IP23. We reach on almost all models the IP23. This parameter is indicated with IC, determines the level of insulation of the machine. The absolute maximum level in the market is H, all our models have IC H.

Inverter technology is expensive, and difficult to be used. Sometimes, producers not able to use correctly the inverter technology, try to hide in their machines hybrids cocktails, which can be immediately recognised by their weight: a light machine, giving 100 A, can weight maximum 4-5Kg, all the middle class between 130 A and 180 A can weight about 5-6 Kg, if you see similar products weighting 10 Kg, be careful, it means it is a product with a big transformer inside.

The big transformers means that the producer was not able to use correctly the inverter technology, the machine will dissipate a lot of energy in heat. When speaking of Tig machines, they can weight about 10-12 Kg if simple inverter, 30-40Kg when ACDC inverters Arc Force Gives a power source variable additional amperage during low voltage (short arc length) conditions while welding. Helps avoid "sticking" electrodes.

Hot Start Used on some Stick (SMAW) machines to make it easier to start electrodes. Used for arc starting only.

This feature allows TIG arc starting without high frequency. Starts the arc at any amperage without contaminating the weld with tungsten.

The lines cycle, special exclusive and big have a special function called standby: when on but not welding the devices turns automatically after 30 sec. , from an absorbed power of about 350 W with output 70 V to an absorbed power of 60 W with output 7 V.
By touching the piece with the electrode, the machines starts again working as before. Nothing to touch or set from the user, which can spare in this way about 1 Kw every 3 hours!

Rare metallic element with extremely high melting point (3410o Celsius) is used in manufacturing TIG electrodes.

More on welding techniques & types

Welders use many types of welding equipment set up in a variety of positions, such as flat, vertical, horizontal, and overhead. They may perform manual welding, in which the work is entirely controlled by the welder, or semiautomatic welding, in which the welder uses machinery, such as a wire feeder, to perform welding tasks.

There are about 100 different types of welding.
Arc welding is the most common type. Standard arc welding involves two large metal alligator clips that carry a strong electrical current. One clip is attached to any part of the work piece being welded. The second clip is connected to a thin welding rod. When the rod touches the work piece, a powerful electrical circuit is created. The massive heat created by the electrical current causes both the work piece and the steel core of the rod to melt together, cooling quickly to form a solid bond. During welding, the flux that surrounds the rod's core vaporizes, forming an inert gas that serves to protect the weld from atmospheric elements that might weaken it.

Welding speed is important. Variations in speed can change the amount of flux applied, weakening the weld, or weakening the surrounding metal by increasing heat exposure.

Two common but advanced types of arc welding are Tungsten Inert Gas (TIG) and Metal Inert Gas (MIG) welding. TIG welding often is used with stainless steel or aluminium. While TIG uses welding rods, MIG uses a spool of continuously fed wire, which allows the welder to join longer stretches of metal without stopping to replace the rod. In TIG welding, the welder holds the welding rod in one hand and an electric torch in the other hand. The torch is used to simultaneously melt the rod and the work piece. In MIG welding, the welder holds the wire feeder, which functions like the alligator clip in arc welding. Instead of using gas flux surrounding the rod, TIG and MIG protect the initial weld from the environment by blowing inert gas onto the weld.

Like arc welding, soldering and brazing use molten metal to join two pieces of metal. However, the metal added during the process has a melting point lower than that of the work piece, so only the added metal is melted, not the work piece. Soldering uses metals with a melting point below 800 degrees Fahrenheit; brazing uses metals with a higher melting point. Because soldering and brazing do not melt the work piece, these processes normally do not create the distortions or weaknesses in the work piece that can occur with welding. Soldering commonly is used to join electrical, electronic, and other small metal parts. Brazing produces a stronger joint than does soldering, and often is used to join metals other than steel, such as brass. Brazing can also be used to apply coatings to parts to reduce wear and protect against corrosion.

Skilled welding, soldering, and brazing workers generally plan work from drawings or specifications or use their knowledge of fluxes and base metals to analyse the parts to be joined. These workers then select and set up welding equipment, execute the planned welds, and examine welds to ensure that they meet standards or specifications. They are even examining the weld while they're welding. By observing problems with the weld, they compensate by adjusting the speed, voltage, amperage, or feed of the rod. Highly skilled welders often are trained to work with a wide variety of materials in addition to steel, such as titanium, aluminium, or plastics. Some welders have more limited duties, however. They perform routine jobs that already have been planned and laid out and do not require extensive knowledge of welding techniques.

Automated welding is used in an increasing number of production processes. In these instances, a machine or robot performs the welding tasks while monitored by a welding machine operator. Welding, soldering, and brazing machine setters, operators, and tenders follow specified layouts, work orders, or blueprints. Operators must load parts correctly and constantly monitor the machine to ensure that it produces the desired bond.

The work of arc, plasma, and oxy-gas cutters is closely related to that of welders. However, instead of joining metals, cutters use the heat from an electric arc, a stream of ionized gas (plasma), or burning gases to cut and trim metal objects to specific dimensions. Cutters also dismantle large objects, such as ships, railroad cars, automobiles, buildings, or aircraft. Some operate and monitor cutting machines similar to those used by welding machine operators. Plasma cutting has been increasing in popularity because, unlike other methods, it can cut a wide variety of metals, including stainless steel, aluminium, and titanium. (ISHN,2014)

Cutting processes in Welding

Oxy-fuel cutting is a cost-effective method of plate edge preparation for bevel and groove welding. It can be used to easily cut rusty and scaled plates and only requires moderate skill to produce successful results. The oxy-fuel gas cutting process creates a chemical reaction of oxygen with the base metal at elevated temperatures to sever the metal. The necessary temperature is maintained by a flame from the combustion of a selected fuel gas mixed with pure oxygen.

The process is based on the rapid formation of iron oxide which occurs when a high-pressure pure oxygen stream is introduced into the cutting envelope. The iron is quickly oxidized by the high purity oxygen and heat is liberated by this reaction. The oxygen stream and combusted gas transport the molten oxide away and the metal in its path burns, producing a narrow cut known as a kerf. Continued iron oxide formation requires large volumes of oxygen to be delivered to the

cut zone at a controlled pre-set pressure. The intense heat produced by this reaction sustains the cutting process and the production of the cut.

Common oxy-fuel cutting applications are limited to carbon and low alloy steel. These materials can be cut economically, and the setup is quick and simple. For manual oxy-fuel gas cutting there is no electric power requirement and equipment costs are low. Materials from 1/16in (1.6mm) to 4in (102mm) thick are commonly cut using manual oxy-fuel gas cutting. Materials 12in (0.3m) and greater in thickness are successfully severed using machine cutting.

Plasma Arc Cutting (PAC) severs metal by melting a localized area of the material with a constricted electric arc that removes the molten material with a high velocity jet of hot ionized gas.

The PAC process can be used to cut any electrically conductive metal if its thickness and shape permit full penetration by the plasma jet. Because the PAC process can be used to cut nonferrous materials, and is faster than oxy-fuel cutting with ferrous material less than three inches thick, it is the most economical alternative for many industrial applications.
PAC equipment is available for cutting a wide range of material thicknesses, and precision plasma can produce laser-like quality cuts in some applications for significantly lower equipment and operating costs.

Laser Beam Cutting (LBC) is a thermal cutting process that utilizes highly localized melting or vaporizing to sever metal with the heat from a beam of coherent light, usually with the assistance of a high-pressure gas. An assist gas is used to remove the melted and volatilized materials from the beam path. Both metallic and non-metallic materials can be cut by the laser beam process. The output beam is often pulsed to very high peak powers in the cutting process, increasing the travel speed of the cutting operation.
The two most common types of industrial lasers are carbon dioxide (CO2) and neodymium-doped yttrium aluminium garnet (Nd:YAG). A CO2 laser uses a gaseous medium to produce the lasing action while the Nd:YAG use a crystalline material. CO2 lasers are commercially available in powers up to 6kW and Nd:YAG systems are available up to 6kW.
Done by mechanized equipment, laser cutting delivers highly reproducible results with narrow kerf width, minimal heat-affected zone and little-to-no distortion. The process is flexible, easy to automate and offers high cutting speeds with excellent cut quality. Equipment costs are high but are becoming lower as resonator technology becomes less expensive.(Lindeus,2023)

Standard metals for welding projects

Best Metals For Welding
Welding is a complicated process that combines the science of electricity (aside from ox fuel welding), heat, metallurgy, different states of matter, and oxidation. This also means there are many complications that can arise which can lead to weld failure. One way to reduce the risk is by selecting a metal that is easily weldable and does not require many extra pre-weld and post-weld operations to prevent weld failure. Some of the best metals for welding include:

- Low Carbon Mild Steel
- Aluminium
- Stainless Steel
- Other Metals

1. Low carbon mild steel

Low carbon mild steel is one of the most, if not the most weldable metal. This is due to several different factors. One reason for its excellent weldability is the fact that it has historically been very commonly used in numerous applications. The historic abundance and demand for low carbon steel has led to scientists and engineers developing ways to weld it. Developments include patented electrical arc waveforms, special filler material chemical compositions, and top-of-the-line welding power sources to weld low carbon steel. All of this enables welders to make satisfactory carbon steel welds with relative ease. Another reason that low carbon steel is so weldable is because it is more ductile than other types of steel. This is because it has very low amounts of carbon and only trace amounts of other alloying elements. This prevents the formation of brittle microstructures such as martensite. All of this eliminates the risks of certain types of weld failures, such as hydrogen cracking. As the amount of carbon increases, so does the difficulty of making a satisfactory weld.

2. Aluminium

While it can be trickier than low carbon steel, aluminium can be welded without much difficulty as long as you have the proper knowledge and techniques. One concern when welding aluminium is making sure that the proper grade is selected. Grades in the 1XXX series can be welded without much extra effort needed. Grades in the 6XXX series can be welded, but proper filler material and welding operation must be used to aid in crack prevention. Aluminium in the 2XXX series is typically not weldable at all, although a few grades in this series can be welded with proper filler material and technique.

One other consideration when welding aluminium is material strength. Some aluminium alloys, such as those with a T6 designation, have been artificially aged to increase the strength. This means that they have been heated to a certain temperature for a specific amount of time so that intermetallic precipitates are the proper size and shape to increase the strength of the aluminium. When these grades of aluminium are welded, the intermetallic precipitates change their form, and it is common for the strength of the aluminium to be reduced greatly. To return these welded aluminium alloys back to their original strength, they must be artificially aged again by means of a heat treatment process.

3. Stainless Steel

Stainless steel is a metal that can also be welded readily when proper technique is used and adequate knowledge is applied. Many stainless steels, known for their corrosion resistance, can be welded despite their complex chemical composition. The most important consideration when welding a stainless steel is to know what grade is being welded. There are three major types of stainless steel: austenitic, ferritic, and martensitic. Many ferritic stainless steels are very weldable. Austenitic stainless steels can be weldable as well. Martensitic stainless steels are generally more difficult due to their high hardness and their propensity to crack.

A major consideration when welding stainless steels is intergranular corrosion. When stainless steels are subjected high temperature environments, like those that occur during welding, the chromium can be susceptible to joining with the carbon within the steel. This formation of chromium carbide prevents the ability of the chromium to combine with oxygen. Therefore no chromium oxide layer is formed, and the oxygen is free to combine with the iron in stainless steel, contributing to corrosion. There are a couple of methods available that can prevent this. Using a grade stabilized with titanium or niobium such as Grade 321 can prevent intergranular corrosion as the titanium is more likely to form with the carbon atoms before the chromium. Another way to prevent intergranular corrosion is through the use of low carbon stainless steels.

These simply do not offer enough carbon to stop the formation of a protective chromium oxide layer.

4. Other Metals

While there are exceptions, welding tends to get more complicated with other types of metals. The welding of titanium will typically require extra equipment or shielding to prevent it from being oxidized. High carbon steels will generally require preheat and post-weld heat treatment to avoid cracking. Some super alloys can only be welded in a vacuum. Every metal that is going to be welded should be researched on an individual basis to ensure that welding methods exist to make a successful weld. (Metal Supermarkets,2014)

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of welding technology. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Welding Techniques

Teaching Strategies

Key: Analyse welding processes according to safety standards.
Introduce the students to safety standards in welding processes. Guide them into the different welding types and techniques.
Provide reading materials for students to do research. Use guiding questions to do group research in safety and different welding types and techniques.

Learning Strategies

Activity 1 Students read and brainstorm on safety and different welding types and techniques.
Activity 2 Use guiding points and question to do research in groups.
Activity 3 Present their findings in groups.

Resources

Texts on welding, cutting and safety.

Lesson 2: Cutting Processes in Welding

Teaching Strategies

Key: Analyse cutting processes according to safety standards.
Introduce the students to safety standards in using welding processes to cut metals. Guide them into the different weld-cut types and techniques.
Provide reading materials for students to do research. Use guiding questions to do group research in safety and different weld-cut types and techniques.

Learning Strategies
Activity 1 Students read and brainstorm on safety and different weld-cut types and techniques.
Activity 2 Use guiding points and question to do research in groups.
Activity 3 Present their findings in groups.

Resources
Texts on welding, cutting and safety.

Lesson 3: Standard Metals for Welding Projects
Teaching Strategies
Key: Analyse metal properties of metals in accordance with standard metal properties.
Provide reading materials for standard metals used for welding projects.
Students read and brainstorm and do research using guidelines questions and points.
Present individually.

Learning Strategies
Activity 1 Study and take notes of standard metal properties.
Activity 2 Read standard metal properties used for welding projects.
Activity 3 Compile and present reports of findings of readings on welding metals used for welding projects.

Resources
Text readings on metals used for welding projects.

STEAM Activity Students work in groups to create an activity incorporating metals in welding.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to analyse the properties of metals and the welding techniques and cutting processes according to safety regulations and standards. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.
Performance Assessment
1. Analyse welding and cutting processes according to safety standards..
2. Analyse metal properties of metals in accordance with standard metal properties

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Demonstrate accurately the safety standards in weld – cutting processes.	Very High and accurate demonstration.	Has high demonstration	Shown some degree of demonstration	Low demonstration shown
2. Demonstrate metal properties of metals in accordance with standard metal properties.	Very High and accurate demonstration.	Has high demonstration	Shown some degree of demonstration	Low demonstration shown

UNIT 4 Welding Technology

Content Standard 3.4. Investigate and analyse safety procedures, print reading, measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing principles and apply fundamentals of fabrication codes, inspections, testing principles and apply fundamentals of fabrication.

Benchmark 11.3.4.5. Analyse and select suitable materials for machining or welding processes identifying forms of welding with precision measurement for quality output.

Topic 5: Forms of Welding

Learning Objectives

By the end of this topic, the students will be able to;

1. Analyse and select appropriate materials for machining and welding processes
2. Identify forms of welding joints

Essential Questions:

1. Which materials are used for machining and welding processes?
2. What are the common forms of welding joints?

Essential Knowledge, Skills, Values and Attitudes:

Knowledge: Forms of welding, machining materials, welding processes, precision measurement
Skills: Analyse, select materials suitability
Values: Awareness, appreciation and value
Attitudes: Open-minded and safety cautious when performing welding techniques.

Content Background

Material Selection for welding and machining

The metal fabrication industry makes use of various materials and techniques to create high-performing, reliable products for diverse industries and applications. Blanking, cutting, drawing, stamping, bending, hydroforming, roll forming, stamping, and welding are a few of the most popular fabrication techniques, but the best method will depend on the specific application at hand and the end products' unique requirements and specifications.
Along with fabrication techniques, material selection is also critically important. Steel, stainless steel, aluminium, and other alloys are all commonly used within the industry, each offering unique properties and benefits for different applications. All of these metals are easily available and relatively cost-effective. Other alloys are typically used for more specialized applications.

When selecting from the former group of materials, a number of key factors should be kept in mind to ensure optimal product performance.

The Material Selection Process
Before selecting a material for fabrication process, take the time to carefully consider the unique requirements of the application and any environmental challenges the product may encounter. Also consider material properties such as ductility, weldability, machinability, tensile strength, and corrosion resistance.
Ductility — How pliable is the material? Are you able to draw it into a wire or form it into different shapes? Aluminium has a low ductility, for instance, whereas stainless steel has high ductility.

Weldability — How easy is it to solder the metal? In other words, will it require preparation and advanced welding techniques and tools, thereby increasing overall project costs? Steel is easily weldable, while stainless steel has medium weldability.

Machinability — Machinability refers to the ability to cut materials with a blade. Highly machinable metals can be cut at high speeds. Steel has medium machinability, for instance, while stainless steel has hard machinability.

Tensile Strength — How much force is required to snap the metal? How strong is the metal you've chosen? Stainless steel can handle very high tension. Aluminum cannot.

Corrosion Resistance — How well a substance can withstand damage caused by oxidization or other chemical reactions.

It's also important to consider the cost and versatility of the material. How expensive or inexpensive is the material compared to other options? Will it work as well as another material for the specific project being considered? The shape will also come into play. Common geometries for metal applications include flat plates and sheets, flat bars, C channels, angle irons, pipes, round tubes, square/rectangular tubes, I-beams, etc.

What is Welding Joint?

Welding is one of the strongest things human beings ever discovered since their existence. The application of welding is limitless in various forms on earth, in space, and in water. Welding can join different metals together at different angles. A welding joint is an edge or point of two or more pieces of metal. Some more welding joint is a place where weld metal fully penetrates the joint with complete root fusion.

Types of Joints
The strength of welded joint should be more or at least equal to that of the material of the parts being joined. Normally, the welding industry employs five types of welding joints in day-to-day activities.

1. Butt Welding Joint
2. Corner Welding Joint
3. Lap Welding Joint
4. Tee Welding Joint
5. Edge Welding Joint

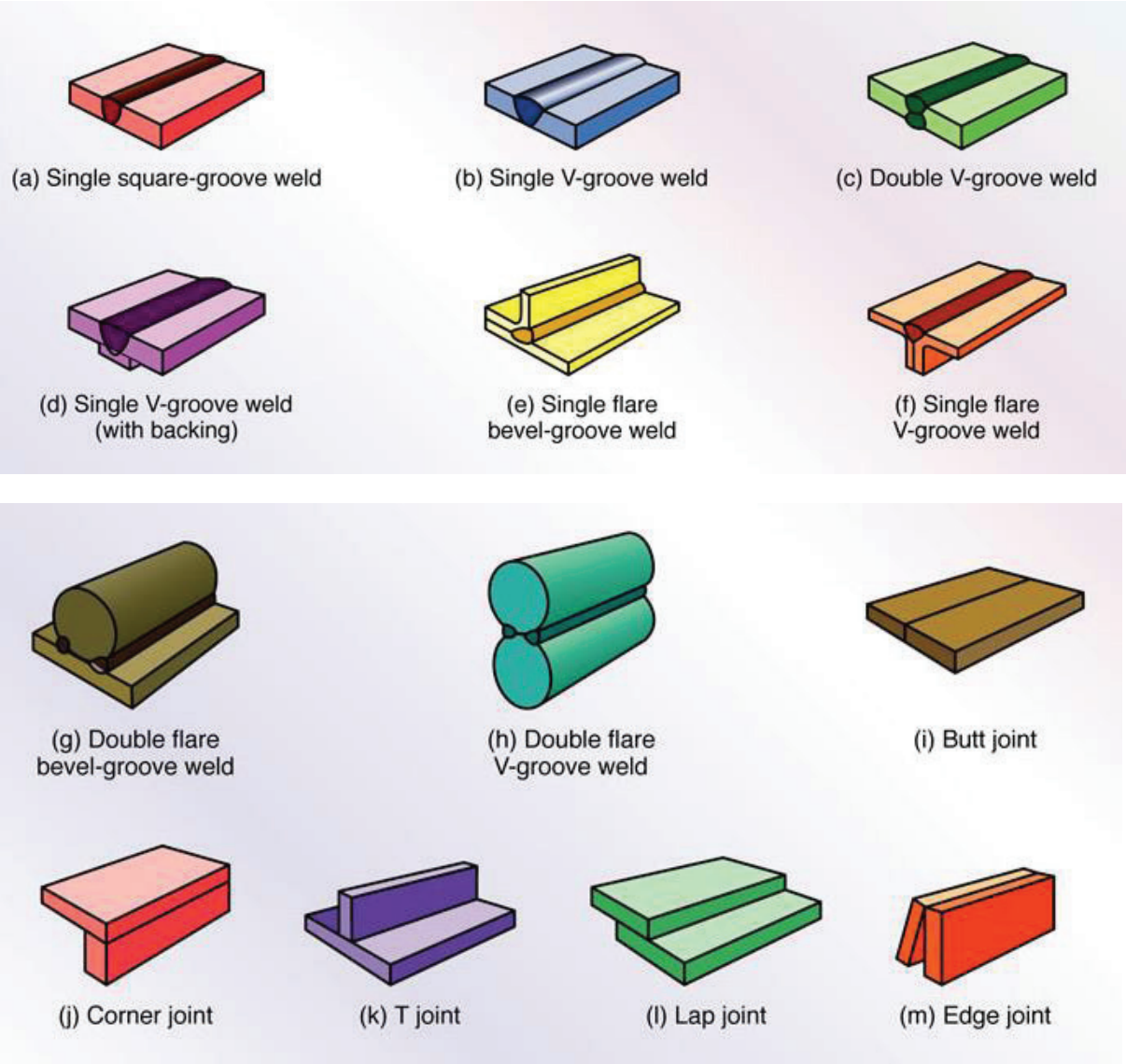

Figure 4.5a Welding joints
Source: https://www.weldinginfo.org/welding-technology/different-types-of-welding-joints/

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of welding technology. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Material Selection for welding and machining

Teaching Strategies

Key: Which materials are used for machining and welding processes?
Students research and investigate materials that are used for welding and machining.
Assist in providing materials, information and ideas for poster presentation.

Learning Strategies
Activity 1 Brainstorm and collate ideas, information and materials for a poster presentation.
Activity 2 Do a group research.
Activity 3 Do major presentation on materials used on welding and machining.

Resources
Reading texts, Library and any help from friends. Poster, marker, pencil.

Lesson 2: Types of Joints

Teaching Strategies
Key: What are the common forms of welding joints?

Students research and identify forms of welding joints.
Assist in providing materials, information and ideas for poster presentation.

Learning Strategies
Activity 1 Brainstorm and collate ideas, information and materials for a poster presentation.
Activity 2 Do a group research
Activity 3 Do major presentation on materials used on welding and machining.

Resources
Reading texts, Library and any help from friends. Poster, marker, pencil.

STEAM Activity Students work in groups to create an activity incorporating concepts welding and machining.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to Analyse and select suitable materials for machining or welding processes identifying forms of welding with precision measurement for quality output. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
Analyse and select appropriate materials for machining and welding processes.
Identify forms of welding joints.

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.
*Display of posters

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Display of appropriate materials for machining and welding processes	Accurately display of appropriate materials for machining and welding processes	Correctly display of appropriate materials for machining and welding processes	Partially display of appropriate materials for machining and welding processes	Cannot display of appropriate materials for machining and welding processes
2. Identify forms of welding joints	Accurately identify forms of welding joints	Correctly identify forms of welding joints	Partially identify forms of welding joints	Cannot identify forms of welding joints

UNIT 4 Welding Technology

Content Standard 3.4. Investigate and analyse safety procedures, print reading, measurement and layout, identify properties of metals, the welding techniques, cutting processes according to welding codes, inspections, testing principles and apply fundamentals of fabrication codes, inspections, testing principles and apply fundamentals of fabrication.

Benchmark 11.3.4.6. Apply safe working procedures, correct processes and techniques in handling lathe and milling machines.

Topic 6: Machinery Safety

Learning Objectives:
By the end of this topic, the students will be able to;
1. Apply safe working procedures and processes in handling lathe and milling machines.
2. Demonstrate safe handling techniques for lathe and milling machines.

Essential Questions:
1. What are the safe techniques in handling lathe and milling machines?
2. What are the safe working procedures and processes to employ when handling lathe and milling machines?

Essential Knowledge, Skills, Values and Attitudes:
Knowledge: Safe working procedures, processes and techniques in handling lathe and milling machines
Skills: Apply
Values: Appreciate and value
Attitudes: Safety cautious, open-minded and responsibly operate a lathe and or milling machine.

Content Background

Lathe Machine Safe Work Procedure.

DO NOT use this machine unless you have been trained in its safe use and operation. Personal Protective Equipment (PPE) Required are;

- Eye Protection
- Appropriate Footwear
- Appropriate Attire

DO NOT operate the lathe wearing loose clothing, finger rings or other jewellery. Long hair must be tied up or tucked under the hard-hat.
Check workspaces and walkways to ensure no slip/trip hazards are present.

Safe Work Procedure Checklist
PRE-Operation:

- Task (Drawings, instructions, Specifications, Material… etc.) is clearly understood. · Identify ON/OFF switch and emergency stop button and test any interlocking devices (if applicable).
- Make sure the machine is turned off or the emergency stop switch is engaged, before comment of any work or inspection.
- Ensure all security guards including the chuck and tool post guards are in place.
- Ensure the work piece has been suitably prepared for the lathe operation.
- Ensure work piece is securely fastened to face plate, chuck or between centres as required by the task.
- Remove the chuck wrench/key immediately after adjusting the chuck.
- Rotate the work piece by hand to check clearance between tool rest and bed.
- Adjust speed and feed to suit the diameter and the material of the work and turning operation.
- Ensure the cutting tools are sharp, in good condition and secured.
- Test the cooling fluid system operation and availability.
- Faulty equipment must not be used and must be immediately reported to the shop technician.

Operation:

- Never leave the machine running while unattended.
- Switch off the lathe and ensure it has come to a complete standstill before making any adjustments.
- Keep the tool rest adjusted close to the work and at the correct height.
- Adjust speed to suit the diameter of the work and turning operation.
- Never use the file to smooth, clean or deburr a work piece.

POST-Operation:

- Switch off the machine and reset all guards to a fully closed position.
- Allow all part to come to stop before making alterations or at completion of work.
- Remove work from chuck and remove chuck key.
- Leave the machine in a safe, clean and tidy state.
- Leave the working area clean and tidy.

Milling Machine Safe Work Procedure.

DO NOT use this machine unless you have been trained in its safe use and operation. Personal Protective Equipment (PPE) Required are;

- Eye Protection
- Appropriate Footwear
- Appropriate Attire

DO NOT operate the Milling wearing loose clothing, finger rings or other jewellery. Long hair must be tied up or tucked under the hard-hat.

Check workspaces and walkways to ensure no slip/trip hazards are present.

PRE-Operation:

- Task (Drawings, instructions, Specifications, Material… etc.) is clearly understood.
- Identify ON/OFF switch and emergency stop button and test any interlocking devices (if applicable).
- Make sure the machine is turned off or the emergency stop switch is engaged, before comment of any work or inspection.
- Ensure all security guards including the spindle guard are in place.
- Ensure the work piece has been suitably prepared for the milling operation.
- Ensure work piece is securely fastened to the working table.
- Remove the chuck wrench/key immediately after installing the tooling.
- Adjust speed and feed to suit the tooling diameter, material and turning operation.
- Ensure the cutting tools are sharp, in good condition and secured.
- Test the cooling fluid system operation and availability, if applicable.
- Faulty equipment must not be used and must be immediately reported to the shop technician

Operation:

- Never leave the machine running while unattended.
- Switch off the milling machine and ensure it has come to a complete standstill before making any adjustments or working on the work piece.
- Keep the tool rest adjusted close to the work and at the correct position.
- Adjust speed to suit the diameter of the tool and turning operation.

POST-Operation:

- Switch off the machine and reset all guards to a fully closed position.
- Allow all part to come to stop before making alterations or at completion of work.
- Remove work from table and remove the tooling.
- Leave the machine in a safe, clean and tidy state.
- Leave the working area clean and tidy.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get a picture of welding technology. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Lathe Machine Safety
Teaching Strategies
Key
What are the safe techniques in handling lathe?
What are the safe working procedures and processes to employ when handling lathe machines?
Guide and introduce the students to safe techniques, safe working procedures and processes in handling lathe machine.
Provide students with texts and necessary information on the safe techniques in handling lathe machine.
Provide key questions for students to follow to research the safe handling of the machine.
Learning Strategies
Activity 1 Read and brainstorm on the safe techniques, safe working procedures and processes in handling lathe machine.
Activity 2 Do individual research.
Activity 3 Individual presentation to the class.

Resources
Text and necessary information on safety measures in using lathe and milling machine,

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Lesson 2: Milling Machine Safety
Teaching Strategies
Key
What are the safe techniques in handling milling machine?
What are the safe working procedures and processes to employ when handling milling machines?
Guide and introduce the students to safe techniques, safe working procedures and processes in handling milling machine.
Provide students with texts and necessary information on the safe techniques in handling milling machine.
Provide key questions for students to follow to research the safe handling of the machine.
Learning Strategies
Activity 1 Read and brainstorm on the safe techniques, safe working procedures and processes in handling milling machine.
Activity 2 Do individual research.
Activity 3 Individual presentation to the class.

Resources
Text and necessary information on safety measures in using lathe and milling machine,

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STEAM Activity Students work in groups to create an activity incorporating concepts of lathe machine safety.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to apply safe working procedures, correct processes and techniques in handling lathe and milling machines. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Apply safe working procedures and processes in handling lathe and milling machines
2. Demonstrate safe handling techniques for lathe and milling machines.

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Apply safe working procedures and processes in handling lathe and milling machines	List with clear English the first 6 procedures and processes in handling milling or lathe machine.	List with clear English 4-5 procedures and processes in handling milling or lathe machine.	List at least 2-3 procedures and processes in handling milling or lathe machine.	List at least 1 procedure and processes in handling milling or lathe machine.
2. Demonstrate safe handling techniques for lathe and milling machines.	Clearly describe the first 6 handling technique for handling lathe and milling machine	Describe 4-5 handling technique for handling lathe and milling machine	Describe at least 2-3 handling technique for handling lathe and milling machine	Describe at least 1 handling technique for handling lathe and milling machine

Unit 5: Engineering Technology

Units	Topics	Lesson Titles
5. Engineering Technology	Topic 1. Introduction to Engineering Concepts Technology system and application	1. Engineering Technology system 2. Types of Engineering Field Technology 3. Types of Problem-Solving Skills and Techniques in Engineering field 4. Trouble shooting in Engineering. 5. OHS in Engineering
	Topic 2. Engineering material specification and implication to development	1. Types of Engineering Materials in Specific Field 2. Methods of Categorising Engineering Material into Specific Field 3. Engineering Implication to Development 4. Method of Problem-Solving on Engineering Effect
	Topic 3.Engineering Management communication Process	1. Management Communications Process 2. Types of Engineering Report and Format 3. Methods of Analysing Report and Presentation Written or Graph Form
	Topic 4. Introduction to Auto CAD program in engineering fields	1. AUTOCAD Program in Engineering Fields 2. Types of AUTOCAD Program in Engineering 3. Significant of AUTOCAD Program in Engineering 4. Methods of Downloading AUTOCAD Program
	Topic 5, The Engineering Development	1. Methods on Engineering Development in Specific Fields, 2. Types of Engineering Fields 3. Methods of Process Material from Raw to Finished Product in Specified Engineering Field 4. Types of Equipment used in Engineering

UNIT 5: Engineering Technology

Content Standard 3.5. Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.

Benchmark 11.3.5.1 Explore and analyse concept of technology systems in determining practical applications for learning and technical problem solving.

Topic 1: Introduction to Engineering Concepts and Technology System

Learning Objectives

By the end of this topic, the students will be able to;

1. Analyse and describe the engineering technology system, its application in solving problems and trouble shooting.

Essential Questions:

1. What is engineering technology system?
2. What are the types of engineering field technology?
3. How are the types of problem solving skills and techniques used in engineering field?
4. Why is it important to do trouble shooting in engineering fields?
5. How is OHS implemented in engineering?

Essential Knowledge, Skills, Values and Attitudes:
Knowledge: Engineering Concepts technology and applications.
Skills: Analyse engineering concepts and technology systems.
Values: Appreciate the importance of engineering in the technological world.
Attitudes: Think critically on the engineering world behind the technological world.

Content Background

Technological System

A technological system is any device in which electronics are combined to create a device to do work. These systems can look very different on the outside, but on the inside, they all have the same basic parts. All systems must have a method in which they obtain input, transform the input, and then produce an output. Some systems are more complex and have many more components while others are very basic. Some systems can perform multiple complex tasks while others have a single purpose and may be very simplistic. Some technological systems examples are everyday household items such as coffee makers, clocks and even doorbells. More complex examples of technological systems are computers, cell phones and even automobiles.

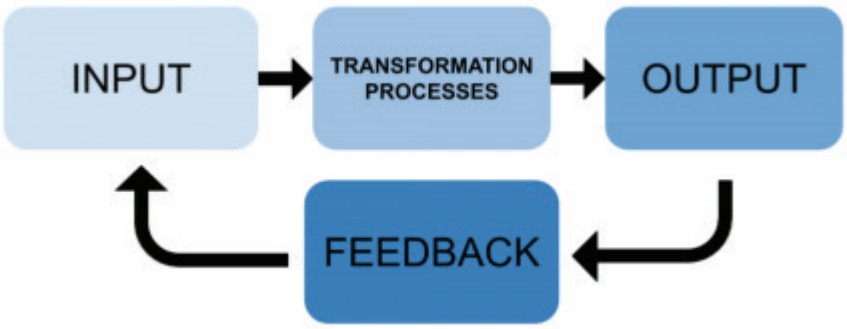
Engineering Concepts Technology system and application

A technological system is a set of interconnected components that has been designed to fulfill a particular function without further human design input. Technological systems transform, store, transport, or control materials, energy, and/or information for a particular purpose.

Basic Operation

No matter their complexity all technological systems have several things in common. In their simplest form, they must be able to receive input, transform that input, and then produce output.

Technological systems are often represented in diagrammatic form, with symbols for the various components. Here is a basic example:



Input
Input is any event, action or information gathered by the system. This can be as simple as a user pressing a button, a specific time of day, or even data received by a sensor such as temperature. In any situation, the input is new information that is entered into the systems that was not there prior.

Transformation
Transformation is the key element of a technological system. Without the transformation process, the systems would be worthless. Transformation is what happens with the information that is input into the system. When a user presses a button on a coffee maker, that button press will be transformed into a series of processes to brew the coffee. Without the transformation process, the input could not be changed and therefore a user would never get anything different from the system other than what was put into the system.

Output
Output is what is produced from the technological system. The output is the purpose for the existence of the technological system. If a system can take input and transform it but is unable to produce output then the system will have no value. The output may or may not be the desired result but a result of the input and transformation processes. Using the example of the coffee maker, the user can press the button to brew the coffee, but if they did not add the correct amount of water and coffee grounds to the coffee maker, the output of the coffee may not be what the user wanted. The coffee may be too strong or too weak. This is not an error of the technological system, but a result of poor input. A technological system can only output in the way it was designed and its output will be a direct representation of the input received.
Control

A control is the way a system should respond to the given input. A clock will display time, but without a control, we have no way to know if this displayed time is accurate. Because of this need for a control, systems are designed based on a control.

Technological Systems is intended to teach students how systems work together to solve problems and capture opportunities. A system can be as small as two components working together (technical system/device level) or can contain millions of interacting devices (user system/network level). We often break down the macro systems into less complicated microsystems to better understand the entire system. However, technology is becoming more integrated and systems are becoming more dependent upon each other than ever before. Electronic systems are interacting with natural (e.g., bio) systems as humans use more and more monitoring devices for medical reasons. Electrical systems are interacting with mechanical and fluid power systems as manufacturing establishments become increasingly automated. This course gives students a general background on the different types of systems with a concentration on the connections between these systems.

Technological Systems, How They Work: Investigate technological systems through their function, design, development, interaction, and maintenance. Systems included in this exploration include communications, construction, manufacturing, biomedical, and power energy.

- Development of Systems: Technological Systems are developed to meet specific criteria and must be able to function to complete the system's loop.
- Issues and Impacts of Technological Systems: Technology can have both positive and negative impacts on the environment and the economy.
- Design of Technological Systems: Technological systems are designed to meet a specific need while addressing design constraints.

Maintaining Technological Systems: Technical information comes in many forms and is used to test, evaluate, and problem-solve within systems.

- Understanding Technical Information: Technical information comes from a variety of sources and is used maintain systems and understand how they work.
- Problem Solving and Maintaining Systems: At times, systems will need to be adjusted or repaired, and tools and equipment must be used safely to maintain these systems.
- System Testing and Evaluation: Systems are designed with a specific purpose, and controls are placed within systems to address their performance.

Technological System Interaction: Technological systems are designed to meet a specific need and can address this need through a variety of functions, processes, and interactions with other systems.

- System Functions, Processes and Development: Processes within systems serve different functions and can cause problems with the performance of the system if there is a malfunction.
- System Design and Development: Knowledge from a variety of fields is used in the development of products and systems, and the completed system can be used in multiple applications.
- System Malfunctions and Troubleshooting: There is no such thing as a perfect design or system. Systems must be maintained over the course of their use to continue proper

functioning. When a system malfunctions, proper troubleshooting is necessary to fix the issue.

Technological Systems in the Designed World: A variety of different technological tools, processes, and materials can be integrated to form systems.

- Power and Energy Systems: Energy is needed for humans, machines, systems, or other means to do work.
- Communication systems: The process of communication can take place between humans, machines, and humans and machines.
- Constructing specialised manufacturing environments: Production and manufacturing environments for biological and medical equipment and materials must align to standards that ensure the quality of the material produced.

ITEEA,(2018) Technological systems at a glance
https://www.iteea.org/File.aspx?id=111322&v=eb1844d3

Troubleshooting and Safety in Engineering
Knowing the potential hazards and putting into place the necessary safeguards will help reduce the incidence of employee illness or injury while protecting productivity and workflow expectations to the satisfaction of employees and employers.
The need for safety guidelines is not limited to just one type of workplace. All workplaces benefit from health and safety training. Health and safety training in engineering workplaces may look a little different than that required for other sectors, however, its because the hazards maybe a little different too.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to Introduction to Engineering Concepts Technology system and application. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Engineering Technology System

Teaching Strategies

Engage students in brainstorming exercise defining what engineering Technology system is.
Engage students to discuss the engineering Technology system.

Learning Strategies

Discover what engineering Technology system is.
Activity 1. Brainstorming activity on the meaning of engineering Technology system.
Activity 2. Conduct research on what engineering technology system is.
Activity 3. Discussions and presentation of research what engineering Technology system is.

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Lesson 2: Types of Engineering Field Technology

Teaching Strategies

Engage students in brainstorming exercise the types of engineering field Technology.
Engage students to discuss the types of engineering field Technology

Learning Strategies
Discover what engineering Technology system is.
Activity 1. Brainstorming activity on the different types of engineering field Technology
Activity 2. Conduct research on the different types of engineering field Technology
Activity 3. Discussions and presentation of research on the different types of engineering field Technology
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Lesson 3: Types of Problem-Solving Skills and Techniques in Engineering Field

Teaching Strategies
Engage students in brainstorming exercise the types of problem-solving skills and techniques in engineering field.
Engage students to discuss the types of problem-solving skills and techniques in engineering field.

Learning Strategies
Discover what engineering Technology system is.
Activity 1. Brainstorming activity on the different types of problem-solving skills and techniques in engineering field
Activity 2. Conduct research on the different types of problem-solving skills and techniques in engineering field
Activity 3 Discussions and presentation of research on the different types of problem-solving skills and techniques in engineering field

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Lesson 4: Trouble Shooting in Engineering

Teaching Strategies

Engage students in brainstorming exercise the trouble shooting of engineering fields
Engage students to discuss the trouble shooting of engineering fields

Learning Strategies
Discover what engineering Technology system is.
Activity 1. Brainstorming activity on the trouble shooting of engineering fields
Activity 2. Conduct research on the trouble shooting of engineering fields
Activity 3. Discussions and presentation of research on the trouble shooting of engineering fields

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Lesson 5: OHS in Engineering

Teaching Strategies

Engage students in brainstorming exercise on OHS in engineering fields
Engage students to discuss OHS in engineering fields

Learning Strategies
Discover what engineering Technology system is.
Activity 1. Brainstorming activity on OHS in engineering fields engineering fields.
Activity 2. Conduct research on OHS in engineering fields of engineering fields
Activity 3. Discussions and presentation of research on OHS in engineering fields.

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STEAM Activity Students work in groups to create an activity that incorporates technology systems to problem solve.

Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to explore and analyse concept of technology systems in determining practical applications for learning and technical problem solving. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Define engineering technology system
2. Types of engineering field technology
3. Types of Problem solving skills and techniques in engineering field
4. Trouble shooting of engineering fields

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Define engineering Technology system	High order analysis and description of the types of technology systems	Competently analysed and described types of technology systems	Did not fully analyse and describe types of technology systems	Did not analyse and describe types of technology systems
2. Identify types of engineering field Technology	Correct identification of more than 5 Classifications of engineering materials	Correct identification of more than 3-4 Classifications of engineering materials	Correct identification of more than 2-3 Classifications of engineering materials	Identification of 1 Classification of engineering material.
3.Develop types of Problem solving skills and techniques in engineering field	Accurately develop types of Problem solving skills and techniques in engineering field	Correctly develop types of Problem solving skills and techniques in engineering field	Partially develop types of Problem solving skills and techniques in engineering field	Cannot develop types of Problem solving skills and techniques in engineering field
4. Describe trouble shooting of engineering fields	Accurately describe trouble shooting of technology systems	Correctly describe trouble shooting of technology systems	Partially describe trouble shooting of technology systems	Cannot describe trouble shooting of technology systems

UNIT 5: Engineering Technology

Content Standard 3.5. Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.

Benchmark 11.3.5.2 Describe the types of materials ,component and process and explain their implication for engineering development

Topic 2: Engineering Material Specification and Implication to Development

Learning Objectives

By the end of this topic, the students will be able to;

1. Investigate engineering materials, components and processes and their implications to development.
2. Analyse and describe method of problem solving in engineering.

Essential Questions:

1. What are the types of engineering materials in specific field?
2. How do engineering materials, processes and components implicate engineering developments or innovations?
3. What is engineering implication to development?
4. What are the methods of problem solving on engineering effect?

Essential Knowledge, Skills, Values and Attitudes:
Knowledge: Engineering materials and specification.
Skills: Apply methods of enquiry.
Values: Appreciate the usefulness of materials used in the engineering process.
Attitudes: View engineering materials as useful in the changing world.

Content Background

Introduction to Engineering Materials

Materials selection is an ordered process by which engineers can systematically and rapidly eliminate unsuitable materials and identify the one or a small number of materials which are the most suitable. It is a step in the process of designing any physical object. In the context of product design, the main goal of material selection is to minimise cost while meeting product performance goals.

Factors affecting the selection of materials:
(i) Component shape:
(ii) Dimensional tolerance:
(iii) Mechanical properties:

(iv) Fabrication (Manufacturing) requirements:
In the long run, understanding the process used in material selection will enhance the process of engineering design analysis, will reduce cost and accelerate the development schedule and provide the project the best chance of success. Depending on manufacturing techniques, different materials will perform differently under certain conditions. When choosing a material, it's vital to determine its flexibility for design and manufacturing. By knowing a material's limitations, the design process is simplified and its restrictions taken into account.

Materials scientists and engineers are interested in properties that affect how a material behaves and, therefore, how it can be used.

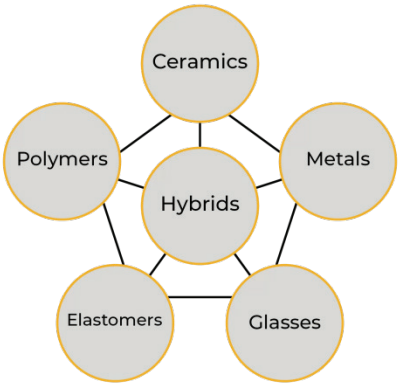
Materials Selection : Engineering Materials, Properties and Selection Methodology

• Engineering Materials
• Material Properties
– Mechanical Properties
– Thermal Properties
– Electrical Properties
– Optical Properties
– Eco-Properties

Materials are a field that is ever evolving. We still use materials we used in the Stone and Bronze Ages and yet new materials are designed every day for different uses.

Types/Families of Engineering Materials

One way to logically break down this large field is through material families.



Metals: Stiff materials with relatively high elastic moduli and exhibit ductility. Can be made strong by alloying, mechanical and heat treatments

• **Ceramics and glasses:**
Materials with high moduli, but, brittle.
– Tensile strength means the brittle fracture strength;
– Compressive strength is the brittle crushing strength (15x fracture strength).
– Low tolerance for stress concentrations (like holes or cracks) or for high contact stresses (at clamping points, for instance)

– Finds application in bearings and cutting tools
– Large scatter in the properties

• **Polymers and elastomers: Materials with low moduli**
– High strength can be as strong as metals
– Elastic deflections can be large due to low moduli
– They exhibit creep (time dependent deformation under constant load) even at room temperature
– Very high strength-to-weight ratio
– Can be made into complex shapes

A composite material consists of two phases:

• **Primary**
– Forms the matrix within which the secondary phase is imbedded
– Any of three basic material types: polymers, metals, or ceramics

• **Secondary – Referred to as the imbedded phase or called the reinforcing agent**
– Serves to strengthen the composite (fibers, particles, etc.)
– Can be one of the three basic materials or an element such as carbon or boron.

Types of composite materials
There are five basic types of composite materials: Fiber, particle, flake, laminar or layered and filled composites.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to understand the Introduction to Engineering Concepts Technology system and application The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Types of Engineering Materials in Specific Field

Teaching Strategies

Engage students in brainstorming exercise the types of engineering materials in specific field.
Engage students to discuss the types of engineering materials in specific field.

Learning Strategies
Discover different types of engineering materials in specific field .
Activity 1 Brainstorming activity on different types of engineering materials in specific field
Activity 2. Conduct research on different types of engineering materials in specific field.
Activity 3. Discussions and presentation of research findings on types of engineering

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Lesson 2: Methods of Categorising Engineering Material into Specific Field

Teaching Strategies
Engage students in brainstorming exercise the methods of categorising engineering material into specific field.
Engage students to discuss the methods of categorising engineering material into specific field.

Learning Strategies
Discover different methods of categorising engineering material into specific field
Activity 1 Brainstorming activity methods of categorising engineering material into specific field.
Activity 2. Conduct research on different methods of categorising engineering material into specific field.
Activity 3. Discussions and presentation of research findings on methods of categorising engineering material into specific field.

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_Lesson 3: Engineering Implication to Development

Teaching Strategies
Engage students in brainstorming exercise to define engineering Implication to development
Engage students to discuss to define engineering Implication to development.

Learning Strategies
Discover different definitions engineering Implication to development.
Activity 1 Brainstorming activity on definitions engineering implication to development.
Activity 2. Conduct research on definitions engineering Implication to development.
Activity 3. Discussions and presentation of research findings on definitions engineering implication to development.

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Lesson 4: Method of Problem Solving on Engineering Effect
Teaching Strategies
Engage students in brainstorming exercise to identify method of problem solving on engineering effect.
Engage students to discuss to identify method of problem solving on engineering effect.

Learning Strategies

Discover different method of problem solving on engineering effect.
Activity 1 Brainstorming activity on identifying method of problem solving on engineering effect.
Activity 2. Conduct research on identifying method of problem solving on engineering effect.
Activity 3. Discussions and presentation of different method of problem solving on engineering Effect.

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STEAM Activity Students work in groups to create an activity on engineering product and reporting the product to other designers. OHS in engineering fields

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Assessment
The main purpose of assessment is to find out if students can use the skill of synthesis to describe the types of materials ,component and process and explain their implication for engineering development. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment
1. Analyse and describe the types of engineering materials in specific field.
2. Identify and describe the methods of categorising engineering material into specific field.
3. Analyse and define engineering Implication to development.
4. Analyse and describe method of problem solving on engineering effect.

Performance Assessment Scoring
Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
1. Analyse and describe the Types of engineering materials in specific field	Accurately and correctly analyse and describe the types of engineering materials in specific field	Correctly analyse and describe the Types of engineering materials in specific field	Partially analyse and describe the Types of engineering materials in specific field	Cannot analyse and describe the Types of engineering materials in specific field
2.Identify and describe the methods of categorising engineering material into specific field	Accurately and correctly identify and describe the methods of categorising engineering material into specific field	Correctly identify and describe the methods of categorising engineering material into specific field	Partially identify and describe the methods of categorising engineering material into specific field	Cannot identify and describe the methods of categorising engineering material into specific field
3. Analyse and define Engineering Implication to development	Accurately and correctly analyse and define Engineering	Correctly analyse and define Engineering	Partially analyse and define Engineering Implication to	Cannot analyse and define Engineering

	Implication to development	Implication to development	development	Implication to development
4.Analyse and describe method of problem solving on engineering effect	Accurately and correctly analyse and describe method of problem solving on engineering effect	Correctly analyse and describe method of problem solving on engineering effect	Partially analyse and describe method of problem solving on engineering effect	Cannot analyse and describe method of problem solving on engineering effect

UNIT 5: Engineering Technology

Content Standard 3.5. Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.

Benchmark 11.3.5.3 Develop Written, oral and Presentation skills and apply these to engineering reports with application of graphics as a communication tool.

Topic 3: Engineering Management Communication Process

Learning Objectives

By the end of this topic, the students will be able to;

1. Analyse the management communications process describing engineering reports and format used.
2. Analyse and describe the methods of analysing report and presentation written or graph form.

Essential Questions:

1. What is management communications process?
2. What are the types of engineering report and format?
3. What are the methods of analysing report and presentation written or graph form?
4. How are important is engineering communication?

Essential Knowledge, Skills, Values and Attitudes:

Knowledge: Engineering communication Skills
Skills: Apply the engineering and communication skills.
Values: Use communication skills responsibly.
Attitudes: Participate meaningfully in effective communication.

Content Background

Engineering Management Communication Process

The main types of communication are oral, written and graphical, and their combinations. Few important phases of a project requiring trusted and efficient communication are: Problem Statement and Specifications.

Communicating as an Engineer

In both academia and industry, engineers speak and write their ideas. While some communication tasks are completed individually, others are performed as a group. Engineers also work as project teams to write proposals and reports.

Engineering communication skills are essential for presenting concepts and designs, and critical to the engineering design process. Engineers with the ability to clearly communicate can confidently present their ideas to decision-makers in presentations, meetings, and reports.

Types of Communication
The list below represents some of the most common communication types in use. Typically, content and organisation distinguish each of these.

Design Reviews
Often, mechanical engineers participate in writing *Design Reviews* with design teams. *Design Reviews* serve as a way for teams to communicate their progress and concerns about a design. Typically, a design team includes various experts.

Graphics
Graphics provide illustrated information to readers. In general, graphics are designed to make it easier for readers to understand your ideas. Deciding when to insert a graphic depends on the information you need to convey.

Poster Sessions
Engineers, participate in *Poster Sessions* during conferences and group meetings. A *Poster Session* allows an engineer to display and discuss his work on a project or the results of his research.

Inspections
Engineers typically write *Inspections* after evaluating an artifact and making assessments. For example, an engineer might inspect the condition of a bridge or pavement and then assess what repairs need to be completed.

Presentations
Mechanical engineers give *Presentations* when they work on projects and *Proposals*. Often, professional *Presentations* require one to verbally and graphically present preliminary designs to colleagues. Engineers use *Poster Sessions* to present research and other technical information.

Lab Reports
Lab work is an important part of every engineer's training. During a lab test or experiment, engineers participate in a "hands-on" experience that no textbook or lecture can provide. Writing a *Lab Report* requires one to reflect on these experiences.

L*ab Reports* are factual presentations of test or experiment results completed in a lab or simulation. Typically, *Lab Reports* discuss procedures as well as describe the details of a test or experiment.

The purpose of a lab report is to present the work completed in a lab test or experiment. This information may be used in several different ways.

Typically, a *Lab Report* includes specific information relating to the work done in a lab. This might include:

- Background Research on Testing Materials
- Equations
- Graphics
- Lab Set Up Description
- Equipment Description
- Procedure Description
- Data
- Results
- Explanations/Conclusions

Project Notebooks

Engineers, should always keep a *Project Notebook*, containing notes of all work. The *Project Notebook* provides a convenient place to keep track both of what he thinks about and the work he does on lengthy projects.

Letters, Memos, E-mail

Engineers, have to write business letters, memos or e-mail. These skills are necessary in industry. Every project one works on will demand that he communicates with other engineers and clients about their ideas and research.

Proposals

Engineers write *Proposals* to present a topic to be researched or to suggest a plan of action. Typically, consulting engineers send *Proposals* to other companies in order to get work. The *Proposal* then works to convince its recipient that a particular engineer or firm is the right choice for the job.

Narrative Writing

As an engineer, much of the writing is not specifically essay or creative writing, such as the writing you might do for a composition or poetry class. However, *Narrative Writing* is useful for explaining concepts or depicting situations that might otherwise be difficult to understand.
However, *Narrative Writing* can help readers visualise a concept or design in specific situations.

Public Meetings

As a civil engineer, one will attend and conduct many *Public Meetings*. These meetings require strong presentation skills due to diverse audiences and situations.
The purpose of a *Public Meeting* is to communicate what plans or decisions are being made on a project. Typically, the information engineers convey at a *Public Meeting* is objective so that unbiased decisions can be made.

Operating Procedures

Engineers write *Operating Procedures* to ensure that the artifacts they create are properly utilized and maintained. *Operating Procedures* require a specific type of writing for a particular audience.
Civil engineers write *Operating Procedures* for different types of artifacts. These artifacts include single pieces of equipment, such as a pump, and more complex equipment, such as reservoir or wastewater treatment plant. Whenever engineers write *Operating Procedures*, they consider who will need to understand the information they provide.

Engineering Reports

Engineers write *Progress Reports* to communicate the status of their work or when they reach a milestone. Typically, consulting engineers produce these reports; however, other engineers might write them as well. Often, changes can affect schedules and even budgets.

Policy Statements

P*olicy Statements* are regulatory documents that help ensure safety.
Unlike *Specifications and Codes* that guide engineers as they create designs, *Policy Statements* are more concerned with specific procedures and operating decisions.

Specifications and Codes
As an engineer, it's likely that you'll read countless *Codes* and possibly write many *Specifications*.
When engineers develop designs for their projects, they consider many issues. In particular, civil engineers have to follow a strict set of restrictions known as *Codes*. These *Codes* help them write the *Specifications* needed for a specific design. Since many engineers develop public artifacts, they also have to consider how a design's appearance appeals to citizens.

Specifications are what engineers write after reviewing the *Codes* affecting their projects. *Codes* are regulatory sets of rules, so *Specifications* "specify" the work that will be completed in order to comply with specific *Codes.* Engineers must take *Codes* into account because these prescriptive rules assist them in meeting the minimum performance standards necessary for health and safety.
.
Technicians read *Specifications* to help them maintain equipment. Since most technicians don't have an engineering background, they don't understand technical engineering terminology. However, technicians are familiar with the equipment and tools necessary for maintenance.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to learn engineering management communication process The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to

them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Management Communications Process

Teaching Strategies
Engage students in brainstorming exercise to define the management communications process.
Engage students in the discussion of the definition the management communications process.

Learning Strategies
Discover different definitions of management communications process.
Activity 1 Brainstorming activity on different definitions the management communications process.
Activity 2. Conduct research on different definitions of management communications process.
Activity 3. Discussions and presentation of research findings on management communication process.

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Lesson 2: Types of Engineering Report and Format
Teaching Strategies
Engage students in brainstorming exercise the types of engineering report and format.
Engage students in the discussion of the types of engineering report and format.

Learning Strategies
Discover different types of engineering report and format.
Activity 1. Brainstorming activity the types of engineering report and format .
Activity 2. Conduct research on different types of engineering report and format.
Activity 3. Discussions and presentation of research findings on types of engineering report and format.

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Lesson 3: Methods of Analysing Report and Presentation Written or Graph Form

Teaching Strategies
Engage students in brainstorming exercise methods of analysing report and presentation written or graph form.

Engage students in the discussion of the methods of analysing report and presentation written or graph form.

Learning Strategies

Discover different methods of analysing report and presentation written or graph form.

Activity 1 Brainstorming activity on methods of analysing Report and presentation written or graph form.

Activity 2. Conduct research on the methods of analysing Report and presentation written or graph form.

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STEAM Activity: Students work in groups to create an activity incorporating concepts of engineering management communication process.

Assessment

The main purpose of assessment is to find out if students can use the skill of synthesis of engineering management communication process. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

Define the management communications process
Analyse and define the types of engineering report and format
Analyse and describe the methods of analysing Report and presentation written or graph form.

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
Define the management communications process	Correctly and accurately define the management communications process	Correctly define the management communicatio ns process	Partially define the management communicatio ns process	Cannot define the management communication s process
Analyse and define the types of engineering report and format	Correctly and accurately analyse and define the types of engineering report and format	Correctly analyse and define the types of engineering report and format	Partially analyse and define the types of engineering report and format	Cannot analyse and define the types of engineering report and format
Analyse and describe the methods of analysing Report and presentation written or graph form	Correctly and accurately analyse and describe the methods of analysing Report and presentation written or graph form	Correctly analyse and describe the methods of analysing Report and presentation written or graph form	Partially analyse and describe the methods of analysing Report and presentation written or graph form	Cannot analyse and describe the methods of analysing Report and presentation written or graph form

UNIT 5: Engineering Technology

Content Standard 3.5. Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.

Benchmark 11.3.5.4 Apply appropriate Computer Aided designing program to create detail designs

Topic 4: Introduction to Auto CAD Program in Engineering Fields

Learning Objectives

By the end of this topic, the students will be able to;

1. Analyse and describe the significance of AutoCAD program in engineering.
2. Apply methods of downloading and application of AutoCAD program.

Essential Questions:

1. What is AutoCAD program in engineering fields?
2. What are the types of AutoCAD program in engineering?
3. How significant is AutoCAD program in engineering?
4. Where would the methods of downloading and application of AutoCAD program be used?

Essential Knowledge, Skills, Values and Attitudes:

Knowledge: Engineering AutoCAD program
Skills: Apply the skills of AutoCAD program
Values: Realise the Importance of engineering
Attitudes: Appreciate new technology to advance learning.

Content Background

AutoCAD Program for Engineering

If we had to define what AutoCAD is in a few words, we would say that it is a **CAD-type software oriented to drawing and modeling in 2D and 3D**. It allows the creation and modification of geometric models with an almost infinite capacity to develop all types of structures and objects.

This ability to work in different fields has made AutoCAD transcend its traditional use in the world of architecture and engineering, to enter the world of graphic and interior design. Currently, AutoCAD has a multitude of specialized auxiliary tools which cover every kind of industrial fields related to 2D design and 3D modeling
How AutoCAD works

AutoCAD works in layers with vector images, although bitmap images can also be imported, which makes us think directly of Photoshop or Illustrator style programs.

However, its entire interface is designed for the design of plans and structures, and is divided as follows:

- Graphic Area: where we will make our designs.
- Options Ribbon: where we will locate the most common actions in our work environment
- Pull-down menu bar and toolboxes.
- Status bar, in which we find information about coordinates, grid control buttons or orthometric mode, among others, in vector form.
- Command line, used to interact with the program by commands to get calculations or information that we may need and that AutoCAD automatically collects.

What Does AutoCAD Mean?

AutoCAD is a computer-aided design (CAD) program used for 2-D and 3-D design and drafting. AutoCAD is developed and marketed by Autodesk Inc. and was one of the first CAD programs that could be executed on personal computers.

AutoCAD

AutoCAD was initially derived from a program called Interact, which was written in a proprietary language. The first release of the software used only primitive entities such as polygons, circles, lines, arcs and text to construct complex objects. Later, it came to support custom objects through a C++ application programming interface. The modern version of the software includes a full set of tools for solid modeling and 3-D. AutoCAD also supports numerous application program interfaces for automation and customization.

DWG (drawing) is the native file format for AutoCAD and a basic standard for CAD data interoperability. The software has also provided support for Design Web Format (DWF), a format developed by Autodesk for publishing CAD data.

Engineers use AutoCAD because it is an efficient way to create precise 2D drawings and 3D models of their designs. The software also helps users communicate their ideas more effectively by allowing them to quickly generate professional-looking visuals. Additionally, AutoCAD can be used to generate detailed manufacturing drawings that can be used by factories to produce products according to engineers' specifications.

Some of the key benefits that AutoCAD offers engineers include:

1. Ability to create professional 2D and 3D drawings quickly and easily.
2. Flexibility to customise designs as needed.
3. Ease of use, with a wide range of features that are easy to learn and use.

4. Wide compatibility with other CAD software applications, making it easy to share

AutoCAD is an extremely versatile tool that can be used for a wide range of purposes, such as designing buildings and bridges, creating detailed electrical schematics, or mocking up product prototypes. Its user-friendly interface and vast array of features make it an essential tool for any engineer or architect.

Introduction to Installation of AutoCAD

AutoCAD is a Computer-Aided Drafting (CAD) software application built by Autodesk. It helps to create both 2D (Two dimensional) and 3D(Three-Dimensional) models of solid as well as mesh surfaces which helps engineers, architects, drafters, and other designing professionals to design the models instead of using manual hand drafting tools like pencils, rulers, compasses, drafting boards, etc. These conventional methods are time-consuming as well as not accurate. Since its release in 1982, AutoCAD has been widely used for its accuracy, robust features, and automated drafting tools. AutoCAD helps you design and create the models, transform that models into 3D model renderings, and create animated presentations.

AutoCAD provides many built-in layouts for users. This built-in layout contains various types of templates that are used for architectural planning and constructing buildings. In this article, we will see the steps to install AutoCAD on the Windows system so that we can use that to create designs.

How to Install AutoCAD on Windows Free?

AutoCAD offers several subscription plans that cater to different needs and budgets.

AutoDesk offers free educational access to AutoCAD for students and educators through their AutoCAD for Students and Educators program.

https://www.educba.com/install-autocad/

Steps to Install AutoCAD on the Windows system are given as follows:

Step 1: Access the Autodesk website
Use web browsers like Google Chrome, Mozilla Firefox, etc. Then Go to the AutoCAD official website by using this link: https://www.autodesk.com.

Step 2: Select Students and Educators from the Menu drop-down list.
It will give you three options, i.e. free trials, students and educators, and worldwide sites. Here I am selecting the students and educators option.

Step 3: You will see Get set up for career success with the Autodesk tab. Click Start now under the Download free software option from that tab.

Step 4: It will list Autodesk products like 3DS Max, Maya, AutoCAD, etc. Under that, click on the AutoCAD option from the list.

Step 5: If you have registered, click Sign in, and the system will forward you to your Autodesk Login information. Otherwise, click Create Account and create a new account using your email ID.

Step 6: Select the version
After signing in, you can select the version of AutoCAD you want to download and install and Operating System: 32-bit or 64-bit.
Note: To check whether your operating system is 32-bit or 64-bit, go to Control Panel > System and Security > System. It will display whether you are running a 32 bits system or 64 bits system.

Then choose a language which is preferable.
The Serial number and product key will be displayed. Copy this information as required for activation after installing the software to authenticate the download.
Now click on download. You will see a prompt with a security warning from the download. In that prompt, click “Run” or “Ok” (which is applicable to continue the download process), as Autodesk products are relatively secure.

Step 7: License and Services Agreement
After that, you will see the “License and Services Agreement” Prompt. Read it carefully, click on the “I Accept” option, and click the next button to install AutoCAD on your Windows System.
The AutoCAD Download Manager will display. Moreover, This can take some time.

Step 8: After installing the manager, you will see an “Autodesk Download Manager” window. Specify the desired path where you want to save that file and click on OK.
The Autodesk Download Manager will be loading. This may take some time.

Step 9: After that, you will see a window where you can configure the Autocad installation process. However, here we give the path where you want to save the files.

Step 10: In the next window, select the Custom Option. Make sure all the features under the drop-down are checked.

Step 11: Then, the next window will prompt. Click on the Install option.

Step 12: After installing all the products and tools related to AutoCAD, Click on Finish.

Step 13: After the installation, you must provide a Product Key to further use AutoCAD.
In case you haven’t copied the Product Key previously, Sign in to your AutoDesk account on the website -> Click on your username -> Click on AutoDesk Account.

Step 14: Click on the “All Products and Services” option. This will show the products you have downloaded.

Step 15: Under the AutoCAD option, Click on the “More actions” drop-down -> click “Serial numbers”.

Now you can see the Serial Numbers and the Product Keys of all the products you downloaded. Copy this information and activate your Autodesk product.
Thus, now you can use AutoCAD software and design your models easily.

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to learn the Introduction to Auto CAD program in engineering fields. The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: AutoCAD Program in Engineering Fields

Teaching Strategies
Engage students in brainstorming exercise to define AutoCAD program in engineering fields.
Engage students to discuss the definitions AutoCAD program in engineering fields.

Learning Strategies
Discover different definitions of AutoCAD program in engineering fields.
Activity 1. Brainstorming activity on different definitions on AutoCAD program in engineering fields.
Activity 2.Conduct research on different definitions on AutoCAD program in engineering fields.
Activity 3 Discussions and presentation of research findings on AutoCAD program in engineering fields.

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Lesson 2: Types of AutoCAD Program in Engineering

Teaching Strategies
Engage students in brainstorming exercise the types of AutoCAD program in engineering.
Engage students to discuss the types of AutoCAD program in engineering.

Learning Strategies
Discover different types of AutoCAD program in engineering.
Activity 1 Brainstorming activity the types of AutoCAD program in engineering.
Activity 2. Conduct research on different types of AutoCAD program in engineering.
Activity 3. Discussions and presentation of research findings on types of AutoCAD program in Engineering.

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Lesson 3: Significance of AutoCAD Program in Engineering

Teaching Strategies
Engage students in brainstorming exercise on the Significant of AutoCAD program in engineering.
Engage students to discuss the significance of AutoCAD program in engineering.

Learning Strategies
Discover different significant of AutoCAD program in engineering.

Activity 1 Brainstorming activity on significance of AutoCAD program in engineering.
Activity 2. Conduct research on the significance of AutoCAD program in engineering.

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Lesson 4: Methods of Downloading and Application of AutoCAD Program

Teaching Strategies
Engage students in brainstorming exercise the methods of downloading and Application of AUTOCAD program.
Engage students to discuss the methods of downloading and application of AutoCAD program.

Learning Strategies
Discover different methods of downloading and Application of AutoCAD program.
Activity 1. Brainstorming activity on methods of downloading and Application AutoCAD Program.
Activity 2. Conduct research on the methods of methods of downloading and application of AutoCAD program.

Resources

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Notes in Appendix Section

STEAM Activity: Students work in groups to create an activity incorporating concepts to designing using AutoCAD/FreeCAD

Assessment

The main purpose of assessment is to find out if students can use the skill of synthesis the Types of AutoCAD program in engineering and its applications. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Define and describe AutoCAD program in engineering fields.
2. Analyse and define the types of AutoCAD program in engineering.
3. Analyse and describe the significance of AutoCAD program in engineering.
4. Methods of downloading and application AutoCAD program.

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
Define and describe AutoCAD program in engineering fields	Accurately and correctly define and describe AutoCAD program in engineering fields	Correctly define AutoCAD program in engineering fields	Partially define and describe AutoCAD program in engineering fields	Cannot define and describe AutoCAD program in engineering fields
Analyse and define the types of AutoCAD program in engineering	Accurately and correctly analyse and define the types of AutoCAD program in engineering	Correctly define the types of AutoCAD program in engineering	Partially analyse and define the types of AutoCAD program in engineering	Hard to Analyse and define the types of AutoCAD program in engineering
Analyse and describe the significant of AutoCAD program in engineering	Accurately and correctly analyse and describe the significance of AutoCAD program in engineering	Correctly describe the significance of AutoCAD program in engineering	Partially analyse and describe the significance of AutoCAD program in engineering	Hard to analyse and define the significance of AutoCAD program in engineering
Methods of downloading and Application AutoCAD program	Accurately and correctly use methods of downloading AutoCAD program	Correctly use methods of downloading AutoCAD program	Partially use methods of downloading AutoCAD program	Cannot use the methods of downloading AutoCAD program

UNIT 5: Engineering Technology

Content Standard 3.5. Investigate and analyse the historical and societal influences in Engineering by understanding the engineering principles, practices, the design process, the management, problem-solving and communication skills appropriate to any engineering field.

Benchmark 11.3.5.5 Describe the developments in technology and their impact in engineering products.

Topic 5: The Engineering Developments

Learning Objectives

By the end of this topic, the students will be able to;

1. Analyse and describe the methods on engineering development in specific fields.
2. Analyse and describe the Methods of process material from raw to finished product in specified engineering field including the types of equipment.

Essential Questions:

1. What are the methods of engineering development in specific fields?
2. What are the methods of processing material from raw to finished product in specified engineering field?
3. What are the types of equipment used in engineering?

Essential Knowledge, Skills, Values and Attitudes:
Knowledge: Engineering development and product
Skills: Apply the engineering development skills to create products.
Values: Appreciate the importance of engineering products in the developing world.
Attitudes: Apply rational approach to product development

Content Background

The Engineering Development and implication on products and equipment

Engineering developments of the 20th Century
Engineering gets most of its attention when things go wrong. Take tragic events such as the Chernobyl nuclear power plant disaster, the Exxon Valdez oil spill, the Tacoma Narrows Bridge collapse, and the Challenger and Columbia shuttle accidents. When engineering undertakings fail, they often do so tragically. Yet failure may be the true mother of invention; very often, grappling with malfunctions leads to creative insights and improvements. Engineering plays a vital role in construction, as engineers design and plan the buildings, roads, and other structures that make up our communities. They ensure that these structures are safe, efficient, and sustainable, while also considering the economic and social impact of their designs. It's the culmination of the work, passion, and grit of an entire group of professionals who can make this big change. Engineers are the silent leaders of modern society. They stimulate innovations and ensure the continuous flow of improvements in basically every facet of human life.

The greatest engineering developments of the 20th century.

1. Electricity
Thousands of engineers made this possible, as they developed fuel sources, power generating techniques, and transmission grids. Today, vast networks of electricity power the developed world. From streetlights to supercomputers, electric power makes our lives safer, healthier, and more comfortable.

2. The Automobile
Revolutionary manufacturing practices made cars more reliable and affordable to the masses, turning the automobile into the world's major mode of transportation and a symbol of personal freedom. Even so many years later, automobiles remain a strong source of economic growth and stability. The automobile is a showcase of twentieth-century engineering ingenuity, with countless innovations made in design, production, and safety.

3. The Airplane
From the Wright Flyer to autonomous military jets, engineering creativity and ingenuity have propelled the airplane's evolution. This innovation has made the world more accessible, transporting both goods and people and spurring globalization.

4. Water Supply and Distribution
For communities, farms, households, and industries, a simple turn of the tap provides clean water — a precious and necessary resource. Engineering advances in water treatment, supply, and distribution systems have prevented the spread of waterborne diseases in developed nations and increased life expectancy.

5. Modern Electronics
Electronics — from vacuum tubes to transistors and integrated circuits — continue to shrink in size and grow in power and efficiency thanks to engineers. They underlie countless innovations, from portable DVD players to your cell phone, iPad, and other electronics, making modern life more convenient and more connected.

6. Radio and Television
These technologies have given us a window to other lives, different parts of the globe, and dramatic events that have defined the course of history. From the wireless telegraph to today's advanced satellite systems, engineers have transformed how the world receives information and entertainment.

7. Agricultural Mechanization
Farm machinery, including tractors, cultivators, and combines, have taken agricultural efficiency and productivity to a new level, leading to a vastly larger, safer, and more affordable food supply.

8. Computers
A defining symbol of twentieth-century technology, the computer impacted businesses and lives on a global scale, eliminating many menial tasks and enabling new functions. Engineering ingenuity fueled this revolution and continues to produce faster, stronger, and more affordable computers every day.

9. The Telephone
This cornerstone of modern life has transformed the way the world communicates personally and in business. From switchboards and satellites to copper wire and fiber optics or the nearly instant Internet connections, engineers continue to answer the call for innovation.

10. Air Conditioning and Refrigeration
Dozens of engineering innovations underpin this breakthrough. Delivering much more than convenience, it extends the shelf life of food and medicines, protects electronics, and plays an important role in healthcare delivery.

11. Highways
The construction of 44,000 miles of U.S. highway in the twentieth century is one of the most impressive achievements of that era, allowing for the distribution of goods and personal mobility. Thousands of engineers built the roads, bridges, and tunnels that connect our communities.

12. Spacecrafts
Humanity's horizons have been immeasurably expanded thanks to our forays into outer space. Further, the space program has inspired tens of thousands of new products and services on Earth, including medical devices, sophisticated weather forecasting, and wireless communications. From early test rockets to sophisticated satellites, the human expansion into space is perhaps the most amazing engineering feat of the twentieth century.

13. The Internet
Developed through a series of engineering innovations, the Internet is now a global communication and information system of unparalleled access, redefining business practices, educational pursuits, and personal communication. What began as a tool to link research center computers is now a vital instrument of social change.

14. Imaging Technology
Twentieth-century imaging technologies have afforded us amazing new views inside the human body — revolutionizing medical diagnostics — and beyond, of the ocean floors, our planet, and distant galaxies.

15. Household Appliances
Relieving much of the labor of everyday tasks, these devices, including electric ranges, vacuum cleaners, dishwashers, and dryers, have made such tasks easier, more efficient, and less time-consuming, leading to an increase in people working outside the home.

16. Health Technologies
The mass production of antibiotics and artificial implants have led to astounding health improvements. Such engineered products — from artificial organs, replacement joints, imaging technologies, and biomaterials — can be credited with improving the quality of life of millions.

17. Petroleum and Petrochemical Technologies
Propelled by engineering advances in oil exploration and processing, petroleum products have had an enormous impact on modern life. While petroleum provides fuel for cars, homes, and industries, of course, petrochemicals are used in products ranging from aspirin to zippers.

18. Laser and Fiber Optics

Pulses of light from lasers are applied to industrial tools, non-invasive surgical devices, satellites, and other products. Highly pure glass fibers now provide the infrastructure to carry information via laser-produced light. And a single fiber-optic cable can enable almost-simultaneous worldwide communication and media.

19. Nuclear Technologies
The harnessing of the atom gave us a new source of electric power and new capabilities in medical research and imaging. Although controversial, the engineering work that went into the creation of nuclear technologies remains one of the most significant achievements of the previous century.

20. High-performance Materials
From the building blocks of iron and steel to the latest advances in polymers, ceramics, and composites, engineers have customized and enhanced properties, creating higher-quality, lighter, stronger, and more adaptable materials for thousands of applications, including aircraft, medical devices, and computers.
Engineering plays a crucial part in every product, every gadget, every system people use in their daily lives. Bridges, cars, phones, computers, aircraft – all are designed and produced by engineers. Most people aren't familiar with the work engineers do, because if it's working, it is not noticed. The smooth running of everything from computer systems to traffic lights is all down to engineers. Engineers work primarily in innovation: either designing a brand new product or improving an existing one. These engineering innovations go on to make our lives easier, more comfortable, or productive. Creative solutions to everyday problems are often at the heart of engineering .

Teaching and Learning Strategies

Teachers are encouraged to introduce students to simulations to better understand the concepts taught. Therefore students will learn effectively and master the knowledge prescribed in each topic. Whilst introducing the topic, guided discovery and research will enable students to get an understanding to the Engineering Development and implication on products and equipment .The knowledge prescribed must be taught. It is not only about teaching what students should know but also to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support teaching and learning. Students must be given opportunities to apply their knowledge, to be creative and to solve problems.

Lesson 1: Methods on Engineering Development in Specific Fields

Teaching Strategies
Engage students in brainstorming exercise the methods on engineering development in specific fields.
Engage students in the discussion of the methods on engineering development in specific fields.
Discover different methods on engineering development in specific fields.

Learning Strategies
Activity 1 Brainstorming activity on different methods on engineering development in

specific fields.

Activity 2. Conduct research on different methods on engineering development in specific fields.

Activity 3. Discussions and presentation of research findings on methods on engineering development in specific fields.

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Lesson 2: Methods of Process Material from Raw to Finished Product in Specified Engineering Field

Teaching Strategies

Engage students in brainstorming exercise the methods of process material from raw to finished product in specified engineering field.

Engage students in the discussion of the methods of process material from raw to finished product in specified engineering field.

Learning Strategies

Discover different methods of process material from raw to finished product in specified engineering field

Activity 1 Brainstorming activity the methods of process material from raw to finished product in specified engineering field

Activity 2. Conduct research on different methods of process material from raw to finished product in specified engineering field

Activity 3. Discussions and presentation of research findings on methods of process material from Raw to finished product in specified engineering field

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Lesson 3: Types of Equipment used in Engineering

Teaching Strategies

Engage students in brainstorming exercise the types of equipment used in engineering.

Engage students in the discussion of the types of equipment used in engineering.

Learning Strategies

Discover different types of equipment used in engineering.

Activity 1 Brainstorming activity on the Types of equipment used in engineering.

Activity 2. Conduct research on the types of equipment used in engineering.

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STEAM Activity: Students work in groups to create an activity incorporating engineering developments.

Assessment

The main purpose of assessment is to find out if students can use the skill of synthesis to assess technology systems. Assessment should be linked to the performance indicator indicated in the lesson plan and the lesson objective.

Performance Assessment

1. Analyse and describe the methods on Engineering Development in specific fields,
2. Analyse and describe the Methods of process material from Raw to finished product in specified engineering field
3. State and describe the types of equipment used in engineering

Performance Assessment Scoring

Assessment can be scored using a rubric (analytical rubric), checklists, or rating scales.

Performance Standard/Criteria	Advanced	Meet Standard	Progressing	Not Yet
Analyse and describe the methods on Engineering Development in specific fields,	Accurately and correctly analyse and describe the methods on Engineering Development in specific fields,	Correctly analyse and describe the methods on Engineering Development in specific fields,	Partially analyse and describe the methods on Engineering Development in specific fields,	Cannot analyse and describe the methods on Engineering Development in specific fields,
Analyse and describe the Methods of process material from Raw to finished product in specified engineering field	Accurately and correctly analyse and describe the Methods of process material from Raw to finished product in specified engineering field	Correctly analyse and describe the Methods of process material from Raw to finished product in specified engineering field	Partially analyse and describe the Methods of process material from Raw to finished product in specified engineering field	Cannot analyse and describe the Methods of process material from Raw to finished product in specified engineering field
State and describe the types of equipment used in engineering	Accurately and correctly state and describe the types of equipment used in engineering	Correctly state and describe the types of equipment used in engineering	Partially state and describe the types of equipment used in engineering	Cannot state and describe the types of equipment used in engineering

Planning and Programming

The 8 steps in Planning and Programming Process

1. **This planning and programming sample is using grade 9 content but the steps described here will be applied to plan and program grade 10 content.** Identify the number of Strands and Units in the subject Syllabus
2. Identify the total number of Content Standards, Benchmarks and Number of Topics (Syllabus and Teacher Guide)
3. Consider the Facts and Considerations in the Planning and Programming Process (subject related)
4. Distribute the Content evenly across the 4 school terms in a Matrix (Proposed Template)
5. Expand and plot the distributed content into the complete Yearly Content Overview for the subject for the grade (Proposed Template)
6. Develop the Termly Programs (Proposed Template)
7. Develop the Weekly Teaching Program (Proposed Template) Daily Lesson Plan (SBC Template
8. Review, Evaluate and Re-plan the yearly, termly, weekly Programs

Planning and Programming Process

The Planning and Programming Process used by the Business and Technology Subjects is an 8 step process. This process begins from Unpacking the Content Standards and Benchmarks and ends with planning a daily lesson plan.

Step 1: Identify the number of Strands and Units in the subject Syllabus
Step 2: Identify the total number of Content Standards, Benchmarks and Number of Topics (Syllabus and Teacher Guide)
Step 3: Consider the Facts and Considerations in the Planning and Programming Process (subject related)
Step 4: Distribute the Content evenly across the 4 school terms in a Matrix (Proposed Template)
Step 5: Expand and plot the distributed content into the complete Yearly Content Overview for the subject for the grade (Proposed Template)
Step 6: Develop the Termly Programs (Proposed Template – 3 part programme)
Step 7: Develop the Weekly Teaching Program (Proposed Template) Daily Lesson Plan (SBC Template)
Step 8: Review, Evaluate and Re-plan the yearly, termly, weekly Programs

TECHNOLOGY AND INDUSTRIAL ARTS PLANNING AND PROGRAMMING PROCESS

Planning and Programming Process involves 8 steps.

Step 1: Identify the number of Strands and Units in the subject Syllabus.

It is important to first identify the strand and unit names for familiarisation and also the number of benchmarks in Grade 11 Construction Technology.

Construction Technology has 5 Units

Table of Strands and Units

The table below outlines the strand and units for Grade 11 Construction Technology subject. This helps teachers understand how to deal with units per strand when they are expanded into evidence outcomes and benchmarks at each grade.

The Strands, Units are outlined in the table below:

Step 1: Identify the number of Strands and Units in the subject Syllabus

STRANDS	UNITS
	Building Technology
	Electrical Technology
	Plumbing Technology
	Welding Technology
	Engineering Technology

Timetabling of Construction Technology as a standalone elective. (Subject)

The teaching and learning of Construction Technology can be organised to be taught in a year by the Practical Skills Teacher.

Programming can be done using sequential and integration programming.

Stand: Construction Technology	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
Benchmarks	6	6	4	6	5
Total Benchmarks	27				

1. Calculate the total number of Benchmarks for the strand.
2. Divide the total number of Benchmarks by the number of weeks in the term.

3. Distribute the number of benchmarks throughout the weeks.
4. For Construction Technology Grade 11, the total number of Benchmarks is 27 and will be divided by 4 terms in a year. This would be 6-7 Benchmarks in a term.

1. The Integration programming involves the teaching of the Construction Technology within a term. All the benchmarks (BM) are distributed by weeks. In grade 11, there are 27 Benchmarks for all the units.
1. Collect the total number of Benchmarks for the grade.
2. Divide the total number of Benchmarks by the number of terms.
3. Distribute the 27 Benchmarks to the 4 terms, indicate the Units by the weeks as they are programmed by using themes and or core curriculum eg Safety, technical drawings

Standards-Based Lesson Planning

What are Standards-Based Lessons?

In a Standards-Based Lesson, the most important or key distinction is that, a student is expected to meet a defined standard for proficiency. When planning a lesson, the teacher ensures that the content and the methods of teaching the content enable students to learn both the skills and the concepts defined in the standard for that grade level and to demonstrate evidence of their learning.

Planning lessons that are built on standards and creating aligned assessments that measure student progress towards standards is the first step teacher must take to help their students reach success. A lesson plan is a step-by-step guide that provides a structure for an essential learning.

When planning a standards-based lesson, teachers instructions are very crucial for your lessons. How teachers instruct the students is what really points out an innovative teacher to an ordinary teacher. Teachers must engage and prepare motivating instructional activities that will provide the students with opportunities to demonstrate the benchmarks. For instance, teacher should at least identify 3-5 teaching strategies in a lesson; teacher lectures, ask questions, put students into groups for discussion and role play what was discussed.

Why is Standards-Based Lesson Planning Important?

There are many important benefits of having a clear and organised set of lesson plans. Good planning allows for more effective teaching and learning. The lesson plan is a guide and map for organising the materials and the teacher for the purpose of helping the students achieve the standards. Lesson plans also provide a record that allows good, reflective teachers to go back, analyse their own teaching (what went well, what didn't), and then improve on it in the future.

Standards-based lesson planning is vital because the content standards and benchmarks must be comparable, rigorous, and measurable and of course evidence based and be applicable in real life that we expect students to achieve. Therefore, teachers must plan effective lessons to teach students to meet these standards. As schools implement new standards, there will be much more evidence that teachers will use to support student learning to help them reach the highest levels of cognitive complexity. That is, students will be developing high-level cognitive skills.

Components of a Standards-Based Lesson Plan

An effective lesson plan has three basic components;

- aims and objectives of the course;
- teaching and learning activities;
- assessments to check student understanding of the topic.

Effective teaching demonstrates deep subject knowledge, including key concepts, current and relevant research, methodologies, tools and techniques, and meaningful applications.

Planning for under-achievers

Who are underachieving students?

Under achievers are students who fail or do not perform as expected. Underachievement may be caused by emotions (low self-esteem) and the environment (cultural influences, unsupportive family)

How can we help underachievement?

Underachievement varies between students. Not all students are in the same category of underachievement.

Given below a suggested strategies teachers may adopt to assist underachievers in the classroom.

- Examine the Problem Individually

It is important that underachieving students are addressed individually by focusing on the student's strengths.

- Create a Teacher-Parent Collaboration

Teachers and parents need to work together and pool their information and experience regarding the child. Teachers and parents begin by asking questions such as;

- In what areas has the child shown exceptional ability?
- What is the child's preferred learning styles?
- What insights do parents and teachers have about the child's strengths and problem areas?

- Help student to plan every activity in the classroom
- Help students set realistic expectations
- Encourage and promote the student's interests and passions.
- Help children set short and long-term academic goals
- Talk with them about possible goals.
- Ensure that all students are challenged (but not frustrated) by classroom activities
- Always reinforce students

To help teachers plan effective lessons, there are sample lessons provided here. Teachers are encouraged to study the layout of the different components of these lessons and follow this design in their preparation and teaching of each lesson. Planning a good lesson helps the teacher in maintaining a standard teaching pattern and does not let the class deviate from the topic.

Sample of Standards-Based Lesson Planning

The following sample lesson can help teachers to plan effective lessons. Teachers are encouraged to study the layout of the different components of these lessons and follow this design in their preparation and teaching of each lesson. Planning a good lesson helps the teacher in maintaining a standard teaching pattern which should not deviate students' learning of the concept from the topic.

Strand: Construction Technology

UNIT 1. Building Technology

Content Standard 3.1. Investigate the history and theory of buildings and analyse the components and systems of buildings, occupational health and safety procedures, the properties of building materials and the processes in which those materials and equipment are used according to industry standards.

Benchmark 11.3.1.1 Explore and analyse the main fundamental of building project management

Topic 1: Introduction Building project managemen
Lesson 1: Building project management

Lesson Objective: Students will be able to:

1. Research the definition of building project management and outline the terminologies used in building system.
2. Research and analyse the other terminologies used in building project management flow chart and processes .

Essential Knowledge, Skills, Values and Attitudes

Knowledge	Skills	Values	Attitudes
• Project Management	Research and analysis	Appreciate	Rationality

Teaching Strategies
Students engage in brainstorming exercise to discover the Definitions of building project management and explain the functions and principals of building project management
They then are allowed to design guiding questions that will enable them to conduct research on the Definitions of building project management
Discussions in groups on the research findings.

Learning Strategies
Be involved in brainstorming exercise to discover definitions of building project management and other terminologies used on building management flow chart.

Teacher	Students
Introduction	
Pose the question for discussion. What is a building project in general	General discussions on building projects
Body	
Modelling	
Activity 1 Discuss all types of projects that can be undertaken in construction.	Do brainstorming activity
Guided Practice	
Activity 2 Plan and carry out Research activity	Conduct research
Independent Practicce	
Activity 3 Group Presentation of research activity on project management.	Group presentation
Conclusion	
Conclude lesson with main concepts being explained	Take lesson notes
Assessment	
Assess the research and presentation activity	Complete assessment task.

Resources

1. Flowcharts of project management

2. Library resources

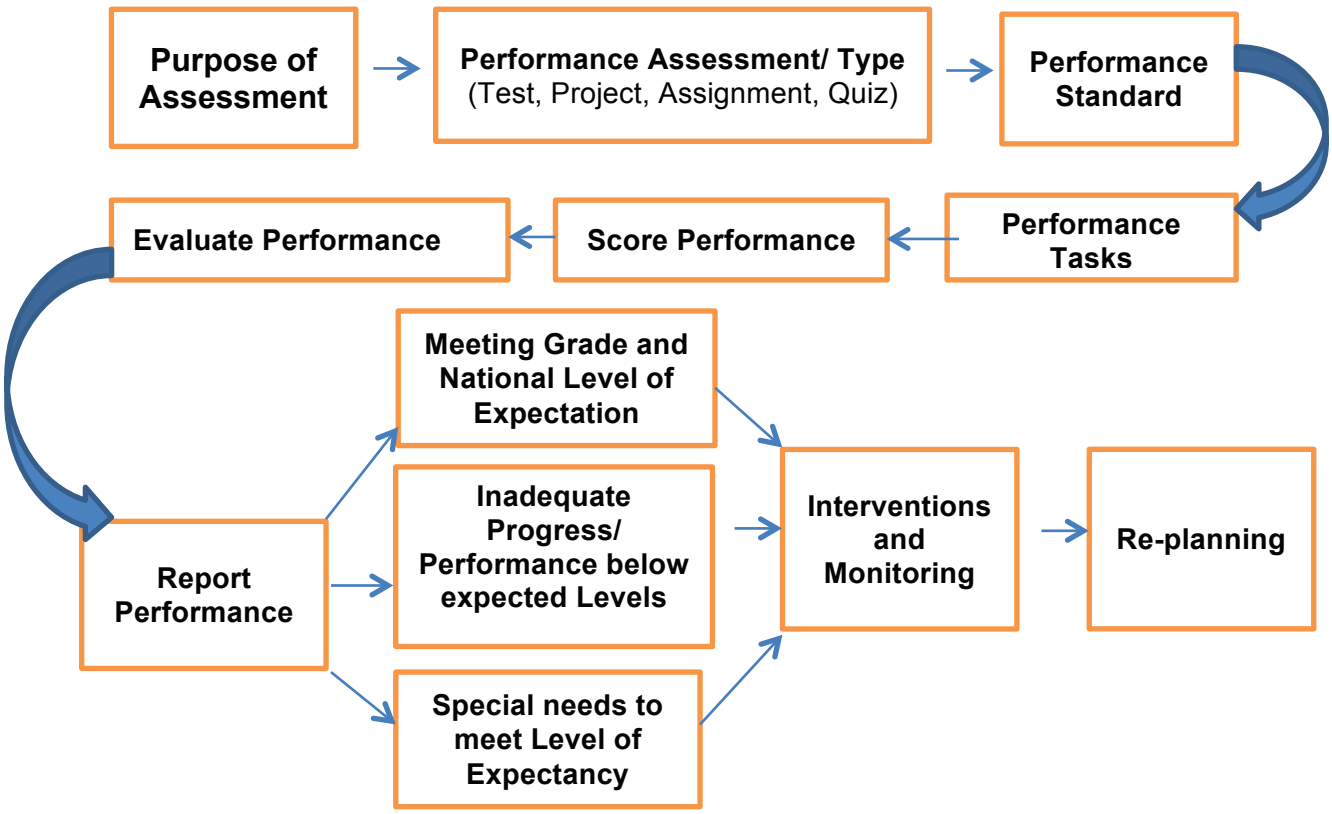
Assessment, Monitoring and Reporting

What is Standards-Based Assessment (SBA)?

Standards-Based Assessment is an on-going and a systematic process of **assessing**, **evaluating, reporting** and **monitoring** students' performance and progression towards meeting grade and national level expectations. It is the measurement of students' proficiency on a learning objective of a content standard and progression towards the attainment of that content standard and benchmark.

Standards-Based Assessment Cycle

The Standards-Based Assessment Cycle begins with the purpose to assess learning. Teachers must always clearly define the purpose and expectations of the assessment tasks or activities before starting the assessment. The cycle consist the delivery of the assessment, scoring of performance, monitoring or learning, evaluating learning and performance, reporting of achievement and underachievement, developing interventions for underachievers and advance learners and replanning assessment as demonstrated below;



Purpose of Standards-Based Assessment

Standards-Based Assessment (SBA) serves different purposes. These include instruction and learning purposes. The primary purpose of SBA is to improve student learning so that all students can attain the expected level of proficiency or quality of learning.

Enabling purposes of SBA is to:

- measure students' proficiency on well-defined content standards, benchmarks and learning objectives.
- ascertain students' attainment or progress towards the attainment of specific component of a content standard.
- ascertain what each student knows and can do and what each student needs to learn to reach the expected level of proficiency.
- enable teachers to make informed decisions and plans about how and what they would do to assist weak students to make adequate progress towards meeting the expected level of proficiency.
- enable students to know what they can do and help them to develop and implement strategies to improve their learning and proficiency level.
- communicate to parents, guardians, and relevant stakeholders the performance and progress towards the attainment of content standards or its components.
- compare students' performances and the performances of other students.

Principles of Standards-Based Assessment

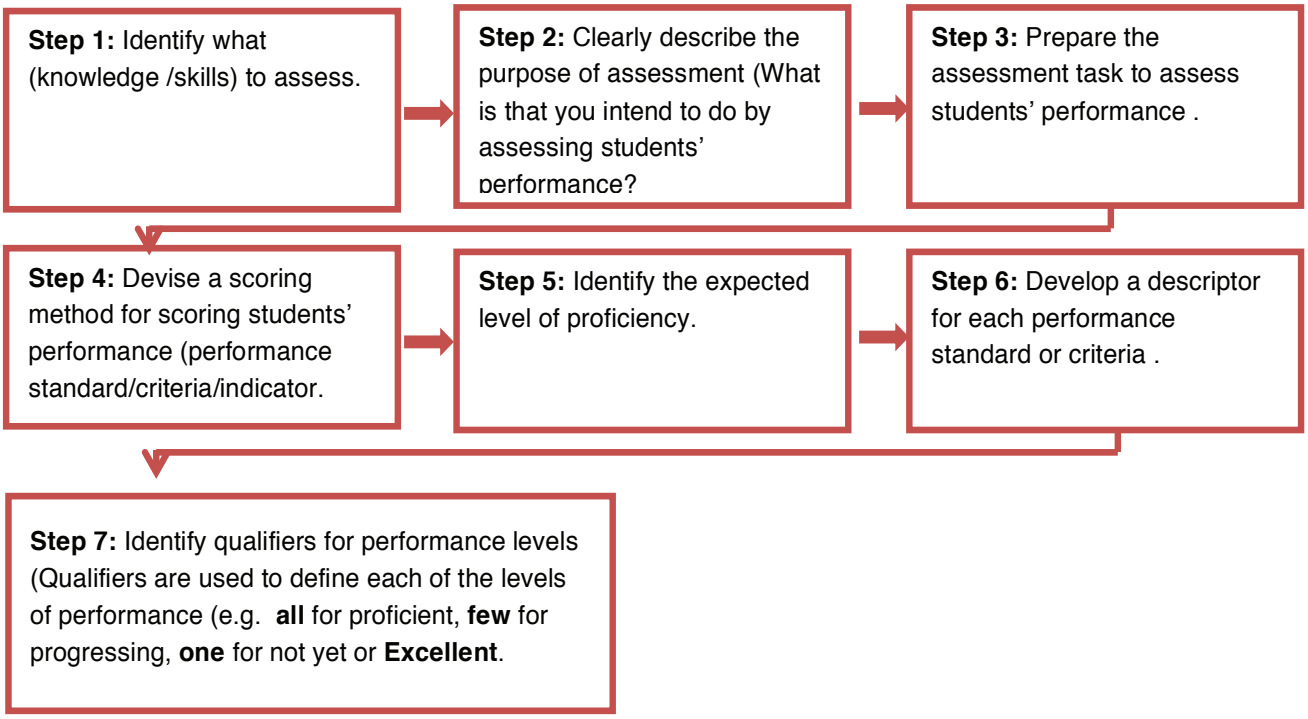
The principle of SBA is for assessment to be;

- emphasing on tasks that should encourage deeper learning,
- be an integral component of a course, unit or topic and not something to add on afterwards,
- a good assessment requires clarity of purpose, goals, standards and criteria,
- of practices that should use a range of measures allowing students to demonstrate what they know and can do,
- based on an understanding of how students learn,

- of practices that promote deeper understanding of learning processes by developing students' capacity for self-assessment,
- improving performance that involves feedback and reflection,
- on-going rather than episodic,
- given the required attention to outcomes and processes,
- be closely aligned and linked to learning objectives, benchmarks and content standards.

Standards-Based Assessment Process

Teachers are required to use the steps outlined below when planning assessment. These steps will guide you to develop effective assessments to improve student's learning as well as evaluating their progress towards meeting national and grade –level expectations.



Authentic Assessment

Authentic Assessments in Standards-based Assessment directly measure student's performance through "real life tasks" or "situations" that resemble "real life situations." Authentic assessment;

- Is performed in a real life context that approximates as much as possible, the use of a skill or concept in the real world.
- Is based on the development of a meaningful *product, performance or process*
- Students develop and demonstrate the application of their knowledge, skills, values and attitudes in real life situations which promote and support the development of deeper levels of understanding.
- Is mostly associated with assessment as or while learning and assessment for learning but occasionally or contextually in summative learning.
- includes assessment activities such as demonstrations, debates, field work, simulations, problem solving, project-based learning, Poster Presentations, Research, Laboratory work, Reflections, Problem-based activities, Role Play, Report/Essay, Field experience, Field report, Recounts etc.

Advantages of Authentic Activities

- Empower students to take ownership in their learning
- Appreciates Learning experience
- enables and encourages the Learning experiences to be used as a basis of learning
- Meaningful, relevant, practical
- Assess the actual learning experience which means; you do not need to "teach" and then assess, rather you assess actual learning experience while it is actually happening

Authentic Assessment Criteria

In standards-based Assessment, teachers are encouraged to step out of their traditional assessment and explore authentic assessment. The criteria in authentic assessment;

- Looks at students actively engaged in completing a task that represents the achievement of a learning objective or standard
- Takes place in real life situations
- Asks students to apply their knowledge, skills, values and attitudes in real life situations
- Students are given the criteria against which they are being assessed

A Comparison of Authentic and Traditional Assessment

Authentic Assessments	**Traditional Assessments**
• Portfolios, demonstrations, field work, case studies, assignments, lab reports • Students take an active role in process • Qualitative • Interpretive • Focuses on performance, process and product • High level thinking • Use of rubric • Use of criterion levels evaluation • Part of teaching and learning Process • Shows mastery and learning performance • Generally extends over time •	• Multiple choice tests, true-false, fill in the blanks, sentence completion, matching, diagram completions • External –(teacher driven – assessing performance of teacher rather than the student) • Teacher-centered (what is appropriate and convenient for the teacher and what teacher thinks is good for students and decides what should be and should not be learnt) • Quantitative (driven to collect marks) • Objective • End product (only looking for the end product and not concerned about the performance and process) • Standardised or norm referenced • Isolated facts • Low level content • Generally occurs in “one setting

Standards-Based Assessment Types

In standards-Based Assessment, there are three broad assessments types.

1. Formative Assessment

Formative assessment includes ‘assessment *for* and *as’* and is conducted during the teaching and learning of activities of a topic.

Purposes of assessment for Learning

- On-going assessment that allows teachers to monitor students on a day-to-day basis.

- Provide continuous feedback and evidence to the teachers that should enable them to identify gaps and issues with their teaching, and improve their classroom teaching practice.
- Helps students to continuously evaluate, reflect on, and improve their learning

Purposes of assessment as Learning

- Occurs when students reflect on and monitor their progress to inform their future learning goals
- Helps students to continuously evaluate, reflect, and improve their own learning
- Helps students to understand the purpose of their learning and clarify learning goals

2. Summative Assessment

Summative assessment focuses on '*assessment of learning'* and is cconducted after or at the conclusion of teaching and learning of activities or a topic.

Purposes of assessment of Learning

- Help teachers to determine what each student has achieved and how much progress he/she has made towards meeting national and grade-level expectations
- Help teachers to determine what each student has achieved at the end of a learning sequence or a unit.
- Enable teachers to ascertain each student's development against the unit or topic objectives and to set future directions for learning.
- Help students to evaluate, reflect on, and prepare for next stage of learning

Performance Assessment

Performance assessment is a form of testing that requires students to perform a task rather than select an answer from a ready-made list. For example, a student may be asked to explain historical events, generate scientific hypotheses, solve math problems, converse in a foreign language, or conduct research on an assigned topic. Teachers, then judge the quality of the student's work based on an agreed-upon set of criteria. It is an assessment which requires students to demonstrate that they have mastered specific skills and competencies by performing or producing something.

Types of performance assessment;

I. Products-Oriented

This refers to concrete tangible items that students create through either the visual, written or auditory media such as;

- Creating a health/physical activity poster
- Video a class game or performance and write a broadcast commentary
- Write a speech to be given at a school council meeting advocating for increased time for health and physical education in the curriculum
- Write the skill cues for a series of skill photo's
- Create a brochure to be handed out to parents during education week
- Develop an interview for a favourite sportsperson
- Write a review of a dance performance
- Essays
- Projects

II. *Process-Oriented Tasks*

It shows the thinking processes and learning strategies students use as they work such as;

- Survival scenarios
- Problem solving initiative/adventure/ activities
- Decision making such as scenario's related to health issues
- Event tasks such as creating a game, choreographing a dance/gymnastics routine, creating an obstacle course
- Game play analysis
- Peer assessment of skills or performances
- Self-assessment activities
- Goal setting, deciding a strategy and monitoring progress towards achievement

III. *Performances-Oriented*

It deals with observable affective or psycho-motor behaviours put into action such as;

- Skills check during game play
- Role plays
- Officiating a game
- Debates
- Performing dance/gymnastics routines
- Teaching a skill/game/dance to peers

Performance Standards

Performance standards are measurement standards that are observed through evidence outcomes and performance indicators. Evidence outcomes and Performance Indicators are used to measure students' performances, proficiency, competency, progression and achievement of the desired grade or level of expectation.

Performance Standards are concrete statements of how well students must learn what is set out in the content standards and benchmarks, often called the "be able to do" of "what students should know and be able to do." Performance standards indicate the quality that specifies how competent a students' demonstration or performance must be. They include explanations of how well students must demonstrate the content, explaining "how good is good enough."

Performance standards:

- measure students' performance and proficiency (using performance indicators) in the use of a specific knowledge, skill, value, or attitude in real life or related situations
- provide the basis (performance indicators) for evaluating, reporting and monitoring students' level of proficiency in use of a specific knowledge, skills, value, or attitude
- are used to plan for individual instruction to help students not yet meeting expectations (desired level of mastery and proficiency) to make adequate progress towards the full attainment of benchmarks and content standards
- are used as the basis for measuring students' progress towards meeting grade-level benchmarks and content standards
- A stem statement for Performance Standards will begin with…."Students will be able to……"
- A stem statement for Performance Indicator will begin with …."Students can be able to……."

Assessment Strategies

It is important for teachers to know that, assessment is administered in different ways. Assessment does not mean a test only. There are many different ways to find out about student's strengths and weaknesses. Relying on only one method of assessing will not reflect student's achievement.

Provided in the appendices is a list of suggested strategies you can use to assess student's performances. These strategies are applicable in all the standards-based assessment types. ***Please refer to the Appendices to see the suggested strategies.***

Action Verbs to Assessment Strategies		
Cognitive Learning	**Action Verbs**	**Assessment Strategies**
Knowledge - to recall or remember facts without necessarily understanding them	Arrange, define, duplicate, label, memorise, name, order, recognise, relate, recall, reproduce, list, tell, describe, identify, show, label, collect, examine, tabulate, quote	• Prior knowledge inventory, misconception/preconception check • Focused listing, empty outlines • Pre-post test, quiz, quick poll
Comprehension – to understand and interpret learned information	Classify, describe, discuss, explain, express, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend, translate, review, restate, locate, recognise, report	• Minute paper, muddiest (or clearest) point • Observe and evaluate a student artifact or performance task using a rubric • Directed paraphrasing • Pre-post test, quiz • Interviews
Application – to put ideas and concepts to work in solving problems	Apply, choose, demonstrate, dramatise, employ, illustrate, interpret, operate, practice, schedule, sketch, solve, use, calculate, complete, show, examine, modify, relate, change, experiment, discover	• Observe and evaluate a student artifact, performance, or task using a rubric • Directed paraphrasing, real-world application (apply learning in a new context) • Test, quiz • Job/internship evaluation, skill ratings
Analysis – to break information into its components to see interrelationships and ideas	Analyse, appraise, calculate, categorise, compare, contrast, criticise, differentiate, discriminate, distinguish, examine, experiment, question, test, separate, order, connect, classify, arrange, divide, infer	• Pro and con grid, categorizing grid, compare and contrast, concept maps • Observe and evaluate a student artifact, performance, or task using a rubric • Journaling • Job/internship evaluation, skill ratings

Evaluation – to judge the value of information based on established criteria	Appraise, argue, assess, attach, defend, judge, predict, rate, support, evaluate, recommend, convince, judge, conclude, compare, summarise	• Reflection component of a portfolio or experience • Journaling • Peer evaluation
Affective Learning	appreciate, accept, attempt, challenge, defend, dispute, join, judge, praise, question, share, support	• Reflection component of a portfolio or experience • Journaling • Observe and evaluate group work • Surveys, interviews, focus groups

ASSESSMENT STRATEGIES

Strategy	Description
Analogies	Students create an analogy between something they are familiar with and the new information they have learned. When asking students to explain the analogy, it will show the depth of their understanding of a topic.
Classroom Presentations	A classroom presentation is an assessment strategy that requires students to verbalize their knowledge, select and present samples of finished work, and organize their thoughts about a topic in order to present a summary of their learning. It may provide the basis for assessment upon completion of a student's project or essay.
Conferences	A conference is a formal or informal meeting between the teacher and a student for the purpose of exchanging information or sharing ideas. A conference might be held to explore the student's thinking and suggest next steps; assess the student's level of understanding of a particular concept or procedure; and review, clarify, and extend what the student has already completed
Discussions	Having a class discussion on a unit of study provides teachers with valuable information about what the students know about the subject. Focus the discussions on higher level thinking skills and allow students to reflect their learning before the discussion commences.
Essays	An essay is a writing sample in which a student constructs a response to a question, topic, or brief statement, and supplies supporting details or arguments. The essay allows the teacher to assess the student's understanding and/or ability to analyse and synthesize information.
Exhibitions/Demonstrations	An exhibition/demonstration is a performance in a public setting, during which a student explains and applies a process, procedure, etc., in concrete ways to show individual achievement of specific skills and knowledge.
Interviews	An interview is a face-to-face conversation in which teacher and student use inquiry to share their knowledge and understanding of a topic or problem, and

	can be used by the teacher to explore the student's thinking; assess the student's level of understanding of a concept or procedure and gather information, obtain clarification, determine positions, and probe for motivations.
Learning Logs	A learning log is an ongoing, visible record kept by a student and recording what he or she is doing or thinking while working on a particular task or assignment. It can be used to assess student progress and growth over time.
Observation	Observation is a process of systematically viewing and recording students while they work, for the purpose of making programming and instruction decisions. Observation can take place at any time and in any setting. It provides information on students' strengths and weaknesses, learning styles, interests, and attitudes.
Peer Assessment	Assessment by peers is a powerful way to gather information about students and their understanding. Students can use set criteria to assess the work of their classmates.
Performance Tasks	During a performance task, students create, produce, perform, or present works on "real world" issues. The performance task may be used to assess a skill or proficiency, and provides useful information on the process as well as the product.
Portfolios	A portfolio is a collection of samples of a student's work, and is focused, selective, reflective, and collaborative. It offers a visual demonstration of a student's achievement, capabilities, strengths, weaknesses, knowledge, and specific skills, over time and in a variety of contexts.
Questions And Answers (Oral)	In the question–and-answer strategy, the teacher poses a question and the student answers verbally, rather than in writing. This strategy helps the teacher to determine whether students understand what is being, or has been, presented, and helps students to extend their thinking, generate ideas, or solve problems.
Quizzes, Tests,	A quiz, test, or examination requires students to respond to prompts in order

Examinations	to demonstrate their knowledge (orally or in writing) or their skills (e.g., through performance). Quizzes are usually short; examinations are usually longer. Quizzes, tests, or examinations can be adapted for exceptional students and for re-teaching and retesting.
Questionnaires	Questionnaires can be used for a variety of purposes. When used as a formative assessment strategy, they provide teachers with information on student learning that they can use to plan further instruction.
Response Journals	A response journal is a student's personal record containing written, reflective responses to material he or she is reading, viewing, listening to, or discussing. The response journal can be used as an assessment tool in all subject areas.
Selected Responses	Strictly speaking a part of quizzes, tests, and examinations, selected responses require students to identify the one correct answer. The strategy can take the form of multiple-choice or true/false formats. Selected response is a commonly used formal procedure for gathering objective evidence about student learning, specifically in memory, recall, and comprehension.
Student Self-Assessments	Self-assessment is a process by which the student gathers information about, and reflects on, his or her own learning. It is the student's own assessment of personal progress in terms of knowledge, skills, processes, or attitudes. Self-assessment leads students to a greater awareness and understanding of themselves as learners.

Scoring Methods for Performance Assessment

Assessment can be scored during or after the students have completed the assessment task. However, it is best done during a lesson- using a checklist, rating scales & rubrics.

A rubric is a coherent set of criteria for students' work that includes descriptions of levels of performance quality on the criteria. Rubrics have two major aspects: coherent sets of criteria and descriptions of levels of performance. Rubrics include;

(1) Descriptions of the of task
(2) The scales to be used
(3) The dimensions of the task
(4) The description of each dimension on the scale

A Rubric

- is a scoring guide that helps teachers evaluate student performance, based on a range of criteria.
- A rubric lists the criteria, or characteristics, that student work should exhibit and describes specific quality levels for those criteria.
- Rubrics are a great way to improve communication, learning, and grading fairness.
- Knowing how to create and use rubrics gives you a better understanding of assessment and another option for assessing student performance.
- are descriptive and not evaluative.
- Of course, rubrics can be used to evaluate, but the operating principle is to match the performance to the description rather than "judge" it.
- Thus rubrics are as good or bad as the criteria selected and the descriptions of the levels of performance under each.
- Effective rubrics have appropriate criteria and well-written descriptions of performance

Purpose of Rubrics

Like any other evaluation tool, rubrics are useful for certain purposes and not for others. *The main purpose of rubrics is to assess performances*. For some performances, you observe the student in the process of doing something, like using an electric drill or discussing an issue. For other performances, you observe the product that is the result of the student's work, like a finished bookshelf or a written report.

1. Support authentic assessment
While traditional tests measure how well students recall content, rubrics measure how well students can apply knowledge to authentic contexts or real-world tasks.

2. Clearly communicate expectations
Because rubrics define student "quality" in terms of objective criteria and standards, they clearly communicate how instructors will evaluate student performance.

3. Improve performance

Rubrics lead to better student performance. When students understand assignments and expectations before they begin, they are more likely to fulfil them. They know what specific criteria and standards of excellence will be used to rate their performance.

4. To inspire fairness
Because rubrics have detailed assessment information, students don't feel that grades are assigned subjectively or arbitrarily. Also, when you have more than one grader, a rubric allows all graders to apply the same criteria in the same way.

Although rubrics have many benefits--and make grading faster and easier--a good rubric takes time, effort and patience to construct. You'll probably need to change (change, not add to) your grading and assessment methods, based on what you believe about learning assessment. Rubrics are best for critical assessments, major projects, and other assignments that require a multi-dimensional performance evaluation. The trick is to know what type of rubric to create for your situation.

Reasons for Creating Rubrics/Marking schemes

Rubrics or marking schemes are created for;

1. Categories to assess-different components or elements that will assess

    - Factual information
    - Application
    - Analysis
    - Writing Skills

2. Criterion for assessment

    - Accuracy
    - Completeness
    - Length or number of examples
    - Supported with research
    - Range of answer
    - Description and support

3. Levels or points 3-5 levels

    - Exemplary. Proficient, acceptable, not acceptable
    - Excellent, good, fair, poor
    - 10 points, 5 points, 1 point

Parts of a Rubric

- A rubric is a matrix of criteria and their descriptors.

- The left side of a rubric matrix lists the **criteria (performance standards)** for the expected product or performance.
- Across the top of the rubric matrix is the **rating scale** that provides a set of values for rating the quality of performance for each criterion.
- **Descriptors** under the rating scale provide examples or concrete indicators for each level of performance.
- The dimensions of the task that **qualifies** the achievement

Criteria	Performance Standards (Descriptors)
BEYOND	**Beyond Standard (s) -*Advanced in Performance and Understanding***
	Consistently demonstrates advanced conceptual mathematical understandings Consistently generates tasks that make connections between and among mathematical ideas Consistently applies strategies to unique situations Consistently demonstrated confidence to approach tasks beyond the proficiency level for grade Consistently initiates mathematical investigations
CONSISTENT	**Meet Standard (s)-*Proficient in Performance and Understanding***
	Consistently demonstrates understanding of mathematical standards and cluster at the grade level Consistently demonstrated conceptual understanding Consistently applies multiple strategies flexibly in various situations Understands and fluently applies procedures with understanding Consistently demonstrates perseverance and precision Constructs logical mathematical arguments of thinking and reasoning Uses mathematical language correctly and appropriately
INCONSISTENT	**Progressing-*Not Yet Proficient in Performance and Understanding***
	Inconsistently uses tools appropriately and strategically Demonstrates inconsistent understanding of key mathematical ideas at grade level Demonstrates inconsistent conceptual understanding of key mathematical ideas at grade level Inconsistent in understanding and application of grade level appropriate strategies Depends upon assistance of teacher and/or peers to understand and complete tasks Needs additional time to complete tasks Applies models of mathematical ideas inconsistently
SELDOM	**Not Yet -*Limited Performance and Understanding***
	Exhibits minimal understanding of key mathematic ideas at grade level Rarely demonstrates conceptual understanding Seldom provides precise response Seldom use appropriate strategies Consistently requires assistance and alternative instruction Use tools inappropriately to model mathematics

Types of Rubrics

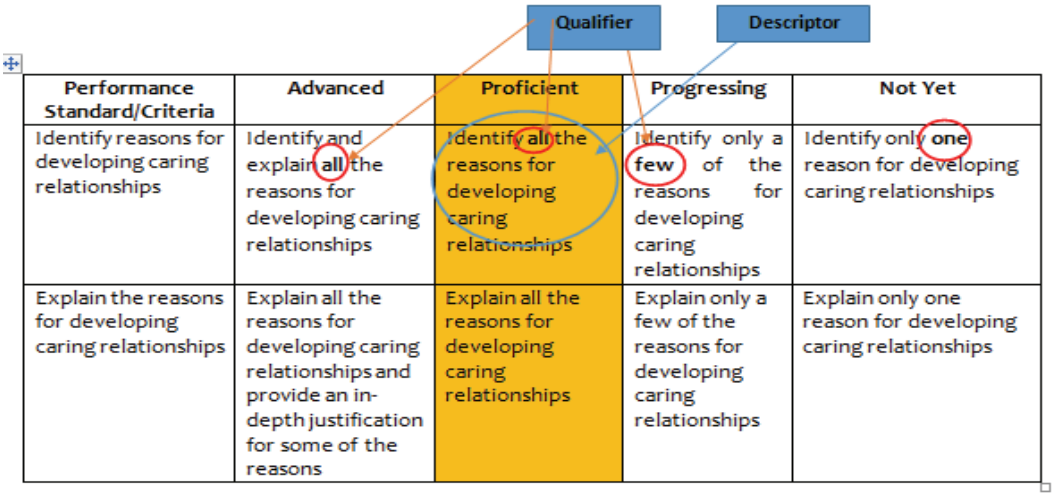
1. Analytic Rubric

Analytic rubrics describe work on each criterion separately. For most classroom purposes, analytic rubrics are best. Focusing on the criteria one at a time is better for instruction and better for formative assessment because students can see what aspects of their work need what kind of attention. Focusing on the criteria one at a time is good for any summative assessment (grading) that will also be used to make decisions about the future—for example, decisions about how to follow up on a unit or decisions about how to teach something next year.

Template for Analytic Rubrics

Criteria	Beginning	Developing	Accomplished	Exemplary	Score
Criteria 1	Description reflecting beginning	Description reflecting movement toward mastery level of performance	Description reflecting achievement of mastery level of performance	Description reflecting of highest level of performance	
Criteria 2	Description reflecting beginning level performance	Description reflecting movement toward mastery level of performance	Description reflecting achievement of mastery level of performance	Description reflecting of highest level of performance	
Criteria 3	Description reflecting beginning level performance	Description reflecting movement toward mastery level of performance	Description reflecting achievement of mastery level of performance	Description reflecting of highest level of performance	
Criteria 4	Description reflecting beginning level performance	Description reflecting movement toward mastery level of performance	Description reflecting achievement of mastery level of performance	Description reflecting of highest level of performance	

Sample Analytic Rubric



Performance Standard/Criteria	Advanced	Proficient	Progressing	Not Yet
Identify reasons for developing caring relationships	Identify and explain **all** the reasons for developing caring relationships	Identify **all** the reasons for developing caring relationships	Identify only a **few** of the reasons for developing caring relationships	Identify only **one** reason for developing caring relationships
Explain the reasons for developing caring relationships	Explain all the reasons for developing caring relationships and provide an in-depth justification for some of the reasons	Explain all the reasons for developing caring relationships	Explain only a few of the reasons for developing caring relationships	Explain only one reason for developing caring relationships

Holistic Rubrics

Holistic rubrics describe the work by applying all the criteria at the same time and enabling an overall judgment about the quality of the work. Holistic rubrics are based on criteria for good work and on observation of how the work meets those criteria.

One classroom purpose for which holistic rubrics are better than analytic rubrics is the situation in which students will not see the results of a final summative assessment and you will not really use the information for anything except a grade. Some high school final examinations fall into this category. Grading with rubrics is faster when there is only one decision to make, rather than a separate decision for each criterion.

Decide on type of rubric to be used (Holistic or Analytic)

1. When to use Holistic Rubric
    - There is no single correct answer/response to a task
    - The focus has no the overall quality, proficiency, or understanding of a specific content or skills.
    - You are assessing large numbers (eg. 150 portfolios)

Holistic Rubric						
Score	**5**	**4**	**3**	**2**	**1**	**0**
Description	Demonstrate **complete** understanding of the problem. **All** requirements of task are **included in response**.	Demonstrate **considerate** understanding of the problem. **All** requirements of task are **included**.	Demonstrate **partial** understanding of the problem. **Most** requirements of task are **included**.	Demonstrate **little** understanding of the problem. **Many** requirements of task are **missing**.	Demonstrate **no** understanding of the problem.	**No** response/ **not** attempted task

2. When to use Analytic Rubric
    - Several subjects are assessing the student work.
    - Description promote consistent scoring.
    - Stakeholders will be examining the rubric scores.
    - Substantial feedback to students or the subjects is desired.

Analytic Rubric				
Criteria	**4**	**3**	**2**	**1**
Criteria # 1	Description reflecting **highest** level of performance.	Description reflecting **mastery** level of performance.	Description reflecting **movement towards** mastery level of performance.	Description reflecting **beginning** level of performance.
Criteria # 2	Description reflecting **highest** level of performance.	Description reflecting **mastery** level of performance.	Description reflecting **movement towards** mastery level of performance.	Description reflecting **beginning** level of performance.
Criteria # 3	Description reflecting **highest** level of performance.	Description reflecting **mastery** level of performance.	Description reflecting **movement towards** mastery level of performance.	Description reflecting **beginning** level of performance.
Criteria # 4	Description reflecting **highest** level of performance.	Description reflecting **mastery** level of performance.	Description reflecting **movement towards** mastery level of performance.	Description reflecting **beginning** level of performance.

Scoring of Performance for Formative Assessment

(Assessment as/while learning and Assessment for learning)

1. Scoring Assessment using Rating Scale

Rating Scales are a type of checklists that judge the degree to which a criteria is met. They generally have a scale of between 1-6 options.

Types of Rating Scales

A. Frequency Rating Scales

A frequency rating scale scores how often a task is done to meet criteria.

Sample Rating Scale Descriptive Words

1. Words that describe the skill of ***selecting 'the right' information*** at varying levels of quality

Excellent	Proficient	Adequate	Limited
Pertinent	relevant	suitable	trivial
Insightful	meaningful	appropriate	superficial
Significant	relevant	predictable	vague
Perceptive	thoughtful	basic	questionable
Precise	logical	partially correct	confusing
Purposeful	focused	appropriate	irrelevant

2. Words that describe the skill of ***selecting 'enough' information*** at varying levels of quality.

Excellent	Proficient	Adequate	Limited
comprehensive	thorough	cursory	superficial
in-depth	sufficient	partial	incomplete
rich & detailed	specific	simplistic	undeveloped
Extensive	substantial	partial	sketchy

3. Words that describe the skill of ***evaluating product or connecting insights to personal experience*** at varying levels of quality

Excellent	Proficient	Adequate	Limited
insightful	thoughtful	predictable	trivial
astute	relevant	appropriate	unfocused
perceptive	thoughtful	routine	trivial
intuitive	logical	rudimentary	unsubstantiated
innovative	credible	predictable	trite
compelling	meaningful	obvious	tenuous

4. Words that describe the skill of ***designing or constructing*** at varying levels of quality

Excellent	Proficient	Adequate	Limited
efficient	practical	viable	unworkable
innovative	effective	workable	ineffective

5. Words that describe the skill of ***organizing or formatting information*** at varying levels of quality

Excellent	Proficient	Adequate	Limited
skillful	systematic	simplistic	haphazard
purposeful	logical	methodical	disorganised

6. Words that describe the skill of ***analyzing information or data*** at varying levels of quality

Excellent	Proficient	Adequate	Limited
accurate	logical	partially accurate	flawed
insightful	logical	simplistic	unsupported
astute	credible	plausible	inaccurate
precise	relevant	basic	irrelevant

7. Words that describe the skill of ***presenting or communicating information or selecting appropriate visuals*** at varying levels of quality

Excellent	Proficient	Adequate	Limited
vivid	interesting	simplistic	lacks appeal
compelling	effective	predictable	does little to sustain interest
enhances	supports	partially supports	interferes with
engaging	interesting	straightforward	ineffective
skillful	effective	appropriate	inappropriate
intriguing	interesting	predictable	ineffective

Sample Scoring using Rating Scale to assess "Collaboration"

Criteria	Frequency			
	Always = 4	**Sometimes = 3**	**Rarely = 2**	**Never - 1**
1. Embraces everyone's' abilities and encourages participation	Always Embraces everyone's' abilities and encourages participation	Sometimes Embraces everyone's' abilities and encourages participation	Rarely Embraces everyone's' abilities and encourages participation	Never Embraces everyone's' abilities and encourages participation
2. Ensures everyone is tasked to and activity	Always Ensures everyone is tasked to and activity	Sometimes Ensures everyone is tasked to and activity	Rarely Ensures everyone is tasked to and activity	Never Ensures everyone is tasked to and activity
3. Encourages everyone to achieve together	Always Encourages everyone to achieve	Sometimes Encourages everyone to achieve together	Rarely Encourages everyone to achieve	Never Encourages everyone to achieve

	together		together	together

2. Scoring assessment using a Checklist

Check lists are one of the easiest methods of scoring assessment tasks. The criteria i.e. skills, cues or tasks are considered separately according to whether they have been accomplished.

Types of Checklists include

- Yes/No
- Tick/Cross
- Circling
- Narrow scale, e.g. Sometimes, rarely, never
- Colouring
- Symbols (signifiers), e.g. pictures, facials, artifacts, signs, drawings, concept maps)

Sample Scoring using Yes/No Checklist Scale to assess "Collaboration"

No	***Criteria***	***Write Yes (score 2) or No (score 1)***
1	*Embraces everyone's' abilities and encourages participation*	
2	*Ensures everyone is tasked to an activity*	
3	*Encourages everyone to achieve together*	

Sample Scoring using Tick/Cross Checklist Scale to assess "Collaboration"

No	***Criteria***	***Place a tick(score 2) or and X (score 1)***
1	*Embraces everyone's' abilities and encourages participation*	
2	*Ensures everyone is tasked to an activity*	
3	*Encourages everyone to achieve together*	

Samples of other scoring methods are in the Appendix Reference. These are based on Business Studies but can be applied in Technology and Industrial Arts

Scoring of Performance for Summative Assessment

Grade rating scales are better scoring tools for summative assessment of students' performance. They indicate students' level of performance using such as; A, B, C, D etc

A Grade is given after the accumulated total for a number of assessments has been completed either at the end of and assessment period, a topic, a term, a grade or year.

The subject assessment components, tasks and weightings should be able to guide the grading of achievements as demonstrated in a rubric designed for this purpose.

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Sample Scenario to score Summative Assessment

For instance; If TIA/BS has an assessment plan for a 100 marks per term, then the grading shall be scored at the end of each term. As per the Assessment weighting, TIA/BS can plan to score assessment of students per term according to this components:

- 1 x Project = maximum of 50marks
- 1 x Moderation = maximum of 50 marks
- 2 x tests = maximum of 30 marks
- 1 x portfolio = maximum of 5 marks
- 1 x participation = maximum of 5 marks

Assessment Components and Task Weighting

The Assessment components and Task Weighting is intended for a Termly Assessment Schedule. It anticipated that the assessment components with their weightings may be changed by the teachers' Business Studies Termly Teaching Programs accordingly but the total scores allocated for the THEORY ASSESSMENT COMPONENTS (TAC) of 40 Marks and PRACTICAL ASSESSMENT COMPONENTS (PAC) 60 Marks should remain as it is the determined as the required 40/60 Moderation Components (i.e. 100 marks) for Business Studies Assessments per Assessment Period.

THEORY ASSESSMENT COMPONENTS (TAC) (40 Marks)	TOTAL SCORE/100	PRACTICAL ASSESSMENT COMPONENTS (PAC) (60 Marks)	TOTAL SCORE/100

		Project Portfolio No. 1	10
		STEAM Project Portfolio No. 1	10
Test No. 1	15	Project No. 1	25
		STEAM Project No. 1	25
Assignment No. 1	10		
Test No. 2	15		
TOTAL THEORY SCORE	**____/40**	**TOTAL PRACTICAL SCORE**	**____/60**
TOTAL SCORES OF TAC + PAC = TOTAL SCORES OUT OF 100	**_____/100**		

Sample subject assessment structure

The internal assessment for the Technology and Industrial Arts/ Business Studies subject is based on the Grade 9 & 10 and Grade 11 and 12 Technology and Industrial Arts Syllabus. The final assessment should be based on a range and balance of assessment strategies and instruments. Assessment must be both normative and criterion.

Component	Weighting	Tasks	Assessment Referencing
Practical Work in response to design brief (Moderation and Projects included here?)	60 % (of mandatory total)	Development and application of design ideas, safe and skillful use of materials, tools and equipment to make a product and the identified processes	Criterion Referencing Rubrics?
Design folio with outcomes of research , investigations and planning	20 % (of mandatory total)	Folio showing results of investigation in response to design brief, rough notes or sketches of design ideas, timelines, final drawings or plans, processes used to make the product and evaluation reports	Criterion Referencing Rubrics?
Tests	20 % (of	Theory and also applications in theory	Normative

	mandatory total)		
Marks	100 %	A combination of design folios, practical applications, moderations and tests.	

Sample Assessment

SBC embraces standards and as such, standards must also drive the administration of assessments to students. It is important that every student must be given the outline of the Assessment that has been planned for the term. Each Term will include 6 pieces (can have any number from 4-6) of assessment. Assessment is weighted accordingly.

Assessment Type	**Description**	**Weighting**
Topic Tests x 2	Students will be given two topic tests based on the content learnt in the term. 1 will be given mid-term and 1 at end-term. The test will be comprised of 10 multiple choice questions and 5 short written answers.	1 = 15 marks 1=10 marks
Portfolio	Individual Students will be assessed……	10 marks
Moderation	In groups of four - five, students work to critically engage with one another in the required design process. Students will address criteria provided in class and prepare and deliver a 5-10 minute presentation addressing the criteria.	30 marks
Project (Application)	In groups of three to four, students work to critically engage with one another in the assigned project. Students will address criteria provided in class and prepare and deliver a 5-10 minute presentation addressing the criteria.	20 marks
Participation	2 marks will be allocated each day for attendance. Another 3 marks will be awarded for active participation.	5 marks

STEAM Assessment

Steps in Developing a STEAM Activity

1. Identify the Real/Authentic Situations that can be solved through the STEAM Activity
2. Select a well-defined a Benchmark in your subject area that will carry the STEAM Activity
3. Identify related subject areas with their concepts to be used solve the Authentic Situation
4. Note down the Main parts of the Unit Of Work for the STEAM Activity
5. Write a Description of the Authentic Situation for the STEAM Activity based on the identified Authentic situation.
6. Write down the Task Descriptions for the STEAM Activity in order to approach the Authentic situation.
7. Develop the Rubric to Assess the STEAM Activity

1. Authentic Situation identified for this STEAM Activity

- Students spending too much time using their smart mobile phones on Facebook, WhatsApp and surfing the internet rather than their school work.

- Students still bringing their smart mobile phones to school despite the school rules telling them not to.
- Most schools need to fully utilise their School Rules, Mottos, Missions and Visions which determines the way they want to shape our students' Knowledge, Attitudes and Values, during and after, they leave the school at end of G10 and G12.
- Our schools in our country have been labeled as 'a very good school to a very bad school' due school student fights and vandalism of school properties.
- Stakeholders of the schools are blaming the school management for the school students behaviour problems and parents are transferring their students out of schools to others school in the country.

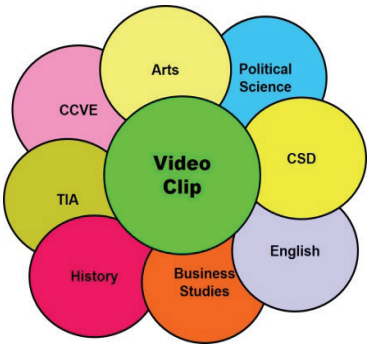
2. ***Select a well-defined Benchmark in your subject area that will carry/drive the STEAM Activity and its associated Big Idea (product, project etc.)***

   - ***Sample:***

     i. **SUBJECT:** BUSINESS STUDIES

     ii. **BENCHMARK 9.2.5.1.** Analyse the impact of information technology on society.

     iii. **Big idea/product:** Video Clip



3. ***Identify other related subject areas with the appropriate concepts to solve the Authentic Situation(s)***

   - Identify related subject areas with their concepts/Knowledge, Skills, Attitudes and Values to be used to solve the Steam Authentic Situation

SUBJECTS	BENCHMARKS	BIG IDEA/ PRODUCT	KNOWLEDGE	SKILLS	ATTITUDES	VALUES
1. Arts (Theatre Arts)	9.2.2.2		Video script	Script Writing		
2. Christian Civic Value Education (CCVE)	9.3.1.3		School Rules, Motto, Vision, Mission	Examine Civic values	Responsibility	Ownership, Love
3. Character Social Development (CSD)	9.1.5.1, 9.1.5.2, 9.1.5.3, 9.1.5.4, 9.1.5.5		School Rules, Motto, Vision, Mission	Asses experiences and mistakes	Caring, Positivity	Respect
4. English	9.2.2.1		Descriptive Writing	Descriptive Writing	Neatness	
5. Social Science (History)	9.2.2.3, 9.2.2.4		School history	Discuss school culture		Ownership
6. Social Science (Political Science)	9.3.3.1, 9.3.3.2		National development aspirations/demands of citizens	Anticipative skills		
7. Technology Industrial Arts (TIA)	9.4.1.4, 9.4.1.5, 9.4.1.6		Range of communications media products	Creative media communication	Alertness	
8. Business Studies	9.2.5.6.	Video clip	Media rich projects	Shooting with mobile	Creativity	Innovative

Ther

4. ***Descriptions of the Steam Authentic Situation***

   - Paragraph 1 describes the problem/situation

- Paragraph 2 describes the solution to the problem/situation and who will be responsible to take up the task
- Paragraph 3 would mention any rewards/awards for an adequate solution to the problem/situation as a booster to create a competitive competition and a promoter of critical thinking amongst the students so that they can come out with the best products.

5. Write down the Task Descriptions for the STEAM Activity

- Plan and write a short write-up for your video-clip.
- Use the notes to Make a 2-minute video clip to advertise and market your school to the public.
- The short video clip must embrace the school rules, motto, and mission and vision statements.
- It must also contain messages of new and competent management.
- This video clip has to have the potential to positively change the image of the school
- This 2-miunte video clip must be captivating and totally convincing to attract students to want to enroll at your school.
- This clip must not be more than 2 minutes (maximum time limit)
- Present your video clip to be assessed
- Submit both your write-up (on a chart) together with your video clip

6. Developing Rubrics to Assess the Steam Video Clips

1) Decide on type of rubric to be used (Holistic or Analytic)
2) Decide what point scale rubric to use (always use 3, 4 or 5 point-scale) and rating scales to use (descriptive words or numerals)
3) Plan the layout to develop the rubric
4) Decide what to assess from the Category of Tasks Description
5) Identify and List down the Category of Tasks Description for the Criteria
6) Reword the Tasks Descriptions to create Criteria
    - Plan and write a short write-up for your video-clip. (***The write up of the video***)
    - Use the notes to make a 2-minute video clip to advertise and market your school to the public. (***The development of the video***)
    - The short video clip must embrace the school rules, motto, and mission and vision statements. (***The content of the video***)
    - It must also contain messages of new and competent management. (***The content of the video***)
    - This clip must not be more than 2 minutes (maximum time limit) (***The presentation of the video***)
    - Submit both your write-up (on a chart) together with your video clip. (***The product***)
7) List the criteria against the Task Descriptions in a table

8) Unpack the Task Descriptions and Identify the essential KSAV that can be assessed
9) Reword the Task Descriptions with the inclusion of KSAVs into a Descriptor statement for each criteria and distribute into each Competency Level/Level of Achievement
10) Determine appropriate variance of Qualifiers for each Descriptors of each Achievement Level
11) Determine the appropriate Descriptive Words or Number for Point Scales of the intended rubric.
12) Completed rubric sample: Video clip Assessment Rubric
13) Consider the Applications of the Steam Rubric

This is a sample for Business Studies and can be used to develop Technology and Industrial Arts Subject STEAM Assessment.

Sample 4

Strand 2: Business Management

Unit 5: Information Technology

Content Standard 2.5: Students will be able to explain the information technology concepts and examine the systems and tools needed to gather, access, analyse, synthesize, evaluate, manage, and disseminate information.

Benchmark: 9.2.5.1. Analyse the impact of information technology on society.

Topic: Impact of information technology on society.

Learning Objective: By the end of this Topic, students will be able to demonstrate a positive impact of information technology on society

Purpose of Assessing the Topic (Benchmark):
To assess whether students can be able to use mobile technology to positively Impact their society and analyse this impacts

How the Performance Task will be done: Group Project Presentation

Performance Standard: By the end of the project**,** students will be able to use mobile technology to positively impact their community/society.

Situation (Authentic)

A school has been faced with the challenge of behavioral issues for some time now and the public has lost its confidence in the school to be a good or genuine school. Most parents fear

sending their children to his school and always opt to transfer their children in very first instances. The Board of Governors of the school has decided to raise the Behavior Standards or Benchmarks to a certain degree to improve its image and standards of learning.

To meet the expectations of the BOG, the principal and teachers intend to market the school to the public of NCD to lure students to have the interest to enroll at the school. With such a PAST bad reputation, the school will really need to convince the public that they have raised their standards and that their school is worth enrolling in it. The Principal and the teachers now have a task on hand to convince the public to enroll their children there and they have to try every means to do so.

To achieve this, the school is now requesting the Business and Technology Department to design an assessment Task for a certain Grade to assist with the situation. The Business & Technology Department has opted to design the task for Grade 9 students as one of their projects towards their assessments. The school principal also announces that the best video assessed by the B&T Department will be rewarded as it is also a competition.

Task Descriptions:

- Plan and write a short write-up for your video-clip.
- Use the notes to make a 2-minute video clip to advertise and market your school to the public.
- The short video clip must embrace the school rules, motto, and mission and vision statements.
- It must also contain messages of new and competent management.
- This video clip has to have the potential to positively change the image of the school
- This 2-miunte video clip must be captivating and totally convincing to attract students to want to enrol at your school.
- This clip must not be more than 2 minutes (maximum time limit)
- Submit both your write-up (on a chart) together with your video clip
- Teacher will present your video clips for the whole class to observe and use the rubric below to assess the video clip.

Materials: Smartphone, butcher papers, markers

1. Developing Rubrics to Assess Video Clips

i. Decide on type of rubrics to be used (Holistic or Analytic)
ii. After you decide, plan the rubrics
iii. Planning to develop the rubric
iv. Categorise the Tasks Description into Criteria's

Sample of Categorising tasks for the rubric

- Plan and write a short write-up for your video-clip. (The write up of the video)

- Use the notes to Make a 2-minute video clip to advertise and market your school to the public. (The development of the video)
- The short video clip must embrace the school rules, motto, and mission and vision statements. (The content of the video)
- It must also contain messages of new and competent management. (The content of the video)
- This video clip has to have the potential to positively change the image of the school (The content of the video)
- This 2-miunte video clip must be captivating and totally convincing to attract students to want to enrol at your school. (The content of the video)
- This clip must not be more than 2 minutes (maximum time limit) (The presentation of the video)
- Present your video clip to be assessed (The presentation of the video)
- Submit both your write-up (on a chart) together with your video clip. (The product)

2. Identify and list down categories of tasks

Category	Task Description
The write up of the video	Plan and write a short write-up for your video-clip.
The development of the video	Use the notes to Make a 2-minute video clip to advertise and market your school to the public.
The content of the video	• The short video clip must embrace the school rules, motto, and mission and vision statements. • It must also contain messages of new and competent management. • This video clip has to have the potential to positively change the image of the school • This 2-minute video clip must be captivating and totally convincing to attract students to want to enrol at your school.
The Presentation of the video	• This clip must not be more than 2 minutes (maximum time limit) • Present your video clip to be assessed
The product	Submit both your write-up (on a chart) together with your video clip.

3. Unpack the Task Descriptions and Identify the essential KSAV that can be assessed

Category	Task Description	Essential KSAVs
The write up of the video script	Plan and write a short write-up for your	Skill : Procedural Writing

	video-clip.	
The development of the video	Use the notes to Make a 2-minute video clip to advertise and market your school to the public.	Values and attitudes: - Teamwork and cooperation - Creativity Knowledge: Know about the school
The content of the video	• The short video clip must embrace the school rules, motto, and mission and vision statements. • It must also contain messages of new and competent management. • This video clip has to have the potential to positively change the image of the school • This 2-minute video clip must be captivating and totally convincing to attract students to want to enrol at your school.	Knowledge: Adequate content about the school Skill: convincing and persuasive Values and attitude: Encouraging and luring
The Presentation of the video	• This clip must not be more than 2 minutes (maximum time limit) • Present your video clip to be assessed	Skill: - Time management - delivery skills (posture, language) and - communication skills - social skills (relativity and connectivity) Values and attitude: confidence
The product	Submit both your write-up (on a chart) together with your video clip.	EKSAVs in the Write up and Presentation :

4. Reword the Task Descriptions with the inclusion of KSAVs into a Descriptor statement for each criteria and distribute into each Competency Level/Level of Achievement

5. Determine the appropriate Descriptive Words or Number for Point Scales of the intended rubric.

Criteria:	Advanced	Progressing	Novice	Mark

The write up of the video script	**Skill:** Procedural Writing **Organised paper of video script writing procedures**	**Organised paper of video script writing procedures**	**Organised paper of video script writing procedures**	/3
The development of the video	Values and attitudes: - Teamwork and cooperation - Creativity **Knowledge:** Know about the school **The video corresponds to the 2-minutes script and illustrates teamwork**	**The video corresponds to the 2-minutes script and illustrates teamwork**	**The video corresponds to the 2-minutes script and illustrates teamwork**	/ 3
Content of the video	**Knowledge:** Adequate content about the school Skill: convincing and persuasive Values and attitude: Encouraging and luring **The short video clip embraces the core ideas of school rules, motto, and mission and vision statements.**	**The short video clip embraces the core ideas of school rules, motto, and mission and vision statements.**	**The short video clip embraces the core ideas of school rules, motto, and mission and vision statements.**	/3
Presentation of the video	**Skill:** - Time management - delivery skills (posture, language) and - communication skills - social skills (relativity and connectivity)	**The video clip captures essence of vital messages of the new and competent management with potentials to positively change the image of the school and captivating and convincing to attract students to want to**	**The video clip captures essence of vital messages of the new and competent management with potentials to positively change the image of the school and captivating and**	/3

	Values and attitude: confidence **The video clip captures essence of vital messages of the new and competent management with potentials to positively change the image of the school and captivating and convincing to attract students to want to enroll at the school.**	**enrol at the school.**	**convincing to attract students to want to enrol at the school.**	
The product	**EKSAVs** in the Write up and Presentation: **Video clip submitted at the assessment deadline for presentations**	**Video clip submitted at the assessment deadline for presentations**	**Video clip submitted at the assessment deadline for presentations**	/3

6. Completed rubric sample: Video clip Assessment Rubric

Criteria	Achieved	Progressing	Novice	Marks
Video Script Write up	**Innovative** and **well** organised paper with **clarity** of video script writing procedures	**Well** organised paper with **clarity** of video script writing procedures	Organised paper with some **clarity** of video script writing procedures	/3
Video Development	**Appropriately considered details** for the video are **well** corresponded to the 2-minutes script and illustrates a well-coordinated teamwork	**Considered details** for the video are **mostly** corresponded to the 2-minutes script and illustrates a coordinated teamwork	**Some details** considered for the video are **partially** corresponded to the 2-minutes script and illustrates a less coordinated teamwork	/3
Video Clip Content	• The short video clip **fully** embraces the core ideas of school rules, motto, and mission and vision statements.	• The short video clip **mostly** embraces the core ideas of school rules, motto, and mission and vision statements.	• The short video clip **somewhat** embraces the core ideas of school rules, motto, and mission and vision statements.	/3

Video Presentation	• The video clip **fully** captures essence of vital messages of the new and competent management with **necessary** potentials to positively change the image of the school and **really** captivating and **totally** convincing to attract students to want to enrol at the school.	• The video clip **mostly** captures the essence of vital messages of the new and competent management with **most** potentials to positively change the image of the school and **mostly** captivating and **partially** convincing to attract students to want to enrol at the school.	• The video clip **somewhat** captures the essence of vital messages of the new and competent management with **some** potentials to positively change the image of the school and **almost** captivating and **less** convincing to attract students to want to enrol at the school.	/3
Video Clip Submission Time	- Video clip submitted **well before** the assessment deadline for presentations	• Video clip submitted **just before** the assessment deadline for presentations	• Video clip submitted **within** the assessment time for presentations	/3

1. How to Score using the rubric

Scoring Rubrics

Criteria	Achieved ~~3~~	Progressing ~~2~~	Novice ~~1~~	Scoring
Video Script Write up -	**Innovative** and **well** organised paper with **clarity** of video script writing procedures	**Well** organised paper with **clarity** of video script writing procedures	Organised paper with some **clarity** of video script writing procedures	2/3
Video Development	**Appropriately considered details** for the video are **well** corresponded to the 2-minutes script and illustrates a well-coordinated teamwork	**Considered details** for the video are **mostly** corresponded to the 2-minutes script and illustrates a coordinated teamwork	**Some details** considered for the video are **partially** corresponded to the 2-minutes script and illustrates a less coordinated teamwork	1/3
Video Clip Content	• The short video clip **fully** embraces the core ideas of school rules, motto, and mission and vision statements.	• The short video clip **mostly** embraces the core ideas of school rules, motto, and mission and vision statements.	• The short video clip **somewhat** embraces the core ideas of school rules, motto, and mission and vision statements.	3/3

Video Presentation	• The video clip **fully** captures essence of vital messages of the new and competent management with **necessary** potentials to positively change the image of the school and **really** captivating and **totally** convincing to attract students to want to enrol at the school.	• The video clip **mostly** captures the essence of vital messages of the new and competent management with **most** potentials to positively change the image of the school and **mostly** captivating and **partially** convincing to attract students to want to enrol at the school.	• The video clip **somewhat** captures the essence of vital messages of the new and competent management with **some** potentials to positively change the image of the school and **almost** captivating and **less** convincing to attract students to want to enrol • at the school.	3/3
Video Clip Submission Time	- Video clip submitted **well before** the assessment deadline for presentations	• Video clip submitted **just before** the assessment deadline for presentations	• Video clip submitted **within** the assessment time for presentations	2/3
11/15				

2. How to Grade using the rubric

Grading Rubrics

Score Range	Grade	Qualifier (Proficiency)	Descriptor	Percentage
13 – 15	**A**	**Advanced**	Description reflecting **highest** level of performance.	**76 - 100%**
9 - 12	**B**	**Achieved**	Description reflecting **mastery** level of performance.	**46 - 75%**
5 – 8	**C**	**Progressing**	Description reflecting **movement towards** mastery level of performance.	**26 - 45%**
0 - 4	**D**	**Novice**	Description reflecting **beginning** level of performance.	**0 - 25%**

3. How to Report using the rubric

A. Reporting an individual student's performance on the task

Assessment Task Report

Assessment Task:			Video Development Project				
Name:		**Grade:**		**Class:**		**Score and Grade:**	**/15**

Criteria	Achieved A	Progressing B	Novice C
Video Script Write up	**Innovative** and **well** organised paper with **clarity** of video script writing procedures	**Well** organised paper with **clarity** of video script writing procedures	Organised paper with some **clarity** of video script writing procedures
Video Development	**Appropriately considered details** for the video are **well** corresponded to the 2-minutes script and illustrates a well-coordinated teamwork	**Considered details** for the video are **mostly** corresponded to the 2-minutes script and illustrates a coordinated teamwork	**Some details** considered for the video are **partially** corresponded to the 2-minutes script and illustrates a less coordinated teamwork
Video Clip Content	• The short video clip **fully** embraces the core ideas of school rules, motto, and mission and vision statements.	• The short video clip **mostly** embraces the core ideas of school rules, motto, and mission and vision statements.	• The short video clip **somewhat** embraces the core ideas of school rules, motto, and mission and vision statements.
Video Presentation	• The video clip **fully** captures essence of vital messages of the new and competent management with **necessary** potentials to positively change the image of the school and **really** captivating and **totally** convincing to attract students to want to enrol at the school.	• The video clip **mostly** captures the essence of vital messages of the new and competent management with **most** potentials to positively change the image of the school and **mostly** captivating and **partially** convincing to attract students to want to enrol at the school.	• The video clip **somewhat** captures the essence of vital messages of the new and competent management with **some** potentials to positively change the image of the school and **almost** captivating and **less** convincing to attract students to want to enrol at the school.
Video Clip Submission Time	- Video clip submitted **well before** the assessment deadline for presentations	• Video clip submitted **just before** the assessment deadline for presentations	• Video clip submitted **within** the assessment time for presentations

Note: The shaded is the student's proficiency score for each task.

Related links to this Business Studies Benchmark in Business Studies with other subject areas:

Subjects	Reference Benchmark Codes
1. Arts (Theatre Arts)	9.2.2.2
2. Christian Civic Value Education (CCVE)	9.3.1.3
3. Character Social Development (CSD)	9.1.5.1, 9.1.5.2, 9.1.5.3, 9.1.5.4, 9.1.5.5
4. English	9.2.2.1
5. Social Science (History)	9.2.2.3, 9.2.2.4
6. Social Science (Political Science)	9.3.3.1, 9.3.3.2
7. Technology Industrial Arts (TIA)	9.4.1.4, 9.4.1.5, 9.4.1.6

The anchor subject in this sample STEAM assessment is Technology and Industrial Arts.

Sample Scenario to score Summative Assessment

Moderation in Technology and Industrial Arts

What is moderation as assessment?

Moderation is the process of teachers sharing, working through and agreeing to expected standards of student achievement and progress. It supports teachers to compare their own judgments to either confirm or adjust them. The process involves teacher collaboration to establish a shared understanding of what achievement of standards looks like and whether or not the student has demonstrated achievement of the standard through the evidences of performance tasks. Teachers work towards making judgments of assessments of standards that are consistent and comparable.

Moderation Purposes

"Moderation is concerned with the consistency, comparability and fairness of professional judgments about the levels demonstrated by students." *(Maxwell, 2002).* Comparable judgments result from teachers understanding of the curriculum, and agreeing on benchmark assessed. The essence is that, there is common understanding of how to assess progress and achievement within and across schools.
Moderation helps teachers to make dependable, evidence-based decisions and leads to consistency.
There is a need for consistency of teacher judgments:

- over time – same evidence viewed at different times or different contexts leading to same judgment by same teacher
- against standards – equivalent application across different types of evidence
- by a teacher - between his/her students
- between teachers – within the same school and different schools
- between teaching years and levels.

Making consistent, reliable and valid decisions across different points in time is important when schools report on student progress, make decisions on school targets and resourcing, or compare different grades data with past information.

All schools experience variables that challenge the consistency of practice such as staff changes, changes in student numbers or changing education demands. Consistent moderation over time can prevent this in a number of ways.

- Always applying the same standardised criteria ensures consistency over time.
- Where nationally standards criteria or exemplars are available, these become the same external reference used each year or each time.
- Moderators will change over time but the same criteria and associated references will remain and continue to guide decisions.

The benefits of moderation

The benefits of involving students in moderation

- When students are actively involved they can participate in selecting evidence (e.g. samples of their work) that best demonstrate the intended learning outcomes.
- The process of assessment develops students' understanding of the desired outcomes and success criteria or expected rubrics developed.
- Making judgments is closely linked to developing the skills of self and peer-assessment.
- This can lead to shared expectations of learning and understandings of standards between teachers and students.
- Greater student confidence in teacher judgments.
- Provides greater transparency of the assessment process.

The benefits of moderation for teachers

- Brings together collective wisdom, resulting in greater consistency of judgment, and focused teaching.
- Provides greater confidence in teacher judgments and assurance that judgments are consistent with other professionals.
- Leads to shared expectations of learning and understandings of levels and progression of learning.
- Develops deeper understandings about content and progressions of learning.
- Improves quality of assessment.
- Alignment of expectations and judgments with curriculum expectations or progressions, and hence improved teaching and learning.
- Assurance to parents and others that interpretations of students' progress and achievement are in line with other professionals.

Process of Moderation

Purpose, learning area and context of the moderation:
It could be moderation of a proficiency based project or design portfolios or the understanding of how to take a running record or of judgments of student achievement and progress for reporting.

Who is involved?

Who needs to be involved? Who will be the coordinator?
It is preferable that the leader/coordinator has the authority to make decisions?
The timing, duration and frequency of moderation meetings:
Will they be extra meetings, or part of staff or team meetings, or non-contact days?
What is the attainment requirement for the moderation? School based certification?

The evidence of student learning that will be moderated:

- For a piece of writing, student writing samples will be used.

- For moderating a design portfolio, the task, text and questions the student responded to may be used, along with notes of student questions, samples of work done and annotated tasks in line with the assessment task and criteria .
- For supervision of an assessment tool: this could be a student's running record and the teacher
- For judgments of student achievement and progress for reporting to parents, a range will be required, covering both formal and informal collection of evidence.
- Developed rubrics written against national exemplar may be used as assessment tools of moderation which can be maintained and improved every year

When to use moderation in TIA

A. Moderation assessment for TIA will be project based and or evidence based assessment. This can be carried out in a year from grades 9-12. This could mean one project in one of the strands or an incorporation of all the strands of the subject TIA in grade 12 where each school makes the decision to undertake moderation as assessment. This could be the final moderation project that will incorporate all the strands in TIA. For grades 9,10, and 11, the moderated projects can be strand based.

Grade 11 Moderation Assessment
Construction Technology

This construction technology moderation project is Building a House

Content Standards

Subject	Benchmark
Engineering Technology [Anchor Benchmark]	11.3.5.3 Develop Written, oral and Presentation skills and apply these to engineering reports with application of graphics as a communication tool. 11.3.5.4 Apply appropriate computer aided designing program to create detail designs
Building Technology	11.3.1.2 Investigate and analyse appropriate materials and their specifications in building 11.3.1.3 Apply Drawing skills in surface development and intersection of solids related to project designs and specifications using AutoCAD program 11.3.1.4 Describe and apply appropriate Health and safety practices pertaining to wood and non-wood products 11.3.1.5 Explore and describe the fundamental building procedures 11.3.1.6 Estimate and apply building materials using AUTO-CAD - computer aided drafting of the building
Electrical Technology	11.3.2.1 Discover and interpret licensing and standard wiring requirements for an electrician in electrical technology. 11.3.2.2 Assess and apply standard safety, health and environmental

	practices. 11.3.2.4 Distinguish between single phase and three phase system 11.3.2.5 Compare and analyse electronic and electrical drawings and illustrations and the skills according to engineering standards manually and using technology 11.3.2.6 Explore and analyse materials, tools, components and accessories used in the electrical installation process.
Plumbing Technology	**11.3.3.1** Explore and analyse fundamental concept on water distribution system, drain, waste, vent system in Plumbing 11.3.3.3 Explore and categorise corrugated stainless steel tubing, Fixtures and faucets 11.3.3.4 Read and analyse blue prints and sketches of pipe system using CAD program
Welding Technology	11.3.4.6. Analyse and select suitable materials for machining or welding processes identifying forms of welding with precision measurement for quality output.

This project requires students to research and develop a design for a House and produce a range of presentation drawings with the option to also construct a 3D model of their design. This project allows for creative design solutions as well as developing skills in technical presentation drawing, scientific enquiry and mathematical application. This project is an example of an integration of engineering, building, electrical, plumbing and welding technology,

Authentic situation

Papua New Guinea is prone to natural disasters and when disasters happen a lot of people are displaced from their homes and often left homeless. A new set of buildings have to be designed to give the displaced people a sense of security with a roof over their heads. The environment must be considered to choose materials that are environmentally friendly and suitable. The homes should be designed to be functional. The house should be space and cost efficient.

Assessment Task

Design a house that will accommodate displaced families. Use the design process to solve the design problem that will be cost, and space effective and within projected budget.

- Design Situation: Architects design both permanent and temporary dwellings and structures.
- Design Brief: Disasters can cause displacement of the local population, and the provision of permanent or temporary housing can be difficult. Students are to:
  - research and design their own low-cost, resource-efficient temporary dwelling, a House to be used in situations of population displacement
  - research the most efficient use of local materials and environmental conditions to create low-cost, energy-efficient sustainable housing, using the House model
  - design a low cost , energy efficient, functional and space efficient house with electrical wirings, plumbing fittings and welded materials.
  - submit a range of presentation drawings using both traditional and CAD methods, a documentation folio and, optionally, a 3D model of their design.

Marking

The moderation assessment will be to assess the portfolio, the process and the product. This assessment is both formative and summative. There must be close tracking of the project for the formative and summative assessment to be effectively carried out.

Criteria for assessing learning
Students will be assessed on their ability to;

- design and build a prototype of a house with consideration to designing, technical drawing sketches, selecting materials and equipment and building the house
- the building of the house with electrical wiring, plumbing piping and welding the equipment.

1. The DESIGN PORTFOLIO

As this is an ongoing or running file of student work the assessment criteria is developed formatively. This portfolio will show all evidence of work done in the designing, planning, making and evaluating the project of building a house..
The criteria are drawn from the description of the assessment activity.

Performance Standard/Criteria	Advanced 4	Meet Standard 3	Progressing 2	Not Yet 1
Create a folio with organisers, sketches, research notes and graphical presentations of data collected.	Shows sufficient samples of sketches, research notes and graphical presentations of data collected.	Shows samples of sketches, research notes and graphical presentations of data collected.	Shows minimal samples of sketches, research notes and graphical presentations of data collected.	Shows lack of samples of sketches, research notes and graphical presentations of data collected.
Technical drawings and or CAD	Produces evidence of high competency in Technical Drawing and using AutoCAD in sketching Domestic Buildings	Produces evidence of competency in Technical Drawing and using AutoCAD in sketching Domestic Buildings	Produces evidence of fair competency in Technical Drawing and using AutoCAD in sketching Domestic Buildings	Produces little/no evidence of competency in Technical Drawing and using AutoCAD in sketching Domestic Buildings
Anecdotal notes on building a cost effective, space effective and functional house	Shows sufficient evidence of written plans for building a cost effective, space effective and functional house.	Shows evidence of written plans for building a cost effective, space effective and functional house.	Shows minimal evidence of written plans for building a cost effective, space effective and functional house.	Shows lack of evidence of written plans for building a cost effective, space effective and functional house.
Data and Information	Shows sufficient samples of research, data and information	Shows samples of research, data and information on Engineering	Shows minimal samples of research, data and information	Shows lack of samples of research, data and information

	on Engineering Principles and Processes and Design Solutions.	Principles and Processes and Design Solutions.	on Engineering Principles and Processes and Design Solutions.	on Engineering Principles and Processes and Design Solutions.
Demonstrated application of Mathematics and Science concepts.	Shows excellent demonstration of mathematics and science skills application in calculations, measurement and design drawings.	Shows fair demonstration of mathematics and science skills application in calculations, measurement and design drawings.	Shows minimal demonstration of mathematics and science skills application in calculations, measurement and design drawings.	Lacks demonstration of mathematics and science skills application in calculations, measurement and design drawings.
Presentation of engineering designs and blueprints	Produces evidence of high competency in the development and presentation of engineering designs and blueprints.	Produces evidence of competency in the development and presentation of engineering designs and blueprints.	Produces evidence of fair competency in the development and presentation of engineering designs and blueprints.	Produces little/no evidence of competency in the development and presentation of engineering designs and blueprints.

2. Building Project Construction.

The development and construction of the project will be assessed using the following;

a. Design Solution/Product
b. Planning
c. Technical Drawing
d. Materials
e. Communication of designs
f. Building a model

a. Design Solution of the House

Performance Criteria	Advanced 4	Proficient 3	Progressing 2	Novice 1
Generate ideas for solutions	The design solutions show excellent relevance to the purpose of the project.	The design solutions show clear relevance to the purpose of the project	The design solutions show minimal relevance to the purpose of the project	The design solutions are not relevant to the purpose of the project.
Research and design.	Shows sufficient evidence of research and designs of their own low-cost,	Shows evidence of research and designs of their own low-cost, resource-efficient	Shows minimal evidence of research and designs of their own low-cost,	Lacks evidence of research and designs of their own low-cost, resource-efficient

	resource-efficient temporary dwelling.	temporary dwelling.	resource-efficient temporary dwelling.	temporary dwelling.
Appropriate use of the elements of design in building construction	Excellent presentation as either graphic or free and provides specific information about the design features.	Presentation as either graphic or free and provides specific information about the design features.	Poor presentation as either graphic or free and provides specific information about the design features.	No presentation as either graphic or free and provides specific information about the design features.
Presentation of and communication of design of the House Project	Excellent presentation of the development of ideas and concepts in a logical and sequential way.	Presentation of the development of ideas and concepts done in a logical and sequential way.	Mediocre presentation of the development of ideas and concepts done in a logical and sequential way.	Poor presentation of the development of ideas and concepts done in a logical and sequential way.

b. Planning

Performance Criteria	Advanced 4	Proficient 3	Progressing 2	Novice 1
Articulate series of goals of the project	Project goals identified and well articulated	Project goals have been articulated.	Project has minimal goals articulated.	Project activities occur with little thought or articulation of goals.
Articulate series of steps/processes & strategies to achieve goals	Team members have a clear understanding of all stakeholder roles and responsibilities, risks of the project, and sequence of activities needed to effectively complete the project.	Stakeholders are identified and roles and responsibilities defined; some breakdown of the required tasks completed; some team members aware of the sequence of steps needed to effectively complete the project.	Some stakeholders are identified and roles and responsibilities defined; minimal breakdown of the required tasks completed; few team members aware of the sequence of steps needed to effectively complete the project.	Little to no initiating or planning of project activities; team members show little to no awareness of roles, required activities, or sequence of steps needed to effectively complete the project.
Determine, procure, optimize all	Resources properly identified for	Some of the resources needed to	Few of the resources needed to	Little to no initiation or planning of

needed resources (human, material, and financial)	each area of the project; effective management of training and scheduling of human resources; budgeting and procurement of other resources are properly tracked and reported.	effectively complete the project have been identified; some estimation of cost, availability, training needs of resources identified and optimized; some tracking of resources	effectively complete the project have been identified; some estimation of cost, availability, training needs of resources identified and optimized; some tracking of resources	project activities; team members show little to no awareness of roles, required activities, or sequence of steps needed to effectively complete the project
Create and maintain budget	Costs of the project have been identified and a budget set; contingency funds set aside to cover potential overruns; project spending tracked; team members aware of budget and practice fiscal responsibility	Some costs of the project identified and availability of funds verified. Some costs being tracked; awareness of overall cost of the project is known.	Few costs of the project identified and availability of funds verified. Some costs being tracked; awareness of overall cost of the project may not be known.	Little to no planning of the overall costs of effectively completing the project; little to no tracking or costs; cost overruns may occur due to poor planning
Calculate time on task	Tasks and time necessary to complete project identified and estimated based on skill and availability of assigned resources	Majority of tasks and time necessary to complete project identified and estimated based on skill and availability of assigned resources.	Some tasks and time known and estimated, or only high-level planning estimates completed without consideration for skill and availability of assigned resources	Little to no estimation of time needed to complete tasks or tasks not fully identified.

c. Technical Drawing

Performance Criteria	Advanced 4	Proficient 3	Progressing 2	Novice 1
2D-3D drawings of the project	Produces evidence of high competency using AutoCAD in 2-3D drawings.	Produces evidence of competency using AutoCAD in 2-3D drawings.	Produces evidence of fair competency using AutoCAD in 2-3D drawings.	Produces little/no evidence of competency in using AutoCAD in 2-3D drawings.

Site Plans for the House	Plans are flawlessly drawn.	Plans demonstrate they have been drawn with precision and care.	Plans are satisfactory drawn	Plans are carelessly drawn.
Floor Plans of the House	Demonstrates thorough, conscious understanding of concepts involved in developing floor plans.	Demonstrates well developed understanding of concepts involved in developing floor plans	Demonstrates some understanding of concepts involved in developing floor plans	Demonstrates little understanding of concepts involved in developing floor plans
Structural Plans of the House	Demonstrates thorough, conscious understanding of concepts involved in developing structural plans.	Demonstrates well developed understanding of concepts involved in developing structural plans.	Demonstrates some understanding of concepts involved in developing structural plans.	Demonstrates little understanding of concepts involved in developing structural plans.
Terrace Plans for the House	Plans are exceptionally neat and tidy.	Plans are sufficiently neat and tidy.	Plans exhibit some neatness and tidiness.	Plans exhibit little neatness and tidiness.
Cross section plans of the House	Demonstrates thorough, conscious understanding of concepts involved in developing cross section plans.	Demonstrates well developed understanding of concepts involved in developing cross section plans	Demonstrates some understanding of concepts involved in developing cross section plans	Demonstrates little understanding of concepts involved in developing cross section plans
Elevation	Plans are flawlessly drawn	Plans demonstrate they have been drawn with precision and care	Plans are satisfactory drawn	Plans are carelessly drawn

d. Materials

Performance Criteria	Advanced 4	Proficient 3	Progressing 2	Novice 1
Selection of the appropriate Timber Materials for construction.	Excellent selection of appropriate timber materials and its uses with estimated cost for the completion of the project.	Good selection of appropriate timber materials and its uses with estimated cost for the completion of the project.	Poor selection of appropriate timber materials and its uses with estimated cost for the completion of the project.	Very poor selection of appropriate timber materials and its uses with estimated cost for the completion of the project.
Selection of the	Excellent selection of	Good selection of appropriate	Poor selection of appropriate	Very poor selection of

appropriate Masonry Materials for construction.	appropriate masonry materials and its uses with estimated cost for the completion of the project.	masonry materials and its uses with estimated cost for the completion of the project.	masonry materials and its uses with estimated cost for the completion of the project.	appropriate masonry materials and its uses with estimated cost for the completion of the project.
Selection of the appropriate Concrete Materials for construction.	Excellent selection of appropriate concrete materials and its uses with estimated cost for the completion of the project.	Good selection of appropriate concrete materials and its uses with estimated cost for the completion of the project.	Poor selection of appropriate concrete materials and its uses with estimated cost for the completion of the project.	Very poor selection of appropriate concrete materials and its uses with estimated cost for the completion of the project.
Selection of the appropriate Steel Materials for construction.	Excellent selection of appropriate steel materials and its uses with estimated cost for the completion of the project.	Good selection of appropriate steel materials and its uses with estimated cost for the completion of the project.	Poor selection of appropriate steel materials and its uses with estimated cost for the completion of the project.	Very poor selection of appropriate steel materials and its uses with estimated cost for the completion of the project.
Selection of the appropriate PVC (polyvinyl chloride) Materials for construction.	Excellent selection of appropriate PVC materials and its uses with estimated cost for the completion of the project.	Good selection of appropriate PVC materials and its uses with estimated cost for the completion of the project.	Poor selection of appropriate PVC materials and its uses with estimated cost for the completion of the project.	Very poor selection of appropriate PVC materials and its uses with estimated cost for the completion of the project.

e. Communication of designs

Performance Criteria	Advanced 4	Proficient 3	Progressing 2	Novice 1
Presentation of and communication of design of the House Project	Excellent presentation of the development of ideas and concepts in a logical and sequential way.	Presentation of the development of ideas and concepts done in a logical and sequential way.	Mediocre presentation of the development of ideas and concepts done in a logical and sequential way.	Poor presentation of the development of ideas and concepts done in a logical and sequential way.

f. Building a Model/Prototype

Performance	Advanced	Proficient	Progressing	Novice

Criteria	4	3	2	1
Completed Model of the House	House plans and model demonstrates high level of creativity and a high level of involvement in project	House plans and model demonstrates proficient level of creativity and a degree of time and effort in project	House plan and model demonstrates little creativity and little time and effort put toward project	House plan and model demonstrates no creativity and little time and effort put toward project

3. Design Process

Design Process Rubrics
Each of the stage of the design process is assessed at the duration of the project.

Identify the Problem

Performance Standard/Criteria	Advanced 4	Meet Standard 3	Progressing 2	Not Yet 1
Analyse the context and analyse issue and the problem	Analyse the context and analyse issue and the problem with logical results, justifications and examples.	Analyse the context and analyse issue and the problem with clear results and justifications	Analyse the context and analyse issue and the problem with no clear results	Do not analyse the context and analyse issue and the problem
Considerations of ideas of designs to address the issue.	More considerations of ideas and designs with examples	A lot of considerations of ideas and designs	Few considerations of ideas and designs.	No considerations of ideas and designs
Propose design solutions	Propose design solutions with clear and realistic expectations of results	Propose design solutions with clear expectations of results	Propose design solutions with no clear results	Do not propose design solutions
Selection of the appropriate	Excellent selection of the appropriate	Very good Selection of the appropriate	Poor selection of the appropriate	Do not select of the appropriate

design solution	design solution	design solution	design solution	design solution

Do Research

Performance Standard/Criteria	Advanced 4	Meet Standard 3	Progressing 2	Not Yet 1
Design research questions	Excellent design of research questions	Very good design of research questions	Poor design of research questions	Do not design research questions
Conduct research	Excellent Conduct of research	Very good Conduct of research	Few research done	Do not conduct research
Evidence of research findings	Excellent Evidence of research findings	Very good Evidence of research findings	Poor evidence of research findings	No evidence of research findings
Evidence of constraints and limits identified	Excellent evidence of constraints and limits identified	Very good evidence of constraints and limits identified	Poor evidence of constraints and limits identified	No evidence of constraints and limits identified
Evidence of critical considerations of how the solution is the most appropriate	Excellent evidence of critical considerations of how the solution is the most appropriate	Very good evidence of critical considerations of how the solution is the most appropriate	Poor evidence of critical considerations of how the solution is the most appropriate	No evidence of critical considerations of how the solution is the most appropriate

Develop Possible Solutions

Performance Standard/Criteria	Advanced 4	Meet Standard 3	Progressing 2	Not Yet 1
Brainstorm possible design solutions to	Excellent and logical brainstorm of	Logical brainstorm of possible design	Some brainstorm done for possible design solutions	No brainstorm of possible design solutions to

address the problem identified	possible design solutions to address the problem identified	solutions to address the problem identified	to address the problem identified	address the problem identified
Evidence of variations of design solution being proposed	A good collection of evidence of variations of design solution being proposed	Clear and sufficient evidence of variations of design solution being proposed	Some evidence of variations of design solution being proposed	No evidence of variations of design solution being proposed
Identify the pros and cons of a possible design solution	Clearly identify the pros and cons of a possible design solution with checklist done,	Clearly identify the pros and cons of a possible design solution	Does identify the pros and cons of a possible design solution	Do not identify the pros and cons of a possible design solution

Choose One Solution

Performance Standard/Criteria	**Advanced** 4	**Meet Standard** 3	**Progressing** 2	**Not Yet** 1
Presentation of proposed design solutions in detail	Excellent presentation of proposed design solutions in detail	Very good presentation of proposed design solutions in detail	Poor presentation of proposed design solutions in less detail	No presentation of proposed design solutions in detail
Study of details of proposed design	Meticulous In-depth study of the details of the proposed design	Good and in-depth study of details of the proposed design	Minimal study of the details of proposed design	No study of the details of the proposed design
Considerations of constraints, cost and time in making the design solution	Clear and justified considerations of constraints, cost and time in making the	Clear considerations of constraints, cost and time in making the design solution	Minimal considerations of constraints, cost and time in making the design solution	No considerations of constraints, cost and time in making the design solution

	design solution			
Selecting the appropriate design solution	Clear and justified selection of the appropriate design solution	Clear selection of the appropriate design solution	No clear selection of the appropriate design solution	No selection of the appropriate design solution

Design and Construct a Prototype

Performance Standard/Criteria	**Advanced** 4	**Meet Standard** 3	**Progressing** 2	**Not Yet** 1
Technical sketches of design product complete with measurements	All technical sketches of design product are complete with and guided explanations	All technical sketches of design product complete with measurements	Few technical sketches of design product with some measurements	No technical sketches of design product
Sketches are in 2D and 3D	All sketches are in 2D and 3D drawings and have very clear details	All sketches are in 2D and 3D drawings with clear details	Not all sketches are in 2D and 3D drawings	Sketches are not in 2D and 3D drawings
Materials are selected	Appropriate materials are selected well considering criteria for performance in making the prototype	Appropriate materials are selected well for good performance when making the prototype	Materials are selected for performance but not considering performance when making the prototype	Materials are not selected for performance in the making of the prototype
The processes in making the prototype	The processes in making the prototype are outlined and followed	The processes in making the prototype are followed	The processes in making the prototype are followed but with some stages missed.	The processes in making the prototype are not followed
Testing the	Complete and	Complete testing	Incomplete	No testing of the

prototype	successful testing of the prototype	of the prototype	testing of the prototype	prototype done
Design of questions asked when the prototype is tested	Very Clear and well design of questions for testing the prototype	Clear and direct Design of questions for testing the prototype	Few questions designed for testing the prototype	No design of questions for testing the prototype
Keeping a record of the process of testing the prototype	Excellent record kept of the process of testing the prototype	Good and clear record kept of the process of testing the prototype	Incomplete record kept of the process of testing the prototype	No record kept of the process of testing the prototype

Communicate Results

Performance Standard/Criteria	**Advanced** 4	**Meet Standard** 3	**Progressing** 2	**Not Yet** 1
Communicating the results of the prototype test using detailed diagrams	Very clear and detailed communication of the results of the prototype test using detailed diagrams	Clear communication of the results of the prototype test using detailed diagrams	No clear Communication of the results of the prototype test	No Communication the results of the prototype test
Use of mathematical evidence, sketches, graphs	Clear and detailed use of mathematical evidence, sketches, graphs including conclusions	Clear and detailed use of mathematical evidence, sketches, graphs	Minimal use of mathematical evidence, sketches, graphs	No use of mathematical evidence, sketches, graphs
Evidence of shared learning in analyzing the results of the test	Clear evidence of shared learning in analyzing the results of the test	Good evidence of shared learning in analyzing the results of the test	Minimal evidence of shared learning in analyzing the results of the test	No evidence of shared learning in analyzing the results of the test

Evaluate and Redesign

Performance Standard/Criteria	Advanced 4	Meet Standard 3	Progressing 2	Not Yet 1
Evaluate the results of the prototype test	Clear evaluation of the results of the prototype test with details shown	Clear evaluation of the results of the prototype test	No clear evaluation the results of the prototype test	No evaluation of the results of the prototype test
Considerations of what worked and what did not	Clear and confident considerations of what worked and what did not	Clear considerations of what worked and what did not	No clear considerations of what worked and what did not	No considerations of what worked and what did not
Evidence of decisions made after the prototype test, to re-modify or change the design solution	Clear and concrete evidence of decisions made after the prototype test, to re-modify or change the design solution	Very clear evidence of decisions made after the prototype test, to re-modify or change the design solution	No clear evidence of decisions made after the prototype test, to re-modify or change the design solution	No Evidence of decisions made after the prototype test, to re-modify or change the design solution

THE DESIGN SOLUTION (PRODUCT)

This assessment too can be used to evaluate the final product of the house if an actual house has been built on site.

Performance Criteria	Advanced	Proficient	Progressing	Novice
Engineering Design	Strictly followed the design process fulfilling all the stages.	Followed the design process fulfilling all the stages.	Followed the design process fulfilling some stages but yet incomplete	Not followed the design process and not fulfilling the stages.
Building Materials	Excellent selection of appropriate materials and its uses with estimated cost for the completion of	Good selection of appropriate materials and its uses with estimated cost for the completion of the project.	Poor selection of appropriate materials and its uses with estimated cost for the completion of the project.	Very poor selection of appropriate materials and its uses with estimated cost for the completion of

	the project.			the project.
Construction Steps	Team members have a clear understanding of sequence of construction steps needed to effectively complete the project.	Team members have a fair understanding of sequence of construction steps needed to effectively complete the project.	Team members have minimal understanding of few sequence of construction steps needed to effectively complete the project.	Team members have little or no clear understanding of the sequence of construction steps needed to effectively complete the project.
Electrical Installations	Excellent installation of appropriate low cost, energy efficient electrical wiring system that promotes conservation of energy.	Good installation of appropriate low cost, energy efficient electrical wiring system that promotes conservation of energy.	Poor installation of appropriate low cost, energy efficient electrical wiring system that promotes conservation of energy.	Very poor installation of appropriate low cost, energy efficient electrical wiring system that promotes conservation of energy.
Plumbing System	Excellent choice and installation of appropriate plumbing system that is low cost, efficient and environmentally friendly.	Good choice and installation of appropriate plumbing system that is low cost, efficient and environmentally friendly.	Poor installation of appropriate plumbing system that is low cost, efficient and environmentally friendly.	Very poor installation of appropriate plumbing system that is low cost, efficient and environmentally friendly.
Welded materials	Excellent selection of appropriate welded materials and welding for the completion of the project.	Good selection of appropriate welded materials fand welding for the completion of the project.	Poor selection of appropriate welded materials and welding for the completion of the project.	Very poor selection of appropriate materials and welding for the completion of the project.
Cost effective	Costs of the project have been identified and a budget set; contingency funds set aside to cover potential overruns; project spending tracked; team members aware of budget and practice fiscal responsibility	Some costs of the project identified and availability of funds verified. Some costs being tracked; awareness of overall cost of the project is known.	Few costs of the project identified and availability of funds verified. Some costs being tracked; awareness of overall cost of the project may not be known.	Little to no planning of the overall costs of effectively completing the project; little to no tracking or costs; cost overruns may occur due to poor planning

Space effective; ergonomics	The designed project takes an excellent effect of space and furniture to suit the needs of the users.	The designed project takes good effect of space and furniture to suit the needs of the users.	The designed project takes some effect of space and furniture to suit the needs of the users.	The designed project takes no effect of space and furniture to suit the needs of the users and there is evidence of clutter.
Functionality of the house	Strictly followed the design process, planning and construction processes to build a fully functional and cost effective house.	Followed through the design process planning and construction processes to build a fully functional and cost effective house.	Followed the design process planning and construction processes to build a fully functional and cost effective house.	Not followed the design planning and construction processes to build a fully functional and cost effective house.

GRADING

The Grading of the Moderation Project will cover the three components.

Criteria	A 197-218	B 164-196	C 109-163	D 0-108
The Design Portfolio	An excellent and orderly compilation of all evidences of the project designing, making and evaluating.	An excellent compilation of all evidences of the project designing, making and evaluating.	A good compilation of evidences of the project designing, making and evaluating.	A poor compilation of evidences of the project designing, making and evaluating.
The House Construction Project	Completed construction of the house on time with controlled costs and time	Completed construction of the house on time	Completed construction of the house with no consideration for time and costs.	Poorly completed construction of the house.
The Design Process	Strictly followed the design process fulfilling	Followed the design process fulfilling all the	Followed the design process fulfilling some	Not followed the design process and not fulfilling

Reporting, Monitoring and Evaluation

Recording, reporting, monitoring and evaluation are integral part of assessment for students from grades 9 to 12. Therefore, it is commended that recording, reporting, monitoring and evaluation of students achievements for Business and Technology Subjects must be done by grade levels in school based assessment or also referred to as internal school assessment.

The marks awarded to students in their internal assessment will be a combination of the internal assessment mark and the examination mark.

Internal assessment provides a measure of student's achievements based on a wider range of syllabus content and benchmarks than maybe covered by the external examination. Business and Technology subjects provide a summation of each student's achievement in Grades 9-12. The internal assessment mark must comply with the types of tasks and assessment rubrics specified in the holistic or analytic rubrics. The external examination provides a measure of student achievement of those aspects of the content standards that can be reliably measured in an examination setting.

Recording

Standards based recording and reporting is about student understanding and mastering a learning standard and less about grades. A standards based report card can list the most important skills students should learn in each subject at a particular grade level. Instead of letter grades, students receive marks or a code that show how well they have mastered the skills. The marks or codes that schools use to represent student progress are;

A- Advanced
B- Proficient
C- Progressing
D-Novice

The l standards are basically the learning standards and expectations for each grade level. SBC requires a new and effective way of recording and reporting to measure progress of student's performance such as in Project Based Learning. Reporting progress is based on the teaching and learning strategies for performance based learning which are accurately assessing the performance towards mastery. The teaching model is changing therefore the performance measurements of Standards-Based Reporting will be more reflective of learning in the classroom. Hence, SBA allows students to be able to know against which criteria they will judge their work, and the standards attached to each of the criteria. It tells students what is required and allows teachers to gain a sense of how students are doing overall based on their achievement of the standards and promotes mastery learning.

Schools must maintain and submit student assessment records according to the school based assessment policy. Teachers can record the evidence of students' demonstrations' of achieving the content standards and benchmarks using assessment instruments that are manageable. Here are some recommended recording methods;

- Individual or class checklists or class grid to record observations
- Comments on students work indicating what they have done well and where they need to improve
- Work samples being added to a portfolio
- Test marks
- Students assessments of their own performances using rubrics or assessment criteria and
- Students assessment of their peers using the assessment criteria

Students are given constructive feedback by the teacher on what they can do well and what they need to improve on. Likewise, teachers are focused on the content they are assessing and are able to apply fair, precise and consistent judgment.

Reporting

Teachers are obliged to report on what students have done or how well they have performed and how they improve further. Formal reporting through written reports and interviews are done to inform parents and guardians of the students learning progress and other related areas such as behavior. Teachers must ensure that the student has demonstrated and achieved the standards independently on a number of occasions. These can be done formally or informally. The achievements are reported to respected stakeholders in relation to;

- Weaknesses in the learner
- Strengths in the learner
- Parent and guardian support and
- Evaluation

Purpose of Reporting

- **Students Are Provided with Appropriate Feedback that Will Improve their Skills**

In a standards-based learning approach, teachers are expected to provide their students with quality feedback that will improve student learning. As opposed to the traditional grading system that only provides students with a single numerical or letter grade, the standards-based grading system requires teachers to provide their students with meaningful and appropriate feedback that will accelerate mastery of learning standards. It is believed that standards-based grading allowed students to identify their areas of growth and to improve on their own competencies. Teachers need to communicate with their students what each proficiency score means and should be explained to the students' parents what each score means and how they can help their children demonstrate mastery of learning standards expected of them for the subject.

- **Students Can Track their Progress**

In a standards-based grading approach, students understand the meaning of each score that they receive. Because there are rubrics that explain the meaning of each proficiency score, students can easily monitor which standards need to be improved further and which learning standards have already been met. as such, students begin to monitor their progress and become accountable for their learning goals.

Interventions and Monitoring

Underachievement is poorer than expected performance. Students who consistently display performance demonstrative of underachievement are identified and interventions for regress are planned to promote learning. Such interventions should be planned not as a general aspect but should address individual students' limitations in learning and should encourage learning.

- **Monitoring of Students Learning**

Monitoring of students learning is done through strategies that teacher devise to track their teaching and students achievement. This is through the assessment program, classroom teaching, and performance in performance-based learning and students self- assessment in achieving the learning standards.

- **Re-planning**

Re-planning of teaching programs and lesson planning are addressed apart from the planning and programming for all other students. This is specifically addressing underachievers. Re-planning includes teaching and learning strategies, resources, remedial activities which can be planned into the normal teaching times instead of creating extra times after classes.

Certification

Certifying of students must be done through an awarding system which will determine the level of achievement. This will be in a form of achievement statements suggested below;

Levels of achievement

1. Very high achievement
2. High achievement
3. Satisfactory achievement
4. Low achievement
5. Below requirement level

All teachers responsible for grades 9-12 must consider school based assessment levels of achievements to be affected across all Business and technology Subjects.

GLOSSARY

Building Glossary	
Aesthetics	Characteristics of a product or system that makes it look beautiful and attractive.
Analyse	Look carefully at a problem or need in order to explain its causes and effects, or carefully look at information to determine its validity and importance, or examine an item (e.g. a structure) and see how it functions and what it consists of.
Anthropometrics	(linked to ergonomics) Measurements of people's shapes and sizes. Such measurements are usually taken when products are designed for human use, e.g. furniture, eating utensils, hairdryers, sporting equipment cars, clothing, etc.
Biophysical environment	The land, air and water around us; it is also the space in which we find ourselves.
Building Code	A building code is a set of regulations written by city or county officials with the help of construction pros that governs the design, construction and modification of commercial buildings, homes and other structures in the jurisdiction
Building Standards	Standards contained in the building code, these standards are guidelines that workers follow in order to adhere to building code regulations.
Classify	Arrange in groups according to similar features or qualities.
Compare	Describe the similarities and/or differences between two products, or items, or solutions or situations.
Compression	A squeezing force.
Constraints	Aspects that limit conditions within which the work or solution must be developed, e.g. time, materials, tools, human resource, cost, etc.
Control	The means by which systems are regulated, i.e. an adjustment of the process, which makes the actual result conform more closely to the desired result.
Conventions	Ways of showing information on designs or working drawings that are understood and recognised to have specific meaning.
Criteria	Statements of a particular standard or requirement that a solution must satisfy.
data	Raw facts and figures (statistics, rainfall figures, temperature readings, etc.). Data may be processed into information.
Demonstrate	Show key features of an item or product.
Describe	Tell in words listing features and/or functions
Discuss	Write or speak about a topic or event or item or problem in order to get feedback / opinions from others.
design (noun)	The plan, sketch, model, drawing, etc. that outlines or shows the

	intention of the proposed solution.
design brief	A short and clear statement that gives the general outline of the problem to be solved as well as the purpose of the proposed solutions.
design process	A creative and interactive approach used to develop solutions to identified problems or human needs. The associated skills are investigating, designing (development of initial ideas), making, evaluating and communicating. The design process is utilised by engineers, architects, industrial designers, and many others when developing original ideas to meet needs or wants, and to solve problems.
enabling tasks	Activities used to teach and then practice specific skills in preparation for a more advanced task – sometimes also called resource tasks.
Ergonomics	Features of a product or system that makes it user-friendly.
Explain	Make clear by giving more information.
Findings	Things that have been discovered after a process of investigation or research.
Fitness-for-purpose	A solution should be evaluated in terms of the design brief, specifications and constraints AND whether it will meet the purpose for which it was designed.
Forming	Changing a material's shape without cutting it.
Identify	Establish who/what something is e.g. identify a type of structure.
Illustrate	Explain or make something clear by using examples or words or diagrams.
Input	The command/information entered into a system.
information	Data that has been processed (recorded, classified, calculated, stored, etc.). Knowledge is gained when different kinds of information are compared and conclusions are drawn.
isometric	A 3D drawing where the lines of sight are set at 30 degrees.
machine	A device made up of a combination of simple mechanisms linked so as to form a system for the purpose of doing work. It can be designed to increase the mechanical advantage and decrease the velocity ratio OR to increase the velocity ratio while decreasing the mechanical advantage.
materials	Physical substances used in technology, e.g. wood, textiles, fabric, plastic, food, etc
mechanical advantage	A concept that describes how much easier mechanisms or machines can make a particular task. The amount of work done is the same, and the amount of energy expended is the same, but the effort used (force) is less because it is applied over a greater distance, and for a longer period of time.
mechanism	Parts that can turn one kind of force into another and give mechanical advantage or a distance advantage. Mechanisms can be combined to form a machine. The basic mechanisms are the lever and the wedge/inclined plane. Cams/ cranks and pulleys/gears are adaptations of the wheel and axle – which is itself a special case of the first class lever.
Mode	A way or manner in which a thing is done.
modelling	The testing of a solution, (product or system). This could include using small replicas (scale models), and intangible representations of the solution (mathematical models, computer models, etc.).

need	A necessity for basic function, e.g. food is a need.
Oblique	A 3D drawing where the depth of an object is projected at a 45 degree angle to the 2D front view.
opportunity	The chance to do something about a need or a want.
Orthographic	A type of 2D drawing. It usually shows three separate views of the same object (e.g. front, top and left views). The technique is used to draw formal working drawings.
output	The actual result obtained from a system.
Perspective	A 3D artistic drawing in which the lines of sight converge to vanishing points on the horizon. It can be drawn either to a single vanishing point or to double vanishing points (at this level).
technological processes	Any process using technology to perform a task e.g. generating electricity, extracting iron from iron ore, galvanising steel by electroplating, injection moulding a plastic bucket, etc.
tension	A force that stretches an object or material, a pulling force.
technological literacy	technological solution A plan that arises by using a systematic problem solving process (ideas, flowcharts, models, etc.). The ability to use, understand, manage and evaluate technology.
Building Product	Ready-made particles or sections made from various materials, that are fitted in architectural hardware and decorative hardware parts of a building.
Preserving	A process that prolongs the natural life of a product.
Process	The part of a system that combines resources to produce an output that is in response to input.
Problem	Something that leads to a need or want and that can give rise to an opportunity.
Pulley	A wheel with a groove on its circumference. It is used to transmit movement and is used with a belt or a rope.
Recycle	To reuse all or part of a substance, including breaking it down to raw material status.
recyclable	A material that can be recycled.
safety	The way that a person works with tools, materials and equipment that does not harm themselves or others physically.
Science	The study and description of natural phenomena.
Shaping	A process used to change the shape or contour of materials – shaping always involves the removal or addition of material.
Specification	An organised, detailed description of the requirements/criteria that the solution or product must meet, e.g. safety, size, material, function, human rights, environment, etc.Note: Once a product has been manufactured, the original design specifications become the features of the product, i.e. specifications before = features after.
structure	Something that has been built, made or been put together in a particular way.
system	Something that is made up of interlinked parts that function together as a whole to accomplish a goal. For example a mechanical system has a combination of mechanisms that make it function as a whole; an electrical system has interrelated electrical parts that work together to make the system do what it was designed to do.
Tabulate	Arrange data or information in the form of columns and rows.

Electrical Glossary	
amplitude modulation (AM)	a process of modulating the carrier wave in which the amplitude of the carrier wave is changed in sympathy with the modulating signal (information)
analogue	a system in which changing values are represented by a continuously variable electrical signal
audio	relating to a system concerned with frequencies within the range of human hearing
base	one terminal of a transistor through which 2% of the supply current will flow
binary logic	an assembly of digital logic elements which operate with two distinct states
binary number	a number system to the base 2
bandwidth	the range of frequencies to which a system will respond in the required manner
bipolar-transistor	a transistor in which current is carried through the semiconductor both by holes and electrons; it is a current operated device
bistable	a circuit which can have two stable states, and which can remain in either state indefinitely
Boolean algebra	a system of formal logic used for minimising complex digital systems
Capacitor	a component used in electronic circuits that has the ability to store electrical charge for a period of time
class A amplifier	a system of which the output is identical to the input in terms of frequency and shape but not in amplitude
class B amplifier	a system of which the output signal is altered in amplitude and shape representing half of the output signal
class C amplifier	a system of the output signal is altered in amplitude and shape to represent less than half of the input signal
collector	one terminal of a bipolar transistor through which 98% of the supply current will flow
conductor	a material through which an electric current can flow relatively easily
conventional current	electric current, regarded as flowing from positive to negative
central processing unit (CPU)	the main number-processing and control section of a computer. In a microcomputer the CPU will be a microprocessor.
Darlington pair	transistors used in cascade, giving high gain and high input impedance
decibel (dB)	one-tenth of a bell; a measure of power gain, on a logarithmic scale (e.g. a power level equal to 10 times the common logarithm of the ratio of the output power to the input power). The decibel is a convenient unit for representing a very large range of power gain.
delta network	a combination of three components connected to form a triangular configuration like the Greek letter delta; also known as a mesh connection
demodulation	the process of recovery of a modulating signal from a modulated carrier
design	includes the study of a variety of basic design processes that are used

digital electronics	the branch of electronics concerned with the processing of digital systems, usually in binary
diode	a component, either semiconductor or thermionic, that permits current to flow through it in one direction only
Electrical installation	encompasses the study of residential, commercial, industrial and recreational applications of Building Technology, including systems required to maintain and service them
electron flow	regarded as the flow of electrons from negative to positive
emitter	one terminal of a bipolar transistor through which 100% of the supply current will flow
energy	focuses on domestic, industrial, generation and transmission services
farad	unit of capacitance.
fibre-optic	a glass or plastic fibre used for the transmission of information through light
field-effect transistor	a type of transistor characterised by a very high input resistance that is a voltage operated device
flip-flop	general term for a **bistable, astable** or **monostable** circuit
frequency	the number of complete repetitions of a wave form in one second, expressed in Hertz
gain	the factor by which the output of a system exceeds the input
gate	a component in a digital logic circuit or one terminal of a field-effect transistor, or other semiconductor device
henry	unit of inductance
integrated circuit	an electronic system, or part of a system, produced on a silicon chip using microelectronic techniques
impedance	The resistance in a circuit which is a combination of ohmic resistance and capacitive/inductive reactance.
insulator	a material through which electric current will not easily flow
Karnaugh mapping	a visual technique used in the planning of digital systems for the minimisation of logic circuits
liquid crystal display (LCD)	a reflective display used in digital systems for the presentation of output; characterised by a very low power consumption
light-emitting diode (LED)	an electronic component in which electric current is converted directly into visible or infrared light
logic	the basic principles and applications of truth tables, interconnections of on/off circuit elements, and other factors involved in mathematical computation in a computer; also used as a general term for various types of **gates, flip-flops,** and other on/off circuits used to perform problem-solving functions in a digital computer
manufacturing and materials	product design, process and production planning, raw materials, manufacturing processes and quality control
microcomputer	a computer in which the central processing unit is a microprocessor
microprocessor	a central processing unit constructed using large-scale integration in which all the CPU circuits are fitted into a single integrated circuit
modulation	variation of the frequency, phase or magnitude of a high frequency waveform in accordance with a waveform of lower frequency
monostable	a circuit with a single stable state
multimeter	a general-purpose measuring instrument, usually able to measure

	resistance, current and voltage
negative feedback	feedback applied to a system in such a way that it tends to reduce the output
NPN	a bipolar transistor that has three terminals arranged as negative-positive-positive
Ohm	the unit of resistance (**Ω**)
operational amplifier	a highly stable, **gain,** DC amplifier, usually produced as a single integrated circuit
opto-electronics	electronic systems or devices that involve the use of light
Oscillator	an electronic system that produces a regular periodic output
Oscilloscope	an instrument for displaying electrical waveforms on a cathode ray tube
photo-resistor	also known as an LDR (light-dependent resistor); a resistor whose value depends upon the amount of light falling on it
Piezo crystal	usually refers to quartz crystal, used as a precision timing element in many circuits; may refer to the term piezoelectric.
piezoelectric effect	the direct conversion of electrical to mechanical energy or vice versa in some crystalline materials
programmable logic controller (PLC)	a control device, normally used in industrial control applications, that employs the hardware architecture of a computer and a programming language
PNP Transistor	a bipolar transistor that has three terminals arranged as positive-negative-positive.
power supply	source of electrical energy
positive feedback	feedback applied to a system in such a way that it tends to increase the output
protective device	a particular type of equipment used in electric power systems to detect abnormal conditions and to initiate appropriate corrective action
rectification	– the process of changing an alternating current to a unidirectional current
relay	an electromechanical device in which an electric current controls a switch
resistance	the property of a material that resists the flow of electrical current
speaker	an electromechanical device for converting electrical energy into sound (e.g. a loudspeaker)
star network	a set of three or more branches with one terminal of each connected at a common node to give the form of a star; also known as a Y connection
technological process	the identification, design, development and evaluation of processes and products related to Electrical Technology
thyristor	a component similar to a semiconductor diode but having in addition a gate connection by which the component, normally non-conducting, can be triggered into conduction
tolerance	generally the amount by which a specified component value can vary from the marked value
triac	a semiconductor component similar to the **thyristor** but which will conduct in either direction
uni-junction transistor	a semiconductor device used in some oscillators

voltage regulation	a process to maintain the terminal voltage within required limits despite variations in input voltage or load
wavelength	the physical distance between two similar and successive points on an alternating wave
zener diode	a semiconductor **diode**, used for voltage regulation. When the zener diode is reverse-biased, it exhibits a sudden increase in conductivity at a certain specific voltage

Plumbing Glossary	
Back Flow	The act of water traveling from one system back into any part of the main distribution system (usually by siphoning).
Back Flow Preventer	A device to prevent backflow i.e. into a potable water supply. Usually required for sprinkler systems, handheld showers, pullout faucet spouts, kitchen sprayers, etc..
Back Pressure	Pressure that resists the flow of fluid in a piping system
Back Siphonage	The negative pressure that causes backflow..
Back Vent	: Plumbing fixture's separate vent in a building drainage system
Back Wash	The process of cleaning a filter by reversing the flow of water through it. Accumulated sediments are sent to waste.
Black Water	The discharge from water closet and urinal is called Black water.
Building Drain (BD)	The building drain is the part of the lowest horizontal piping of a drainage system which receives the discharge from soil, waste and other drainage pipes inside the walls of the building and conveys it to the building sewer beginning one meter outside the building wall...
Building drainage system	consists of plumbing fixtures, drainage pipes & fittings and septic tanks/public sewer
Building Sewer	The building sewer is the part of the horizontal piping of a drainage system which extends from the end of the building drain and which receives the discharge of building drain and convey it to a public sewer, private sewer, individual sewage disposal system or other point of disposal
Check Valve	A type of backflow preventer installed in a pipe run that allows water to flow in only one direction.
Drain/waste/soil pipes	are large pipes that carry waste water and other wastes away from the home and into appropriate places such as septic tanks or sewer mains.
DWV	In modern plumbing, a **drain-waste-vent** (or DWV) is a system that allows air to enter the plumbing system to maintain proper air pressure to enable the removal of sewage and greywater from a dwelling. Drain refers to water produced at fixtures such as sinks, and showers; waste refers to water from toilets. As the water runs down, proper venting is required to allow water to flow freely, and avoid a vacuum from being created. As the water runs down air must be allowed into the waste pipe either through a roof vent (external), or an internal vent
Frost Line	The line joining the points of greatest depths below ground level up to which the moisture in the soil freezes.
Faucet	a fixture for drawing or regulating the flow of liquid especially from a pipe

Galvanizing	The process of applying a coating of zinc to the finished product to provide corrosion protection. The coating can be applied by hot dipping or electrolytic deposition.
Grey Water	The discharge from bathtubs, showers, wash basins, kitchen sink, washing machine which does not contain human excreta is called Grey Water.
Hard Water	Natural water containing impurities in various proportions. Traditional hardness is a measure of calcium or dissolved solids in a solution, measured in parts per million. Hard water generally ranges from 100 to 250 ppm.
High Altitudes	Elevations higher than 1 500 m above mean sea level (MSL).
Hydraulic Pressure	Pressure that exists in a system containing non-compressible liquid.
Invert Level	The distance between the ground surface level to the base interior level of a sewer pipe
Lagging	. Thermal insulation on pipes.
Leach Field	Porous soil area, through which septic tank leach lines run, emptying the treated waste.
Leach Lines	Pipes that carry effluent from the septic system out to the leach field.
Leach pit	Leach pits/ Soak pits/ Seepage pits are used to remove contaminants and impurities from the liquid that emerges from the septic tank and safely disperses the same into the soil.
Leakage	Loss of fluid usually due to mechanical breakdown or gasket wear.
Manhole	Access opening to a hole, usually with a cover, through which a person may enter a sewer, boiler, drain, etc. (usually round to prevent the cover from falling into the opening).
Manhole Cover	A manhole cover is a removable plate forming the lid over the opening of a manhole, to prevent anyone or anything from falling in, and to keep out unauthorized persons and material.
Outlet / Discharge	The opening through which the water exits the pump
Outlet Sewer	Pipe section in a septic system which runs between the septic tank and the drainage field.
Overflow Tube	The vertical tube inside a toilet tank that directs water into the bowl in case the ballcock malfunctions. It is usually part of the flush valve. It prevents potential water damage caused by a tank overflow. A “constant-running” condition alerts the user to a problem. On most toilets, the overflow tube also has a refill tube flowing into it, which directs water from the ballcock through the overflow tube to the bowl, after a siphon break.
Pipes	a hollow cylinder used to move liquids, gases or oil. Pipes come in several types and sizes. They can be divided into three main categories: metallic pipes, cement pipes and plastic pipes. Metallic pipes include steel pipes, galvanised iron pipes and cast iron pipes. Cement pipes include concrete cement pipes and asbestos cement pipes
Pipe fittings	A **fitting** or **adapter** is used in pipe systems to connect straight sections of pipe or tube, adapt to different sizes or shapes, and for other purposes such as regulating (or measuring) fluid flow.[1] These fittings are used in plumbing to manipulate the conveyance of water, gas, or liquid waste in domestic or commercial environments, within a system of pipes or tubes.
Plumber	is a person who installs and maintains piping for water and their drains

	and waste systems in a dwelling, business or industrial facility. He installs bathroom appliances such as showers, toilets, sinks, kitchen appliances (e.g. dishwashers), water heaters required in a new or remodelled houses or buildings. Plumbers need various skills to perform their jobs successfully like blueprint reading, ability to locate through diagrams locations for installation of pipes, fitting pipes together for the correct functioning of plumbing systems. A plumber shall be aware of basic Plumbing Codes and Standards specified.
Plumbing	Pipes, fixtures and other apparatus inside a building for bringing in water supply and removing the waste water out of the building constitute plumbing system. Plumbing is a skilled trade of working with the above pipes, fixtures and apparatus for use with water and drainage.
Plumbing Fixture	A general term applied to any plumbing receptacle, device or appliance that can be temporarily or permanently fixed in place. It is connected to the drinking-water supply or to the drainage system either by an indirect or direct connection.
Plumbing Vent Pipes	are an integral part of a plumbing system as they allow the piping to "breathe". Air flow is necessary to equalize pressure in plumbing systems and plumbing vents allow for proper flow of air through the pipes.
Pressure Pipes	that carry fresh water to various fixtures.
Raw Water	Water supplied to the plant before any treatment.
Sanitary Fitting	Fitting that joins the assorted pipes in a drain, waste, and vent system, designed to allow solid material to pass through without clogging.
Sanitary Sewer	House drain that carries wastewater away from the house to a sewer system or septic tank.
Scale:	A thin coating or layer, usually calcium on the bottom of a tank or interior parts that may prevent heat transfer.
Sewer Gas:	Gases, esp. methane, which may be combustible and poisonous from the decay of organic materials in the sewer system.
Septic Tank (ST)	A Septic Tank is a watertight concrete box, buried in the ground just outside the home. The septic tank acts as a small-scale sewage treatment system common in areas where no connection to main sewerage system provided by the local body. It helps in disposing of household sewage / wastewater safely.
Septage	Black Water which undergoes treatment in septic tank is called Septage
Sewage	is the water, carrying body wastes including human excreta and other house hold waste. a) The discharge from water closet and urinal is called Soil or Black Water. b) The discharge from bathtubs, showers, wash basins, kitchen sink, washing machine which does not contain human excreta is called Waste Water / Sullage / Grey Water.
Sewerage system	Sewerage system is a closed system of pipes from the waste receptacle to the final disposal point either on land or into a body of water and the flow is gravitational or free flow and not under pressure as in the case of water supply pipes
Sovent Single Stack	The Sovent System is an engineered single stack drainage system. It

DWV System	offers a different concept of waste and venting by slowing the velocity of liquids and solids through a series of aerator fittings and double offsets. Before entering the building drain a deaerator fitting is placed at the base of the stack to minimize solid build up and slow the drainage before entering the building drain.
Stack	Any vertical pipe in the system like vertical soil or vent pipe is called stack.
Vent Stack	Upper portion of the soil stack above the topmost fixture through which gases and odors escape

Welding Glossary	
acceptable weld	A weld that meets the applicable requirements.
acetone:	A colorless, flammable, volatile liquid used as a paint remover and as a solvent for oils and other organic compounds. Used in acetylene cylinders to saturate the monolithic filler material to stabilize the acetylene
acetylene feather	The intense white, feathery-edged portion adjacent to the cone of a carburizing oxyacetylene flame.
actual throat	The shortest distance between the weld root and the face of a fillet weld.
adhesion	A state of being stuck together. The joining together of parts that are normally separate.
aluminum	One of the chemical elements, a silvery, lightweight, easily worked metal that resists corrosion
ampere	A unit of electrical current measuring the rate of flow of electrons through a circuit. One ampere is equivalent to the current produced by one volt applied across a resistance of one ohm.
annealing	A process of heating then cooling metal to acquire desired qualities such as ductility
anode	The positive terminal of an electrical source.
alloy	A substance with metallic properties, composed of two or more chemical elements of which at least one is a metal
alloying element	Elements added in a large enough percentage to change the characteristics of the metal. Such elements may be chromium, manganese, nickel, tungsten, or vanadium; these elements are added to produce specific physical properties such as hardness, toughness, ductility, strength, resistance to corrosion, or resistance to wear.
alloy steel:	A plain carbon steel to which another element, other than iron and carbon, has been added in a percentage large enough to alter its characteristics
alternating current (AC)	An electric current that reverses its direction periodically.
alternative fuels	Propane, methylacetylene propadiene (MPS), natural gas, or fuel gases, other than acetylene, used for welding or cutting.
arc blow	The deflection of an arc from its normal path because of magnetic forces.
arc force	The axial force developed by an arc plasma.
arc gap	A nonstandard term used for the arc length.
arc gouging	Thermal gouging that uses an arc cutting process variation to form a bevel or groove.
arc plasma	A gas that has been heated by an arc to at least a partially ionized

	condition, enabling it to conduct electric current.
arc spraying	A thermal spraying process using an arc between two consumable electrodes of surfacing materials as a heat source and a compressed gas to atomize and propel the surfacing material to the substrate
arc strike	A discontinuity resulting from an arc, consisting of any localized re-melted metal, heat-affected metal, or change in the surface profile of any metal object.
arc time	The time during which an arc is maintained in making an arc weld.
arc welding	Arc welding is a group of welding processes in which fusion is produced by heating with an electric arc or arcs with or without the application of pressure and with or without the use of filler metal.
arc voltage	The voltage across the arc.
axis of a weld:	A line through the length of a weld, perpendicular to and at the geometric center of its cross-section.
backing	A material or device placed against the back side of the joint, or at both sides of a weld in electroslag and electrogas welding, to support and retain molten weld metal. The material may be partially fused or remain unfused during welding and may be either metal or nonmetal.
backstep sequence	A longitudinal sequence in which weld passes are made in the direction opposite to the progress of welding.
bare electrode	A filler metal electrode consisting of a single metal or alloy that has been produced into a wire, strip, or bar form and that has had no coating or covering applied to it other than that which was incidental to its manufacture or preservation.
base metal (material)	The metal (material) to be welded, brazed, soldered, or cut
butt joint	A joint between two members aligned approximately in the same plane.
concavity	The maximum distance from the face of a concave fillet weld perpendicular to a line joining the weld toes.
convexity	The maximum distance from the face of a convex fillet weld perpendicular to a line joining the weld toes.
covered electrode	A composite filler metal electrode consisting of a core of a bare electrode or metal cored electrode to which a covering sufficient to provide a slag layer on the weld metal has been applied. The covering may contain materials providing such functions as shielding from the atmosphere, deoxidation, and arc stabilization and can serve as a source of metallic additions to the weld.
crater	In arc welding, a depression at the termination of a weld bead or in the molten weld pool
depth of fusion	The distance that fusion extends into the base metal or previous pass from the surface melted during welding.
DC or direct current	Electric current which flows only in one direction. In welding, an arc welding process wherein the power supply at the arc is direct current.
fillet weld	A weld of approximately triangular doss section joining two surfaces approximately at right angles to each other in a lap joint, T-joint or corner joint.
fillet weld leg	The distance from the joint root to the toe of the fillet weld.
flat position	The welding position used to weld from the upper side of the joint; the face of the weld is approximately horizontal.
flux	Material used to prevent, dissolve, or facilitate removal of oxides and other undesirable surface substances

gas metal arc welding(GMAW)	An arc welding process that produces coalescence of metals by heating them with an arc between a continuous filler metal (consumable) electrode and the work. Shielding is obtained entirely from an externally supplied gas or gas mixture.
gas tungsten arc welding (GTAW)	An arc welding process that produces coalescence of metals by heating them with an arc between a tungsten (non-consumable) electrode and the work. Shielding is obtained from a gas or gas mixture. Pressure may or may not be used and filler metal may or may not be used. (This process has sometimes been called TIG welding, a non-preferred term.)
groove weld	A weld made in the groove between the work pieces.
heat-affected zone	That portion of the base metal that has not been melted, but whose mechanical properties or microstructure have been altered by the heat or welding, brazing, soldering, or cutting.
horizontal position	(a) fillet weld - The position in which welding is performed on the upper side of an approximately horizontal surface and against an approximately vertical surface. (b) groove weld - The position of welding in which the weld axis lies in an approximately horizontal plane and the weld face lies in an approximately vertical plane.
joint penetration	The depth a weld extends from its face into a joint, exclusive of reinforcement.
lap joint	A joint between two overlapping members in parallel planes
Lathe machine	A lathe is a machine tool used to shape wooden or metallic products. It furnishes a wooden or metal piece by rotating it about an axis while a stationary cutting tool keeps removing unwanted material from the workpiece to form the desired shape.2
machine welding	Welding with equipment that performs the welding operation under the constant observation and control of a welding operator. The equipment may or may not load and unload the work pieces.
manual welding	A welding operation performed and controlled completely by hand.
melting rate	The weight or length of electrode melted in a unit of time
open circuit voltage	The voltage between the output terminals of the welding machine when no current is flowing in the welding circuit.
overhead position	The position in which welding is performed from the underside of the joint.
overlap	The protrusion of weld metal beyond the weld toe or weld root.
peening	The mechanical working of metals using impact blows.
porosity	Cavity type discontinuities formed by gas entrapment during solidification.
post heating	The application of heat to an assembly after welding, brazing, soldering, thermal spraying or cutting operation.
pre heating	The application of heat to the base metal immediately before welding, brazing, soldering, thermal spraying, or cutting
root opening	A separation at the joint root between the work pieces.
root penetration	The depth that a weld extends into the joint root.
seal weld	Threaded joint sealed, without thread compound, by back welding.
semiautomatic arc welding	Arc welding with equipment that controls only the filler metal feed. The advance of the welding is manually controlled
shielded metal arc welding	(SMAW) An arc welding process that produces coalescence of metals by heating them with an arc between a covered metal electrode and the workpieces. Shielding is obtained from decomposition of the electrode covering. Pressure is not used and filler metal is obtained from the

	electrode.
spatter	The metal particles expelled during fusion welding which do not form a part of the weld.
stress relief heat treatment	Uniform heating of a structure or a portion thereof to a sufficient temperature to relieve the major portion of the residual stresses, followed by uniform cooling.
stringer bead	A type of weld bead made without appreciable weaving motion.
tack weld	A weld made to hold parts of a weldment in proper alignment until the final welds are made.
tungsten electrode	A non-filler metal electrode used in arc welding or cutting made principally of tungsten
underbead crack	A crack in the heat-affected zone generally not extending to the surface of the base metal.
undercut	A groove melted into the base metal adjacent to the weld toe or weld root and left unfilled by weld metal
vertical position	The position of welding in which the weld axis is approximately vertical.
weave bead	A type of weld bead made with transverse oscillation.
weld	A localized coalescence of metals or non-metals produced either by heating the materials to welding temperature, with or without the application of pressure, or by the application of pressure alone, and with or without the use of filler material.
weld face	The exposed surface of a weld on the side from which welding was done.
weld metal That	portion of a weld which has been melted during welding.
weld pass	A single progressional of welding or surfacing along a joint or substrate. The result of a pass is a weld bead, layer, or spray deposit.
weld pool	The localized volume of molten metal in a weld prior to its solidification as weld metal. weld root: The points, as shown in cross section, at which the back of the weld intersects the base metal surfaces
weld size	(a) groove weld size - The joint penetration of a groove weld. (b) fillet weld size - For equal leg fillet welds, the leg lengths of the largest isosceles right triangle which can be inscribed within the fillet weld cross section For unequal leg fillet welds, the leg lengths of the largest right triangle that can be inscribed within the fillet weld cross section.
weld toe	The junction of the weld face and the base metal
welding procedure	The detailed methods and practices involved in the production of a weldment.
welding rod	A form of welding filler metal, normally packaged in straight lengths, that does not conduct electrical current.
weldment	An assembly whose component parts are joined by welding.

Engineering Glossary	
Acceptance	The process of assessing whether a system satisfies all its requirements
Acceptance test	A test that assesses whether a system satisfies all requirements.
Activity Diagram	A diagram type in UML which models the flow of actions in a system or in a component including the data flows and areas of responsibility where necessary.
Actor	Generally in Requirements Engineering, a person, a system or a technical device in the context of a system that interacts with a

	system.
Adequacy (of a requirement)	The degree to which a requirement expresses the stakeholders true desires and needs.
Application domain	Those parts of the real world that are relevant for determining the context of a system.
Artifact	An intermediate or final result of system development; for example, a requirements specification.
Attribute	A characteristic property of an entity.
Baseline	A stable, change-controlled configuration of artifacts
Behaviour model	A model describing the behaviour of a system or component
Bug	A defect
Changeability (of an artefact)	The degree to which an artifact enables a required modification of the artifact.
Checking (requirements)	Comprises requirements validation and checking requirements for qualities such as unambiguity or comprehensibility.
Class	Represents a set of objects of the same kind by describing the structure of the objects, the ways they can be manipulated and how they behave.
Completeness (of requirements)	For a single requirement: the degree to which a requirement contains all necessary information which is necessary to for developing a system that satisfies a stakeholders' desires and needs.
Compliance	The capability of an artifact to adhere to standards, regulations, laws, or other formally imposed documents.
Component	In general; a delimit able part of a system.
Configuration	A consistent set of logically coherent units. The units are individually identifiable artifacts in at most one version per unit.
Conformity (of requirements)	A degree to which a requirements specification conforms to regulations given in some standard.
Consistency (of requirements)	The degree to which a set of requirements is free of contradicting statements.
Constraint	A requirement that limits the solution space beyond what is necessary for meeting the given functional requirements and quality requirements and quality requirements.
Context	In general; the network of thoughts and meanings needed for understanding phenomena. It is also the part of a system's environment being relevant for understanding the system and its requirements.
Context boundary	Boundary between the context of a system and those parts of the application domain that are irrelevant for the system and its requirements.
Context diagram	A diagrammatic representation of a context model.
Context model	A model describing a system in its context.
Correctness	The degree to which the information contained in an artifact is proven as true this is also a synonym of adequacy.
Customer	A person or organisation who receives a product or service.
Customer requirements specification	A course description of the required capabilities of a system from the customer's perspective.
Dataflow diagram	A diagram modelling the functionality of a system or component by processes (also called activities), data stores and data flows. Incoming data flows trigger processes which then consume the

	received data, transform them, read/write persistent data held in data stores and then produce new data flows which may be intermediate results that trigger other processes or final results that leave the system.
Defect	A spot in an artifact that is incorrectly described or crafted. It can also be called a fault or a bug.
Domain	A range of relevant things (for some given matter),
Effectiveness	The degree to which something actually happens in the way it ought to happen.
Efficiency	The degree to which a result is achieved with minimum consumption of resources.
End user	User
Entity	In general; an element or set of elements that may stand for any conceivable item, e.g., a system, a part of a reality, a thing, an organisation, a process etc.
Entity relationship diagram	A graphic representation of an entity relationship model.
Error	A discrepancy between an observed or result and the specified behaviour or result. AN error is typically a symptom for the existence of a fault or defect in some artifact. Though there may be not much distinction between the notions of error and fault.
Fault	Defect
Fault tolerance	The capability of a system to continue normal operations despite the presence of (hardware and software)faults.
Feature	A delimitable characteristic of a system that provides value for stakeholders.
Goal	A desired state of affairs that a stakeholder wants to achieve. They describe the intentions of stakeholders that may conflict with one another.
Inspection	A kind of review where the artifact under review is inspected by a group of experts according to given criteria. The experts' findings are then collected and consolidated.
Language	A structured set of signs for expressing and communicating information. Signs are elements that are used for communication; expressions in a language, symbols, gestures etc.
Model	An abstract reperentation of an existing reality or a reality to be created.
Modeling language	A language expressing models of a different kind. Maybe textual, graphic or a some combination thereof.
Performance requirement	A requirement describing a performance characteristic (timing, speed, volume, capacity,)
Prototype	In manufacturing; apiece which is built prior to the start of mass production.
Quality	The degree to which a set of inherent characteristics of an entity fulfils requirements.
Redundancy	Multiple occurrence of the same information or resource.
Reliability	The capability of a system to maintain a specified level of functionality and performance when used under specified conditions.
Requirement	A condition or capability needed by a user to solve a problem or achieve an objective.
Requirements analysis	Analysis of elicited requirements in order to understand and document

	them.
Requirements baseline	A baseline for a set of requirements.
Requirements engineer	A person who- in collaboration with stakeholders-elicits, documents, validates and manages requirements.
Review	A formally organised endeavour for checking an artifact by a group of experts. Checking may be performed with respect to both contents and conformance.
Risk	AN event that threatens the success of an endeavour. A risk is assessed in terms of its probability and potential damage.
Safety	The capability of a system to achieve an acceptable level of probability that operating the system will not result in harming people, property or the environment.
Scope (of a system)	The range of things that can be shaped and designed when developing a system.
Security	The capability of a system to protect (a) its data and resources against unauthorised use and (b) its legitimate users against denial of service.
Sequence diagram	A diagram type in UML which models the interactions between a selected set of objects and/ or actors in the sequential order that those interactions occur.
Specification	A systematically represented description of the properties of an entity (a system, a device, etc.) that satisfies criteria.
Stakeholder	A person or organisation that has a (direct or indirect) influence on a systems requirements.
Standard	A uniform regulation for perceiving, manufacturing or executing something.
System context	A requirement
System requirements specification	A requirements specification pertaining to a system.
Tool (in software engineering)	A (software) system that helps develop, operate and maintain systems.
Traceability (of requirements)	The ability to trace a requirement(1) back to its origins, (2) forward to its implementation in design and code,(3) to requirements it depends on (and vice-versa). Origins maybe stakeholders, documents, rationales, etc.
UML	Abbreviation for Unified Modeling Language, a standardised language for modelling problems or solutions
Useability	The capability of a system to be understood, learned, used, and liked by its users.
Use case	A description of the interactions possible between actors and a system. The boundary between the actors and the use cases constitutes the system boundary.
Use case diagram	A diagram type in UML that models the actors and the use cases of a system.
User	A person who uses the functionality provided by a system. Also called an end user.
Validation (of requirements)	The process of checking whether documented requirements match the stakeholders' needs.
Verifiability (of requirements)	The degree to which the fulfilment of a requirement by an implemented system can be checked. E.g. by defining acceptance test

	cases, measurements or inspection procedures.
Version (of an entity)	If an entity exists in multiple exists in multiple, time ordered occurrences, where each occurrence has been created by modifying one of its predecessors, every occurrence is a version of that entity.
View	An excerpt from an artefact, containing only those parts one is currently interested in. A view can abstract or aggregate parts of the artefact.
Viewpoint	A certain perspective on the requirements of a system.
Walkthrough	A kind of review where the author of an artefact under review walks a group of experts systematically through the artefact. The experts' findings are then collected and consolidated.

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APPENDICES

APPENDIX 1: BLOOM'S TAXONOMY

LEVEL OF UNDERSTANDING	KEY VERBS
CREATING **Can the student create a new product or point of view?**	Construct, design, and develop, generate, hypothesize, invent, plan, produce, compose, create, make, perform, plan, produce, assemble, formulate,
EVALUATING **Can the student justify a stand or decision?**	Appraise, argue, assess, choose, conclude, critique, decide, defend, evaluate, judge, justify, predict, prioritise, provoke, rank, rate, select, support, monitor,
ANALYZING **Can the student distinguish between the different parts?**	Analysing, characterise, classify, compare, contrast, debate, criticise, deconstruct, deduce, differentiate, discriminate, distinguish, examine, organise, outline, relate, research, separate, experiment, question, test,
APPLYING **Can the student use the information in a new way**	Apply, change, choose, compute, dramatize, implement, interview, prepare, produce, role play, select, show, transfer, use, demonstrate, illustrate, interpret, operate, sketch, solve, write,
UNDERSTANDING **Can the student comprehend ideas or concepts?**	Classify, compare, exemplify, conclude, demonstrate, discuss, explain, identify, illustrate, interpret, paraphrase, predict, report, translate, describe, classify,
REMEMBERING **Can the student recall or remember the information?**	Define, describe, draw, find, identify, label, list, match, name, quote, recall, recite, tell, write, duplicate, memorise, recall, repeat, reproduce, state,

APPENDIX 2: 21ST CENTURY SKILLS

WAYS OF THINKING	**Creativity and innovation** • Think creatively • Work creatively with others • Implement innovations **Critical thinking, problem solving and decision making** • Reason effectively and evaluate evidence • Solve problems • Articulate findings **Learning to learn and meta-cognition** • Self-motivation • Positive appreciation of learning • Adaptability and flexibility
WAYS OF WORKING	**Communication** • Competency in written and oral language • Open minded and preparedness to listen • Sensitivity to cultural differences **Collaboration and teamwork** • Interact effectively with others • Work effectively in diverse teams • Prioritise, plan and manage projects
TOOLS FOR WORKING	**Information literacy** • Access and evaluate information • Use and manage information • Apply technology effectively **ICT literacy** • Open to new ideas, information, tools and ways of thinking • Use ICT accurately, creatively, ethically and legally • Be aware of cultural and social differences • Apply technology appropriately and effectively
LIVING IN THE WORLD	**Citizenship – global and local** • Awareness and understanding of rights and responsibilities as a global citizen • Preparedness to participate in community activities • Respect the values and privacy of others **Personal and social responsibility** • Communicate constructively in different social situations

	• Understand different viewpoints and perspectives **Life and career** • Adapt to change • Manage goals and time • Be a self-directed learner • Interact effectively with others

APPENDIX 3: TEACHING AND LEARNING STRATEGIES

STRATEGY	TEACHER	STUDENTS
CASE STUDY **Used to extend students' understanding of real life issues**	Provide students with case studies related to the topic of the lesson and allow them to analyse and evaluate.	Study the case study and identify the problem addressed. They analyse the problem and suggest solutions supported by conceptual justifications and make presentations. This enriches the students' existing knowledge of the topic.
DEBATE **A method used to increase students' interest, involvement and participation**	Provide the topic or question of debate on current issues affecting a bigger population, clearly outlining the expectations of the debate. Explain the steps involved in debating and set a criteria/standard to be achieved.	Conduct researches to gather supporting evidence about the selected topic and summarising the points. They are engaged in collaborative learning by delegating and sharing tasks to group members. When debating, they improve their communication skills.
DISCUSSION **The purpose of discussion is to educate students about the process of group thinking and collective decision.**	The teacher opens a discussion on certain topic by asking essential questions. During the discussion, the teacher reinforces and emphasises on important points from students responses. Teacher guide the direction to motivate students to explore the topic in greater depth and the topic in more detail. Use how and why follow-up questions to guide the discussion toward the objective of helping students understand the subject and summarise main ideas.	Students ponder over the question and answer by providing ideas, experiences and examples. Students participate in the discussion by exchanging ideas with others.

GAMES AND SIMULATIONS **Encourages motivation and creates a spirit of competition and challenge to enhance learning**	Being creative and select appropriate games for the topic of the lesson. Give clear instructions and guidelines. The game selected must be fun and build a competitive spirit to score more than their peers to win small prices.	Go into groups and organize. Follow the instructions and play to win
OBSERVATION **Method used to allow students to work independently to discover why and how things happen as the way they are. It builds curiosity.**	Give instructions and monitor every activity students do the activity.	Students possess instinct of curiosity and are curious to see the things for themselves and particularly those things which exist around them. A thing observed and a fact discovered by the child for himself becomes a part of mental life of the child. It is certainly more valuable to him than the same fact or facts learnt from the teacher or a book. Students Observe and ask essential questions Record Interpret
PEER TEACHING & LEARNING ***(power point presentations, pair learning)*** **Students teach each other using different ways to learn from each other. It encourages; team work, develops confidence, feel free to ask questions, improves communication skills and most importantly develop the spirit of inquiry.**	Distribute topics to groups to research and teach others in the classroom. Go through the basics of how to present their peer teaching.	Go into their established working groups. Develop a plan for the topic. Each group member is allocated a task to work on. Research and collect information about the topic allocated to the group. Outline the important points from the research and present their findings in class.
PERFORMANCE-RELATED TASKS ***(dramatization, song/lyrics, wall magazines)*** **Encourages creativity and take on the overarching ideas of the topic and are able to recall them at a later date**	Students are given the opportunity to perform using the main ideas of a topic. Provide the guidelines, expectations and the set criteria	Go into their established working groups. Be creative and create dramas, songs/lyrics or wall magazines in line with the topic.
PROJECT (individual/group) **Helps students complete tasks individually or**	Teacher outline the steps and procedures of how to do and the criteria	Students are involved in investigations and finding solutions to problems to real life experiences. They carry out researches to analyse the causes and

collectively		effects of problems to provide achievable solutions. Students carefully utilise the problem-solving approach to complete projects.
USE MEDIA & TECHNOLOGY to teach and generate engagement depending on the age of the students	Show a full movie, an animated one, a few episodes from documentaries, you tube movies and others depending on the lesson. Provide questions for students to answer before viewing	Viewing can provoke questions, debates, critical thinking, emotion and reaction. After viewing, students engage in critical thinking and debate

APPENDIX 4: STEAM

This Sample STEAM Lesson Planning is for Business Studies but can be applied to Technology and Industrial Arts.

Strand 2: Business Management

Unit 5: Information Technology

Content Standard 2.5: Students will be able to explain the information technology concepts and examine the systems and tools needed to gather, access, analyse, synthesize, evaluate, manage, and disseminate information.

Benchmark: 12.2.5.2. Explain the steps involved in entering and manipulating text and data using a variety of input technologies.

Topic: Steps in entering and manipulating text and data using a variety of input technologies

Learning Objective: By the end of this topic, students will be able to explore the steps in entering and manipulating text and data using a variety of input technologies.

Purpose of Assessing the Topic (Benchmark):
To assess whether students can be able to use the MS Excel to positively explore the steps in entering and manipulating text and data using a variety of input technologies

How the Performance Task will be done: Group Project Presentation

Performance Standard: By the end of the project, students will be able to use the MS Excel application to positively explore the steps in entering and manipulating text and data using a variety of input technologies.

Situation (Authentic)

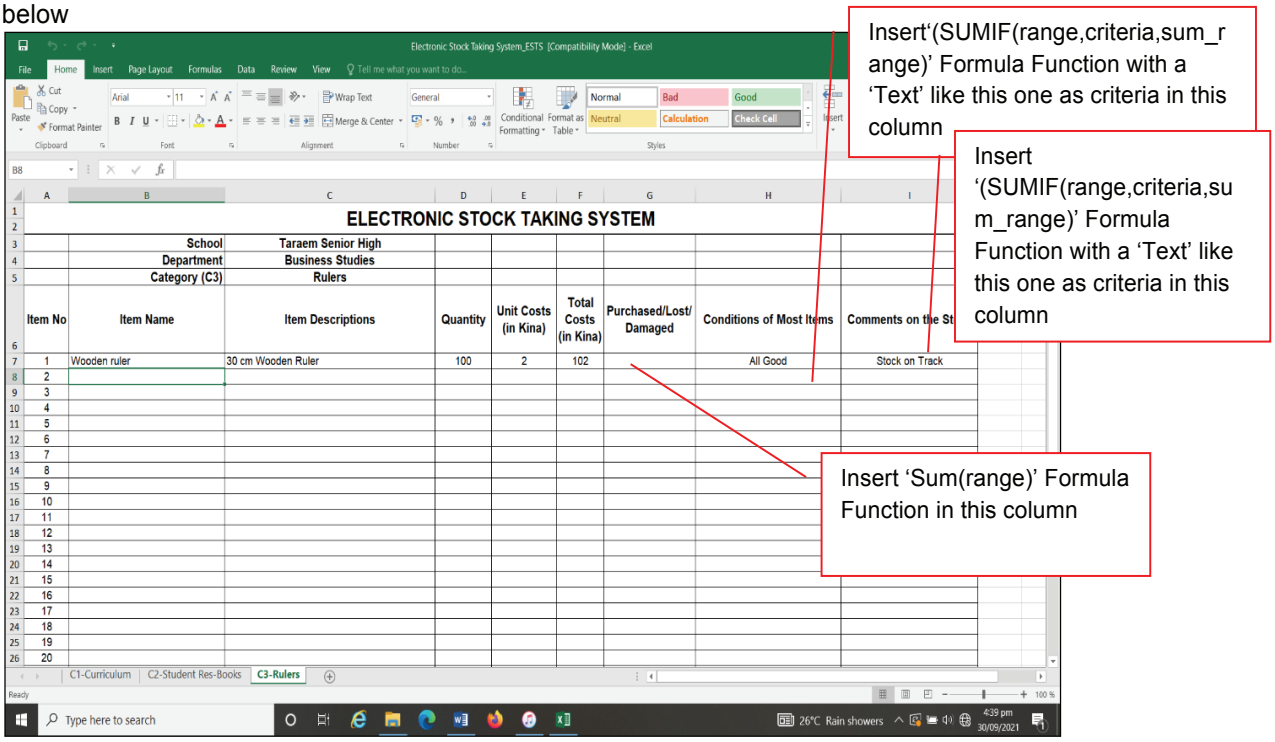
Your school should have been accounting for all the stock of the materials it has. The stocks of materials may include the materials like all the electronic equipment, the tools in the tool store, the sports equipment and materials and the departmental equipment and materials. There is a manual stock taking system (stock book) to take stock of all the equipment and materials in the school. With the manual stock taking system currently used in schools, the Principal and the teachers have experiences with improper stocks quantity checks and stocks updates.

When this was reported by the Principal in a BOG meeting, the BOG moved a motion for the development of a functional Electronic Stock Taking System (ESTS) using the current available technology. In order to meet the expectations of the BOG, the principal and teachers task the Grade 12 students to participate in the creation of the ESTS using the MS Excel application.

To achieve this, the school is now requesting the Business Studies Department to design an Assessment Task for a grade to assist and guide the activity. The Business Studies Department has opted to design the Task for Grade 12 students as one of their projects towards their assessments. The school principal also announces that the best ESTS assessed by the Business Studies Department will be rewarded as it is also a competition.

Task Descriptions:

- Select a Subject Department or a Specialist Room (Store-room, Tool-room) in your school to Collect Data of different items for your Electronic Stock Taking System (ESTS) project.
- Plan and write the steps of creating the Electronic Stock Taking System.
- Use the steps to design and create the ESTS using the MS Excel application like the sample format below



- The ESTS must contain appropriate contents and formulae functions.
- It must also contain comments to justify the status of the individual stocks.
- This ESTS has to be user-friendly to the school officials to use.
- Presentation of the MS Excel of ESTS must not be more than 2 minutes (maximum time limit)
- Submit your MS Excel ESTS for assessment.

- Whole class to observe and use the rubric below to assess the Presentation of the MS Excel of ESTS.

Materials: Computer, Tablets, Smartphones, MS Excel Application

Related Benchmarks to this Business Studies Benchmark in Business Studies and other Subject areas:

Subjects	Reference Benchmark Codes
8. Arts (Visual Arts)	12.3.2.2
9. Character Social Development (CSD)	12.1.5.2, 12.1.5.3
10. English	12.2.1.2
11. Business Studies	12.2.5.1
12. General Mathematics	12.4.1.3
13. Technology Industrial Arts (TIA)	12.4.1.4

A Sample Scoring Rubric

Annotation 1
A statement (descriptors) describing the expected the level of competency for each prescribed criteria

Annotation 2
Rating scales includes either numerical or descriptive labels

Annotation 3
Indicators or qualifiers ensures that the levels reflect variance in quality

Annotation 4
Shaded descriptors indicating Student's Marks for the corresponding

Criteria	Achieved 3	Progressing 2	Novice 1	Scoring
Collecting Data for Electronic Stock Taking System (ESTS)	**Well** organised paper with **clarity** identifying, classifying and enumerating the different items.	Organised paper with some **clarity** identifying, classifying and enumerating the different items.	**Poorly** organised paper that lacked **clarity** identifying, classifying and enumerating the different items.	2/3
Development of ESTS	**Collaboratively organise** and categorise data of different items. Illustrate the **most likeable** way the Data can displayed in the MS Excel Application format.	Display **some collaboration** to organise and categorise data of different items. Illustrate a **likeable** way the Data can displayed in the MS Excel Application format.	Display **very little collaboration** to organise and categorise data of different items. Illustrate a way the Data can displayed in the MS Excel Application format.	1/3

Content and Formulae Functions in ESTS	Typed **accurately all the appropriate contents** for each columns and typed in the **all correct** formulae function symbols for the 'SUMrange function' and 'SUMIF function' in **all** their correct MS Excel cell references	Typed **most contents** in their **appropriate** columns and typed in **most** of the **correct** formulae function symbols for the 'SUMrange function' and 'SUMIF function' in **some** of their MS Excel cell references	Typed **very few contents** in their **appropriate** columns and typed in **very few** formulae function symbols for the 'SUMrange function' and 'SUMIF function' in **very few** of their MS Excel cell references	3/3
Presentation of ESTS	**Displayed time consciousness** with **adequate** delivery skills (posture, language), **expected** communication skills and social skill (relativity and connectivity)	**Mostly** time consciousness with **some adequate** delivery skills (posture, language), **some** expected communication skills and **some** social skill (relativity and connectivity) displayed	**Very little** time consciousness with **little adequate** delivery skills (posture, language), **little** expected communication skills and **little** social skill (relativity and connectivity) displayed	3/3
Portfolio of ESTS Developments and MS Excel ESTS – The Product	A **comprehensive** portfolio with **all** the Steps in planning, designing and developing the ESTS with a **complete** and **functional** MS Excel of the ESTS.	A portfolio with **most** of the Steps in planning, designing and developing the ESTS with a **complete** and **malfunctioned** MS Excel of ESTS.	A portfolio with **very few** of the Steps in planning, designing and developing the ESTS with an **incomplete** and **malfunctioned** MS Excel of ESTS.	3/3
				12/15

A Sample Portfolio

1. Idea Generation

a. Inform the students that most the projects (like shirt, bowl, furniture) are based on existing ideas to solve a problem. Ask the students to choose from these list words/phrase (**substitute, combine, adapt, modify, put to another use, eliminate, reverse/rearrange**) one word/phrase that provokes your thoughts about their project idea to solve an existing problem. The word/phrase selected by students will direct the approach the students take towards the ideas of the students projects.

Write this word/phrase in the space provided below.

_____

b. Guide the students to explain how this word/phrase is in line with their ideas of a project.

_____

_____

_____

c. Assist students to develop an inquiry question based on their project idea.

_____

2. Research

Inform the students that their project idea needs to be validated to ensure that the product get the people who will pay for it and that they won't waste time, money, and effort on an idea that won't sell.

a. Students to validate the product ideas by to conducting a survey to get feedbacks from the potential buyers. The students will have to prepare a survey questionnaire with a number of essential questions on their product ideas like the one below.

***Survey on Project Idea**: (Name of the project idea)*

1) Explain how useful is the furniture/garment to you?

_____

2) Explain how often do you have this dish?

_____

3) How much would you like to spend on this garment/furniture if you intend to buy it?

_____

b. At this stage, students should consider the **Safety precautions** to be taken in the stages of **Planning, Prototyping, Production and Marketing**. They can do this by responding to related questions as show in the examples below.

1) What is the First aid symbol?

Students draw the FIRST AID SYMBOL here

2) Explain what is workshop safety?

_____
_____
_____

3) How can safety be enforced in working practices to minimize the risks associated working environment?

_____
_____
_____

4) In the following stages (**Planning, Prototyping, Production and Marketing**), the students will draw 2 items/tools and describe the type of injury that may occur through the incorrect use of each of the items/tools

1. Planning Stage	
Item/Equipment/Tool	***Injury that may occur***
Name: _____ *(Drawing of the item/equipment/tool)*	*1.* *2.* *3.*
Name: _____ *(Drawing of the item/equipment/tool)*	*1.* *2.* *3.*
2. Prototyping Stage	
Name: _____ *(Drawing of the item/equipment/tool)*	*1.* *2.* *3.*
Name: _____ *(Drawing of the item/equipment/tool)*	*1.* *2.* *3.*

5) The students will have state what action they should take to assist the teacher next to each of the injuries described below.

Injury	***Action taken by student***
A student using knife a cuts his/her finger.	*1.* *2.*
A student cooking burns his/her hand on a hot pot	*1.* *2.*

3. Planning

Explain to the students that it is important to take the time to plan carefully before they begin to build your prototype. They need to decide on a number thing when building their prototype. Inform the students characteristics of materials/food to be used texture, design, hardness, durability and colour) etc. All of these is determine by the purpose and the function of the project.

a. Tasting

1) In terms food, students need to actually taste ingredients separately first and after the different ingredients are combined. They will also identify the various ways to cook them. Students will have find out ways to improve the taste for their intended project dish.

b. Sketching

1) In terms of fabric garments and construction technology projects, students have to sketches of the various prototypes needs to prepared and evaluated for their practicality and usefulness. They also need to consider the purpose and function of their project for they will determine the materials to be used, the characteristics for the materials to be used. Students have to determine ways to improve the design of their fabric garment and construction technology projects.

4. Prototyping

a. For Fabrics and construction technology, the students will have to select projects sketches that will be made into prototypes, be sampled and do detailed working diagrams/patterns/templates to ergonomics standards. Students evaluate their prototype and make appropriate changes on the detailed working diagrams/patterns/templates to meet the ergonomics standards.

b. As for food, students written up a recipe and cook sample dishes various ways. Students will make appropriate taste evaluation of each dish to select the one to use as the project.

5. Production

a. Students need to be selective gathering the required materials and food ingredients as per their materials/recipe list to for the project based on their prototypes and the ergonomics standards. This is because of the conditions of the raw materials to be used for their project. The materials have to be evaluated for defects or damages acquired by the materials to select the appropriate materials. Students should select the materials according to the descriptions of materials needed for their project.

b. For Food, students have to use the confirmed recipe from the prototype to prepare and create the dish.

c. Students will use the confirmed outlined garment patterns/templates to measure and cut out the material list for their project. For technology construction, students utilise the confirmed cutting list and the detailed working diagram to cut out the materials for their project like the one below.

Project Name	
Total Unit (No of Project)	

Material List				
Quantity	**Name of Material(s)**	**Description(s)**	**Unit Cost**	**Total Cost**

d. While working on the projects, the students will have to fill in and complete the table of the Procedures in the Production of their project

Procedure (How to make my Project)

NO	**OPERATIONS**	**NEEDED TOOLS/EQUIPMENT**
1		
2		
3		
4		
5		
6		
7		

6. Costing

a. The students are required to calculate the cost of their project. To calculate their project, they have to calculate the cost of all the materials used in their project, the labour cost (based on their rate per hour) and these adds up to the selling/marketing cost. Students have to add 30% markup of the selling/marketing cost to determine the selling price.

b. Students should also evaluate the responses from product research survey as they could influence the cost the project.

c. The cost for making the project are:

4) Material costs: K____

5) Labor costs (No of Hours Spent X Your Rate): 10 hrs x K ___ = K____

6) Selling/Marketing cost: K____

g. Students will use the simple formula below to calculate a good markup percentage for their project:

MARKUP PERCENTAGE = (SELLING PRICE – UNIT COST) / UNIT COST x 100%

h. They simply take the sales price minus the unit cost, and divide that number by the unit cost. Then, multiply by 100 to determine the markup percentage.

For example, if the project costs K50 to make and the selling price is K75, then the markup percentage would be 50%: (K75 – K50) / K50 = 0.50 x 100 = 50%.

7. Marketing

a. Students need to review the responses/feedback from the Surveys done on the project idea and inform the interested people of the completed project.

b. Students could put out flyers, brochures and posters to promote the completed project to the public.

c. Students could create promotional webpages on social media to market the product

A Sample Student Self-Assessment

Student Self-Assessment/Teacher Assessment				**Date: / /**
Project Name:				**Term:**
Student Name:		**Grade:**	**Class:**	**Total Score:**

		Give yourself a score of 3, or 2, or 1, or 0 for performances				Teacher scores of students' performances			
	CRITERIA	**Students' scores**				**Teacher's scores**			
		3	**2**	**1**	**0**	**3**	**2**	**1**	**0**
1	**Idea Generation** a. Selection of word/phrase in line with project idea								
	b. Explanation of the word/phrase in-line with project and development of main issue question								
2	**Research** a. Development of a survey questionnaire with a number of essential questions on their project ideas								
	b. Safety for stages of **Planning, Prototyping, Production and Marketing**. i. Draw safety precaution sign								
	ii. Tool/items and injuries that may occur								
	iii. Injuries and actions taken by students								
3	**Planning** a. Identify the various ways to cook them and find out ways to improve the taste for their intended project dish								
4	**Prototyping** a. Select projects sketches that will be made into prototypes, be sampled and do detailed working diagrams/patterns/templates to ergonomics standards								
5	**Production** a. Select the materials according to the descriptions of materials needed for their								

	project.								
6	**Costing** a. Calculate their project, they have to calculate the cost of all the materials used in their project, the labour cost (based on their rate per hour) and these adds up to the selling/marketing cost.								
7	**Marketing** a. Review the responses/feedback from the Surveys done on the project idea and inform the interested people of the completed project. b. Create promotional webpages on social media to market the product								

A Sample Peer Student Assessment

Student Self-Assessment/Teacher Assessment										**Date: / /**			
Project Name:										**Term:**			
Student Name:					**Grade:**					**Total**			
Peer's Name:					**Class:**					**Score: /**			
		Give yourself a score of 3, or 2, or 1, or 0 for performances				Give your peer a score of 3, or 2, or 1, or 0 for performances				Teacher scores of students' performances			
	CRITERIA	**Students' scores**				**Peer's scores**				**Teacher's scores**			
		3	**2**	**1**	**0**	**3**	**2**	**1**	**0**	**3**	**2**	**1**	**0**
1	**Idea Generation** c. Selection of word/phrase in line with project idea												
	d. Explanation of the word/phrase in-line with project and development												

	of main issue question												
2	**Research** c. Development of a survey questionnaire with a number of essential questions on their project ideas												
	d. Safety for stages of **Planning, Prototyping, Production and Marketing**. iv. Draw safety precaution sign												
	v. Tool/items and injuries that may occur												
	vi. Injuries and actions taken by students												
3	**Planning** b. Identify the various ways to cook them and find out ways to improve the taste for their intended project dish												
4	**Prototyping** b. Select projects sketches that will be made into prototypes, be sampled and do detailed working diagrams/patterns/templates to ergonomics standards												
5	**Production** b. Select the materials according to the descriptions of materials needed for their project.												
6	**Costing** b. Calculate their project, they have to calculate the cost of all the materials used in their project, the labour cost (based on their rate per												

	hour) and these adds up to the selling/marketing cost.												
7	**Marketing** c. Review the responses/feedback from the Surveys done on the project idea and inform the interested people of the completed project. d. Create promotional webpages on social media to market the product												

Samples of Student Response System Applications

These are web based apps that work with a multitude of devices and operating systems. Here are the 4 best student response systems that interface with multiple devices.

1. Kahoot

Kahoot is a utility that allows teachers to create quizzes and surveys, and then send them to students. Teachers may allow students an unlimited amount of time to respond to questions, or they may set a time limit on each questions. Points are awarded to students both for correct answers and for responding quickly with those correct responses. Teachers can track students as they make progress.

2. Socrative

Socrative works excellently both for students working on their own or for students who are collaborating with one another. Socrative offers several different ways for instructors to engage their students. There are space races in which students can compete in teams or as individuals to answer questions as quickly and accurately as possible. Polls allow instructors to receive student feedback.

3. Infuse Learning
Infuse learning is (was!) an excellent student response system for teachers who must support students with a variety of learning styles. With infusion a teacher can create questions, quizzes and writing prompts and send them to students who are participating in virtual classrooms or in an online learning program. What makes Infuse Learning unique is that it allows the teacher to give the student multiple response options.

4. Verso

This is a free utility that teachers can use to create virtual classrooms. Verso works with the teacher's Google Drive account. This means that links, files, videos, images, and documents from the instructor's Google Drive can be added to the Verso classroom for students to access. Students who enter the classroom will be shown new items that have been added to the classroom since their last visit.

https://www.emergingedtech.com/2015/09/top-5-multi-platform-student-response-systems/

APPENDIX 5: LESSON PLAN TEMPLATE

Strand: ……

Unit: ……..

Content Standard: .....

Benchmark: ……..

Topic 1: ……..

Lesson Topic: ……

Instructional Objective (s): By the end of the lesson, students will be able to;

- ……
- ……
- ……

Essential Questions:

- ……..
- ……..
- ……....

Knowledge:

- ……..
- ……..

Skill(s):

- ……
- ……

Values:

- ……
- ……...

Attitudes:

- ……...
- ……...

Teaching and Learning Strategies

Teacher will …..	Student will ….
Introduction (time in minutes)	
Body (time in minutes)	
Modeling	
Guided Practice	
Independent Practice	
Conclusion (time in minutes)	

APPENDIX 6: ASSESSMENT TEMPLATE

Performance Assessment Template

Subject: _____

Strand:_____

Unit: _____

Content Standard: _____

Benchmark: _____

Topic: _____

Learning Objective: _____

Purpose of Assessment: _____

Assessment Strategy: _____

Duration: _____

Time/Date of Administration: _____

Due Date/Time: _____

Performance Standard: _____

Performance Tasks

Performance Assessment Criteria:_____

Assessment Scoring: _____

Scoring Tool: _____

APPENDIX 7: Portfolio

(Business Studies, Technology & Industrial Arts and CCVE subject Specific)

This refers to a collection of student work and additional information gathered over a period of time that demonstrates learning progress.

Sample Student Portfolio Template

STUDENT PROJECT PORTFOLIO NO: _____

NAME: _____ **CLASS**: _____ **TERM**: _____ **DATE**: ___/___/___

SUBJECT: _____

STRAND: _____

UNIT: _____

CONTENT STANDARD #: _____

_____
_____
_____

BENCHMARK #: _____

_____
_____
_____

5. **NAME OF PROJECT:** _____
6. **PURPOSE OF THE PROJECT**: (State briefly the reason why you will make the project. Have a complete visualization of any project you wish to make so as to know its usefulness)

   a) _____

   b) _____

7. **Idea Generation**

   a. Most projects are based on existing ideas. Choose from these list words/phrase (**substitute, combine, adapt, modify, put to another use, eliminate, reverse/rearrange**) one word/phrase that provokes your thoughts about your project and goes in line with your own ideas about your project. Write this word/phrase in the space provided below.

   _____

b. Explain how this word/phrase is in line with your ideas about your own project.

_____

_____

_____

8. Research

Your project idea needs to be validated to ensure you're creating a product people will pay for and that you won't waste time, money, and effort on an idea that won't sell. There are several ways you can validate your product ideas, including:

a. Talking about your idea with family and friends. If you decide to use this validation method, prepare a sheet to record your feedbacks like the one below.

Your Project Idea:	(*Write down your project idea*)

Family and friends Names	**Feedbacks/Responses**
1.	
2.	
3.	
4.	

b. Sending out a survey to get feedback. If you decide to use this validation method, prepare a survey questionnaire like the one below.

Survey on Project Idea: (*Write down your project idea*)

i) Explain how useful is the furniture/garment to you?

_____

ii) Explain how often do you have this dish?

_____

iii) How much would you like to spend on this garment/furniture if you intend to buy it?

_____

c. Consider **Safety precautions** to be taken in the stages of **Planning, Prototyping, Production and Marketing**.

i) Elementary first aid and procedures: What is the First aid symbol?

Draw the FIRST AID SYMBOL here

ii) Explain what is workshop safety?

_____
_____

iii) How can safety be enforced in working practices to minimise the risks associated working environment?

_____
_____

d) For each of the following stages (**Planning, Prototyping, Production and Marketing**), draw 2 items/tools and describe the type of injury that may occur through the incorrect use of each of the items/tools

3. Planning Stage	
Item/Tool	**Injury that may occur**
Name: _____ (*Drawing of the item/tool*)	1.
	2.
	3.
Name: _____ (*Drawing of the item/tool*)	1.
	2.
	3.
4. Prototyping Stage	
Name: _____ (*Drawing of the item/tool*)	1.
	2.
	3.
Name: _____ (*Drawing of the item/tool*)	1.
	2.
	3.

e) For each of the injuries described below, state what action you should take to assist the teacher.

Injury	Action taken by student
A student using knife a cuts his/her finger.	1.
	2.
A student cooking burns his/her hand on a hot pot	1.
	2.

9. Planning

It's important to take the time to plan before you begin to build your prototype.

Tasting

In terms food, ingredients have to be tasted separately and combination of different ingredients needs to tasted together to select a prototype.

Sketching

In terms of fabric garments and technology projects, sketches of the various prototypes needs to prepared and evaluated for their practicality and usefulness

10. Prototyping

a. Selected projects sketches will be made into prototypes, be sampled and detailed.
b. As for food, a recipe would be outlined and cooked to make a sample dish. Make appropriate taste evaluation to improve the dish
c. Fabric garments and technology projects create detailed working diagrams from the prototype for patterns or templates if required.

11. Production

a. Gather the required materials and food items as per your list to for the project idea.

b. For Food, use the confirmed recipe from the prototype to prepare and create the dish.

c. Use the confirmed outlined garment patterns/templates to measure and cut out the material pieces for your project idea.

d. For technology construction, use the confirmed cutting list and the detailed working diagram to cut out the materials for your project

Product Name	
Total Unit (No of Project)	

Material List

Quantity	Name of Material(s)	Description(s)	Unit Cost	Total Cost

e. Complete the table of the Procedures in the Production

Procedure (How to make my Project)

NO	OPERATIONS	NEEDED TOOLS/EQUIPMENT
1		
2		
3		
4		
5		
6		
7		

12. Costing

d. The cost for making the T-shirt are:

7) Material costs: K____

8) Labor costs (No of Hours Spent X Your Rate): 10 hrs x K ___ = K____

9) Selling/Marketing cost: K____

You could add a ____% markup on top of the K___ total it cost to make your product as the "plus" of cost-plus pricing. Here's what the formula looks like:

Cost (K____) x Markup (K____) = Selling price (K___)

13. Marketing

a. Review the responses/feedback from the Surveys done for the project idea and inform the interested people of the completed project

b. Put out fliers to advertise the project to public

c. Use social media to market the product

Scoring of Performance for Formative Assessment

(Assessment as/while learning and Assessment for learning)

1. Scoring Assessment using Rating Scale

Rating Scales are a type of checklists that judge the degree to which a criteria is met. They generally have a scale of between 1-6 options.

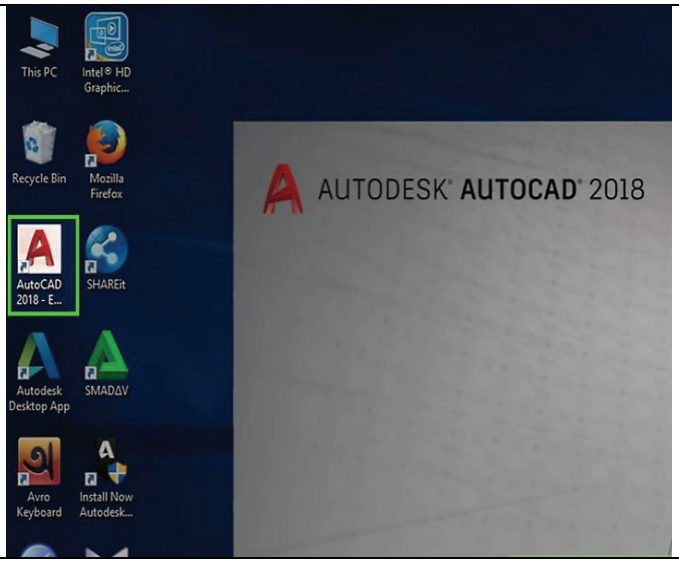
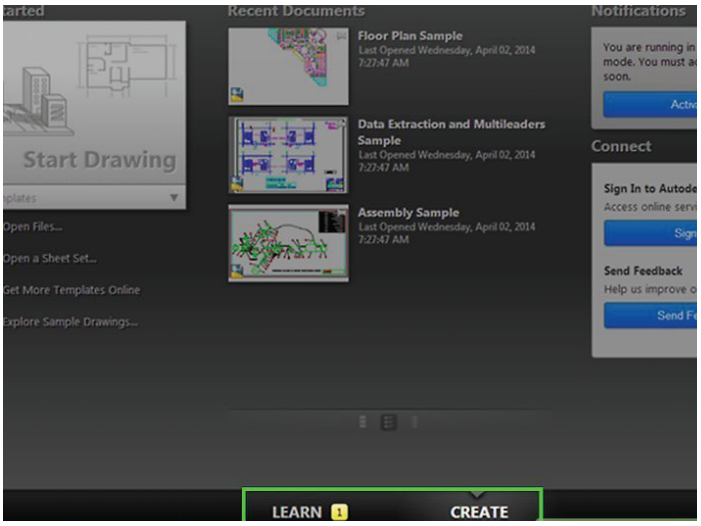
Assessment Performance Records for Term to give grading

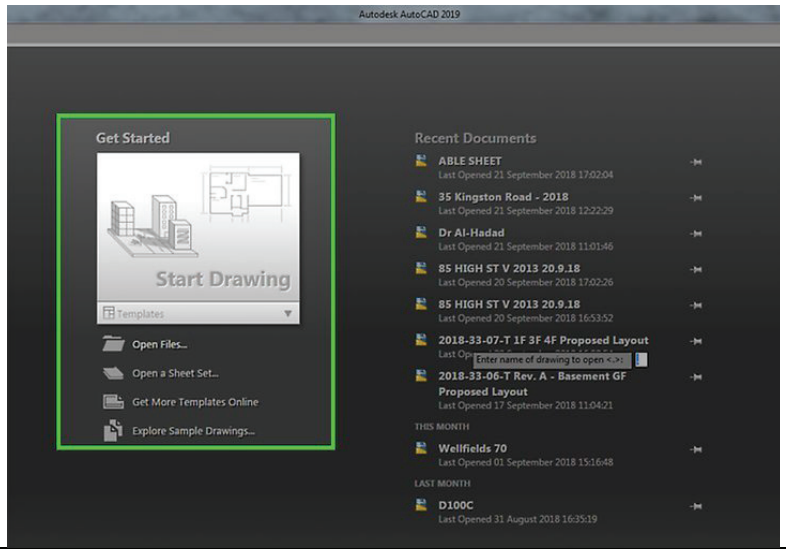
Student's performance in any assessments must be recorded to obtain a final score to be able to give a grading.

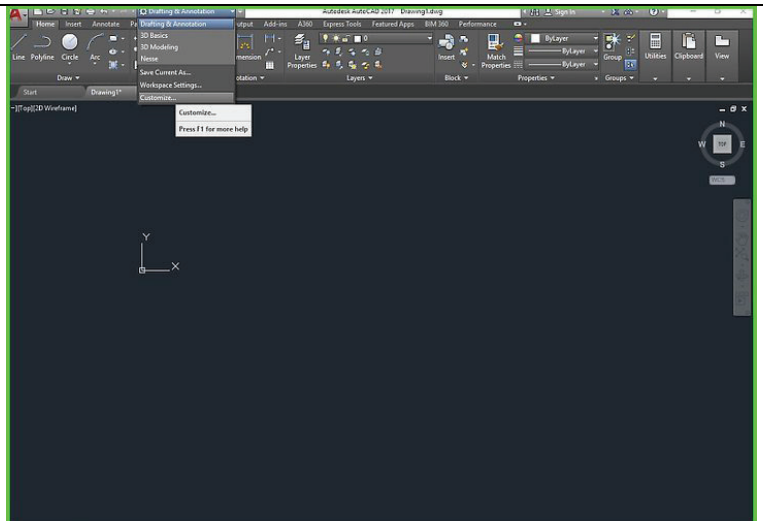
Subject/Strand: _____Grade/Class:_____ Term____

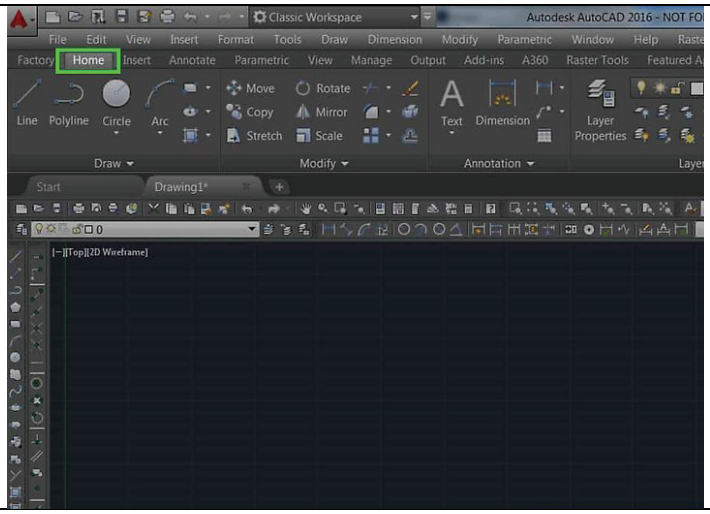
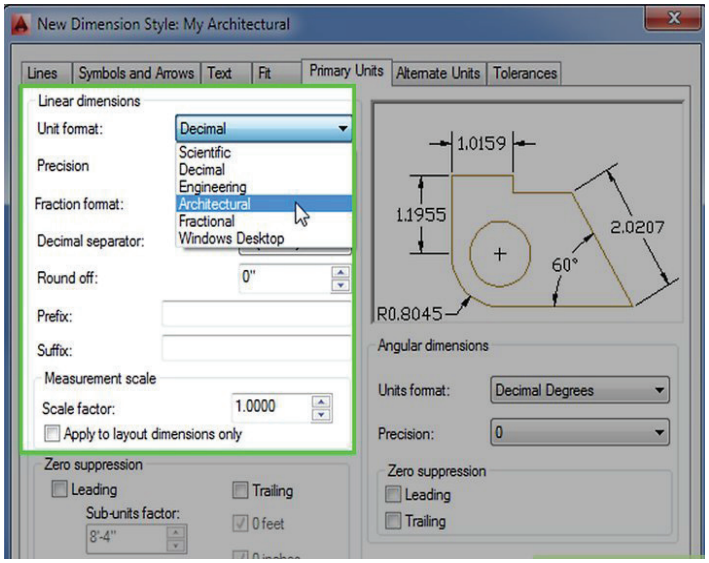
NO	Name	Project 20 marks	Test 1 15 marks	Test 2 10 marks	Portfolio 10 marks	Moderation 30 marks	Participation 5 marks	Total Raw Score
1	Gill							/ 100
2	Jill							/ 100
3	Zill							/ 100
4	Bill							/ 100
Etc.								/ 100

APPENDIX 8: BASIC AUTOCAD STEPS

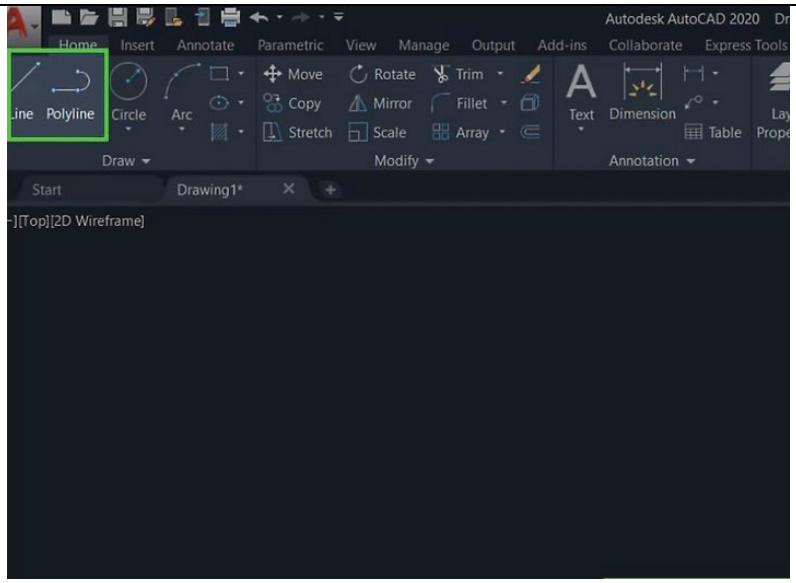
METHOD ONE Getting Started	
1 Open AutoCAD. You'll find it in the Windows menu or your Mac's Applications folder. If you haven't already installed AutoCAD, visit https://www.autodesk.com to download and install it now	
2 Browse the Start screen. When you open AutoCAD, you'll see two tabs on the bottom— LEARN and CREATE (the default tab). If you click the LEARN tab, you'll find helpful videos to get you started with your project. If you click back to the CREATE tab, you'll find the following areas: • In the "Get Started" section on the left, you can select Start Drawing to create a new project, Open Files to choose an existing project, or click the Templates menu to	

start from a template.[1] • If there are any recent AutoCAD documents to work on, they'll appear in the Recent Documents section at the middle of the screen. • If any updates are available, they'll appear in the Notifications area at the top-right corner. • You can also sign in to your A360 account by clicking Sign In at the bottom-right corner.	
3 Click Start Drawing or open an existing file. If you want to start a new project from a template, choose that template instead.[2] • If you don't see the option to do so, click the File menu and select New to create a new drawing now.	
4 Familiarise yourself with the workspace layout. Once you've opened a drawing, take some time to acquaint yourself with the locations of menus and tools: • The drawing area is the part of the workspace with a gridded background. At the top-left corner of this area are two tabs: one is for the current drawing (which will have a name like "Drawing1") and the other	

can take you back to the Start screen. If you open more than one drawing at once, each will have its own tab above the drawing area. • The Y-axis appears in green on the left side of the drawing area, and the X-axis is the red line along the bottom. • The Viewcube is the square with a directional compass around it—you can use this to adjust your perspective when working in 3D. • The ribbon toolbar at the top above the drawing area contains your tools on a series of tabs (Home, Insert, Annotate, etc.). • Click the View tab at the top to show and hide tools and features on the workspace. • The "Type a command" area at the bottom lets you type in commands and tool functions once you get a bit more acquainted with the app.[3]	
5 Click the Home tab. It's at the top-left corner of AutoCAD. You'll see your drawing tools in the "Draw" area on the left side of the ribbon toolbar. • Hover your mouse over any of the tools to see more information about what they do, as well as instructions for finding more help about their uses. • As you draw with any	

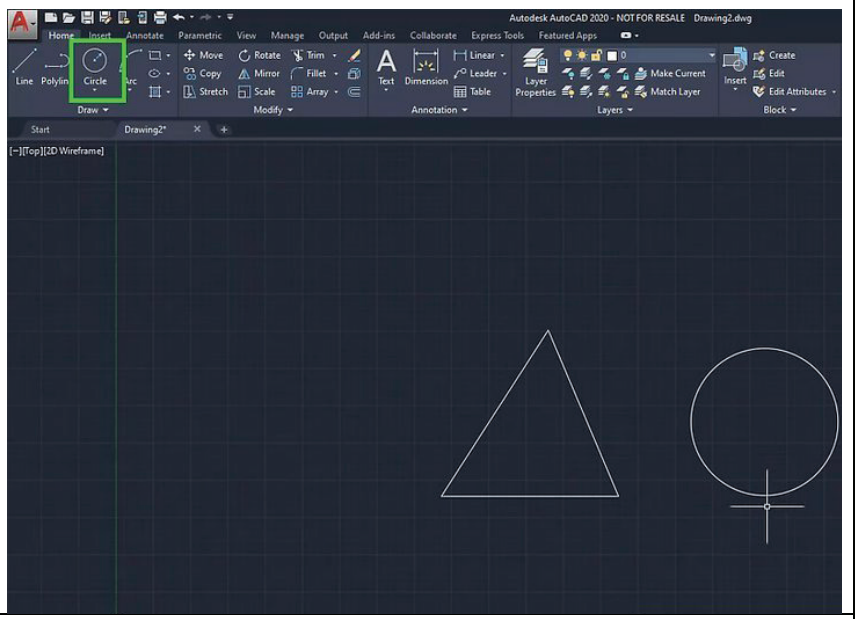
tool, you'll see useful measurements near the cursor, such as length and angle.	
6 Set your default measurement formats. If you need to change the way the scale, length, or angle measurements appear on the screen, units into the command prompt and pressing Enter or Return to bring up the Drawing Units panel. For example, if you're seeing measurements in microns and you need to see them in meters, you can make that change here whenever you want.	
METHOD TWO **Drawing in AutoCAD**	
1 Click the Line or Polyline tool to draw lines. Both tools are at the top-left corner. The Line tool is for drawing individual line segments, while the Polyline tool lets you create a single object from a series of line segments.[4] To draw your first lines: • Click the mouse at the starting point of your line segment.	

- Move the mouse to the place where you'd like to end the segment, and click the mouse at the ending point. If you're using the Line tool, this completes your first segment/line.
- If you're using the Polyline tool, move the mouse again and click to continue creating segments. When you're finished, hit the Esc key to stop drawing.
- If you need to set precise measurements for your segments (and this is true for any tool), type the desired measurement into the box near the cursor instead of clicking a segment endpoint. When you
  press Enter or Return, the endpoint will be placed at the distance you entered.



2
Click the Circle tool to draw a circle. It's to the right of the Polyline tool in the toolbar. To draw a circle:

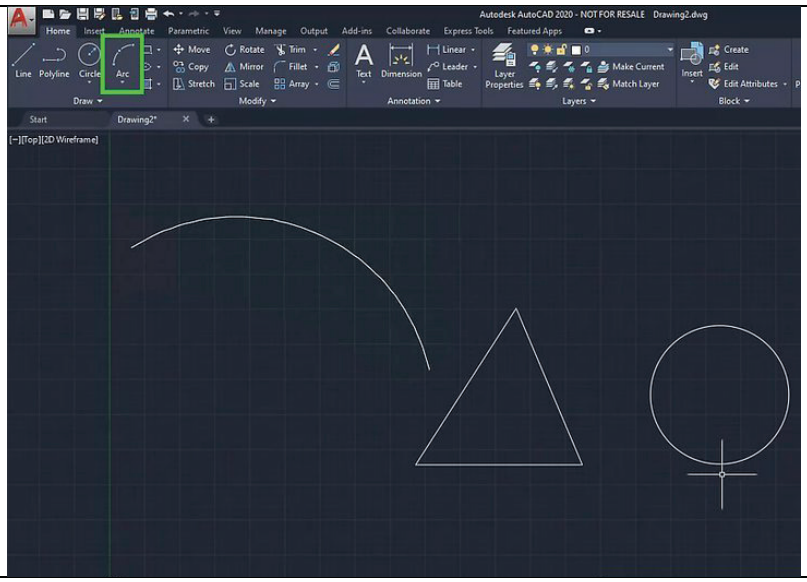
- Click the location on the drawing area where the circle's center should be.
- Drag the mouse outward and click to select the radius.



3
Click the Arc tool to draw a curved line. It's to the right of

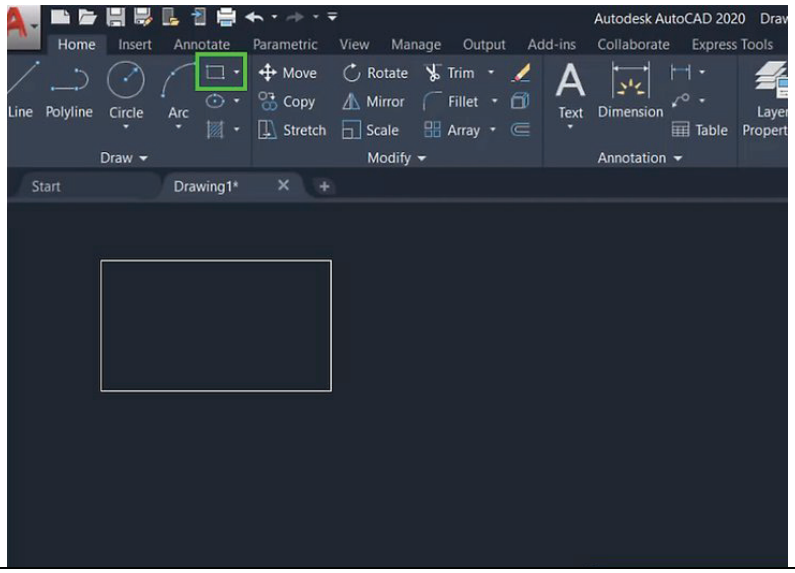
the Circle tool in the toolbar. To draw an arced line:

- Click the mouse at the starting point.
- Move the mouse and then click to end the segment.
- Move the mouse in the direction of the curve you want and click to curve the line.



4

Click the Rectangle tool to create a rectangle. The rectangle tool is simple—click the first point, which will be any corner of the rectangle, and then drag the mouse until the rectangle is the size you want. Click the mouse to place the rectangle.



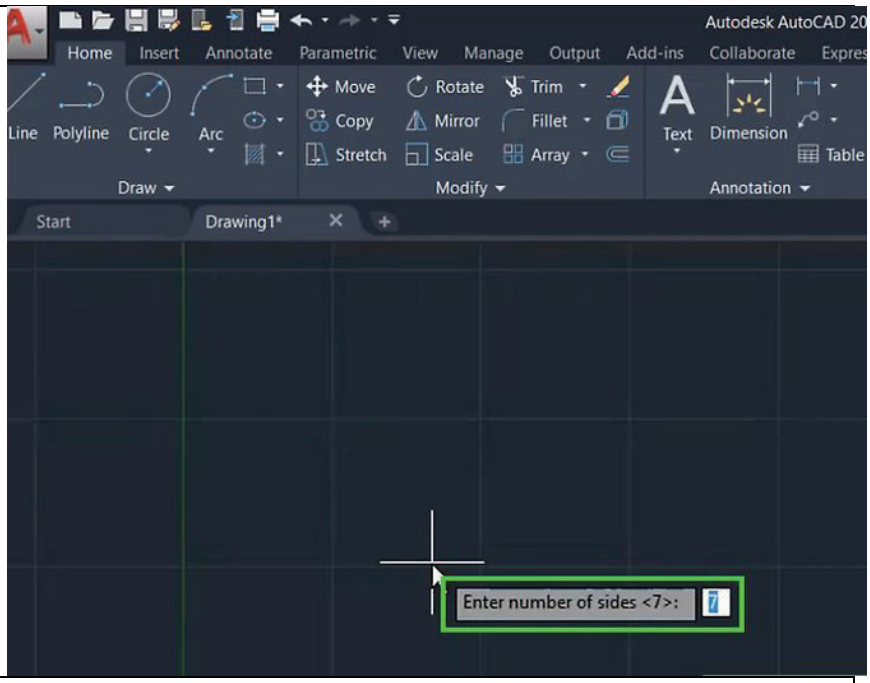
5

Click the `Polygon` tool to a multi-sided shape. Here's how:

- Move the cursor to the drawing area—you'll see a box that says "Enter the number of sides." Type the number of sized and press **Enter** or **Return**.
- Click the center point of

your shape.

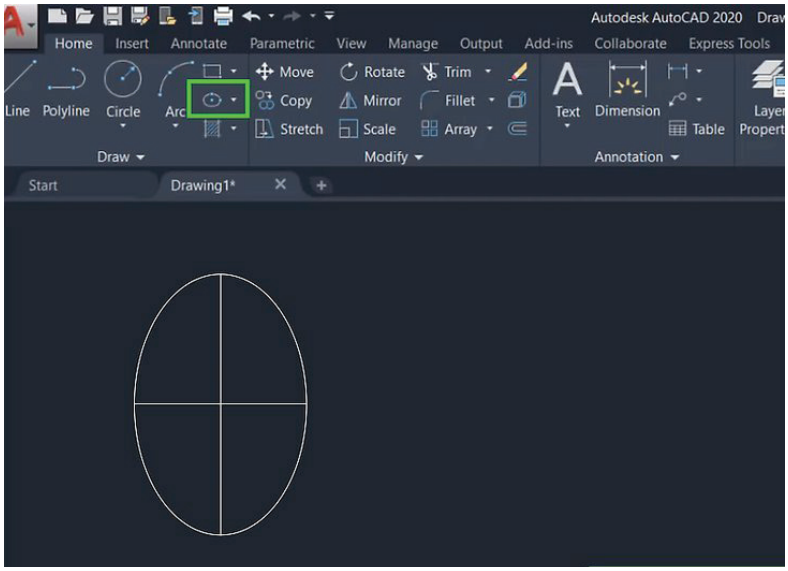
- Move the mouse to the desired size and click to place the shape.



6

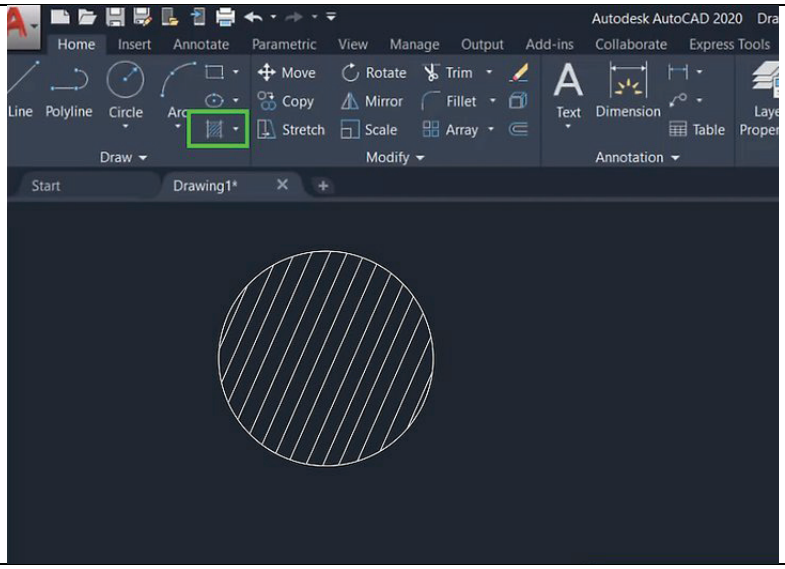
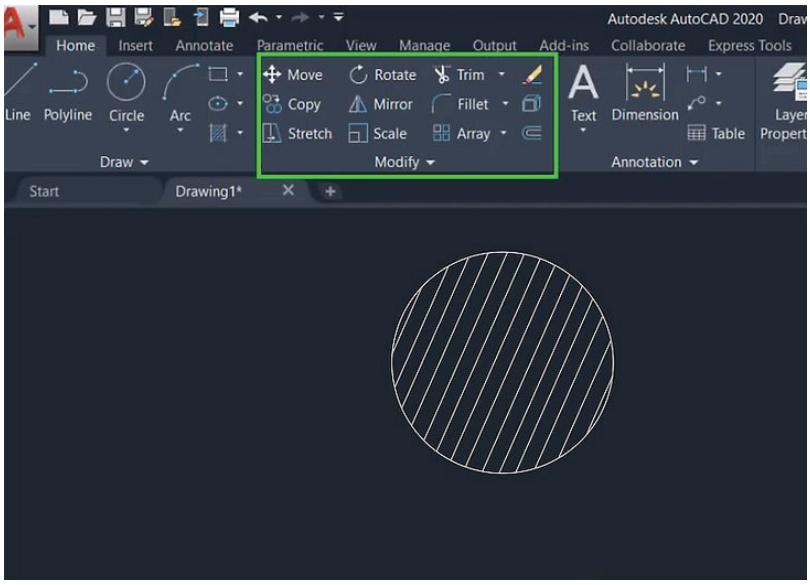
Click the Elipse tool to create an oval. An ellipse is created by placing three points. Here's how:

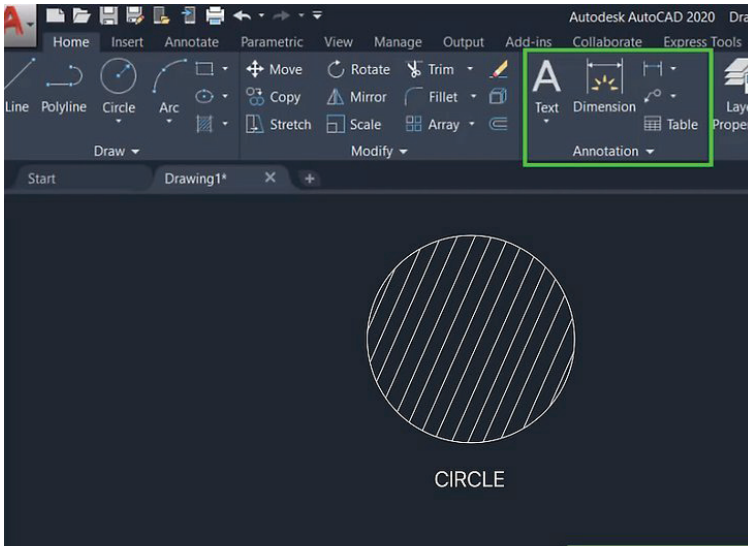
- Click the desired center point.
- Move the mouse to the desired size and click a second point.
- Move the mouse to shape the ellipse and click to place the shape.



7

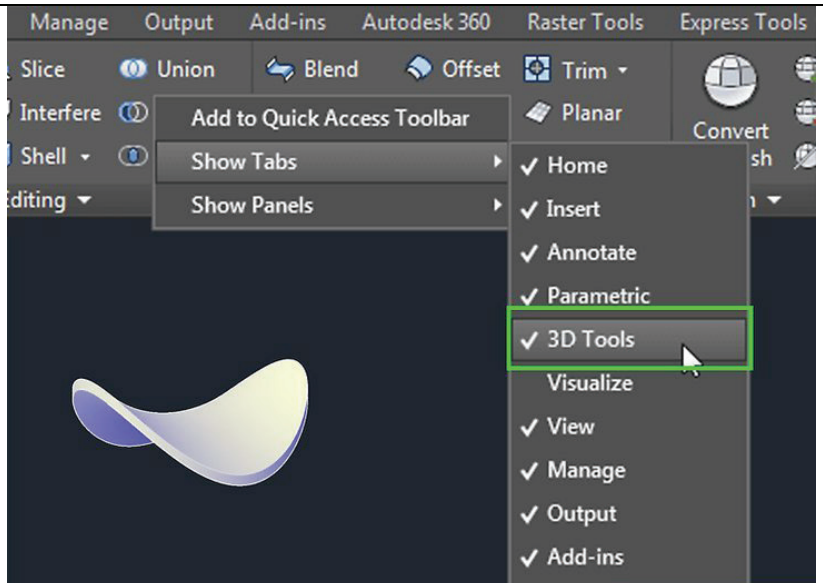
Use the Hatch tool to fill a shape with a pattern. It's the square at the bottom-right corner of the Draw panel in the toolbar. Click the tool,

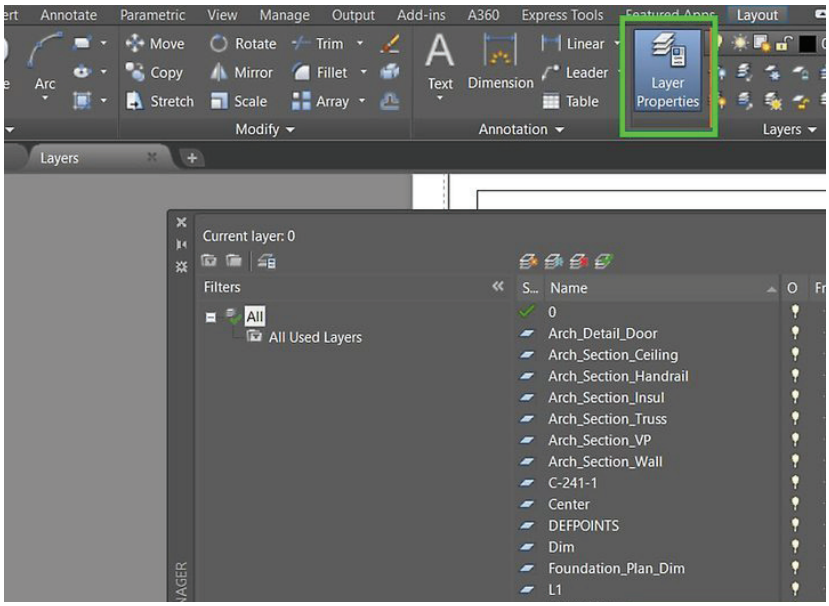
then click a shape to fill it. You can choose any of the patterns or solid fills that appear in the "Pattern" panel that shows in the toolbar while Hatch is enabled.	
8 **Use the tools in the "Modify" panel to edit your shapes.** First, if you just click a shape or line without selecting a tool first, anchor points will appear—you can drag these anchor points to modify the shape if you'd like. There are lots of other modifications you can make: • Click **Move** to move a line or shape. After clicking the tool, click the object you want to move, and then drag it anywhere. You can select multiple objects at once to move them as a group • Click **Rotate** and then a shape to turn it clockwise or counterclockwise. If you want to flip the image, use the **Mirror** tool. • Click **Scale** and then a shape to change its size. Check out How to Scale in AutoCAD to learn more about what you can do with scaling. • Click **Stretch** if you want to resize an image by stretching it rather than keeping it scaled.	

• Click one of the Array tools (**Rectangular Array**, **Path Array**, or **Polar Array**) to create an array of the object you select. • The **Trim** tool lets you cut a segment or side of an object that meets the border of another object, turning them into a single object. • The **Fillet** and **Chamfer** t ools let you create curved and sharp vertices by intersecting two selected sides.	
9 Click the Annotate tab to add text and tables. The tab is next to the "Insert" tab at the top. This is where you can create text boxes, add tables with multiple rows and/or columns, and more. • Click Single Line or Multi Line on the top-left side of the ribbon toolbar to switch between text styles. • Any text you add will also act as a single object that you can move. • This tab also has a "Dimensions" panel that lets you annotate dimensions of shapes and lines.	
10 **Work with 3D objects.** There are two ways to switch to a 3D view—one is to drag the Viewcube at the top-right corner of the drawing area in any direction, and the other is to click the **Orbit** icon in the right	

panel—it's the circle with an upward-pointing arrow inside.

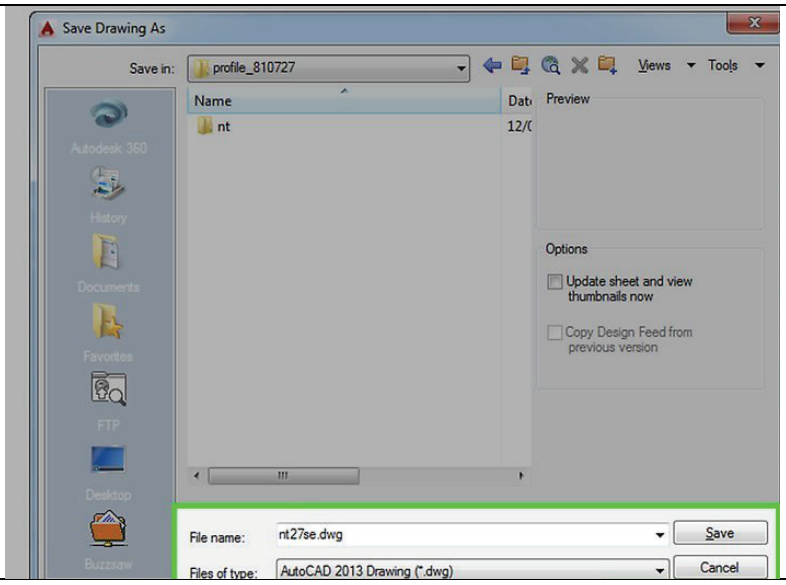
- Click the **3D Tools** tab at the top to open editing tools specific to 3D design. If you don't see this tab, right-click the blank area after the last tab above the ribbon toolbar, open **Show tabs**, and select **3D Tools**.
- Click the down-arrow below "Box" in the "Modeling" panel of the toolbar view and select different 3D objects to draw (e.g., **Cone**, **Sphere**, **Pyramid**). You'll draw the images similar to how you did in regular 2D format, but this time you'll have another axis (the blue line) to work with.
- The shapes will appear as 3D line drawings rather than with volume. You can change this by clicking **2D Wireframe** near the top-left corner of the drawing area and selecting another view, such as **Shaded**, **Realistic**, or **X-ray**.
- To turn a 2D object into a 3D one, use the **Extrude** tool to increase its depth, and/or **Revolve** to rotate it around an axis.[5]
- You can modify 3D objects similarly to 2D objects—click an object to show the blue draggable nodes, then move them around as needed.
- The "Solid Editing" and "Surfaces" panels contain



advanced editing tools for creating and editing complex shapes.	
11 **Place drawings on different layers.** When you're working on more complicated drawings, it can be beneficial to place parts on different layers that you can edit, hide, view, and rearrange.[6] Here's some basics to get you started with layers: • On the **Home** tab, click the **Layer Properties** icon in the "Layers" panel to display the Layer Properties panel. This shows all layers and what you can do with them. • Click the icon of three sheets of paper with a red-and-yellow circle on its left side (it's the first icon on top of the Layer Properties panel) to create and name a new layer. Now you'll have two layers in the panel. • Double-click a layer to select it. The layer with the checkmark is the current layer. • Click the lightbulb on a layer to toggle to hide it/show it. If you're working with particularly large files, use the sun icon to freeze the layer instead of hiding it.	
12 Save your drawing. To save what you're working on, click the A menu at the top-left corner and select Save As,	

and choose Drawing. This lets you save your work as a DWG file, which is the default AutoCAD format.

- Now that you've got the basics down, try drawing an L-shaped stairway or a step pyramid!
- As you become proficient with AutoCAD, you'll be able to convert lines into surfaces, surfaces into 3D solids, add realistic material representations, and manipulate light and shadows.



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