Civil Engineering Graphics and Drawing

Title:	Civil Engineering Graphics and Drawing
Level:	5
Credit value:	25
GLH	150
Unique Reference Number:	K/651/4844
Sector Subject Area:	5.2 Building and Construction
Aim:	The aim of this unit is to provide learners with the skills and knowledge to be able to create, modify and manage civil engineering drawings using traditional and IT based methods.
Assessment Type:	The assessments are internally set and internally assessed by the centres
Assessment Guidance:	The centre devises the assessment, and they can use formative and summative assessments in their process. The summative assessment must outweigh the formative assessment to determine outcomes to the unit.

Learning outcomes *The learner will:*
1. Be able to apply fundamental drawing techniques, including the use of drawing instruments, conventions of lines, scaling, dimensioning, and geometrical constructions, in the context of technical drawings.
Delivery content: The aim of this learning outcome is to provide the learners with the skills and knowledge to demonstrate the correct selection and use of drawing instruments and supporting materials, understanding their applications and limitations in technical drawing. The learner should also apply conventions of lines, representative fractions, and scaling techniques, along with dimensioning methods in line with national / international standards and conventions and construct geometric shapes and tangency with accuracy to ensure clarity and precision in technical drawings. The learner must: • **Drawing Instruments and Supporting Materials:** ○ Demonstrate the correct selection and use of drawing instruments such as rulers, compasses, and protractors for precision in technical drawings.

- Identify and apply appropriate supporting materials such as paper types, pencils, and erasers for specific drawing tasks.
- Show understanding of the applications and limitations of various materials and instruments in technical drawing.

- **Conventions of Lines:**
  - Identify and correctly apply different **types of lines** according to technical drawing conventions.
  - Apply line weights and styles appropriately for different **drawing components.**
  - Demonstrate how conventions of lines contribute to clarity and readability in technical drawings.
- **Representative Fractions and Scales:**
  - Calculate and apply different representative fractions such as reduced, enlarged, and full-size scales in technical drawings.
  - Demonstrate the use of **engineering scales** for accurate scaling in drawings.
  - Apply appropriate scale selection based on the drawing's intended purpose, size, and level of detail.
- **Dimensioning Techniques:**
  - Correctly apply the principles of dimensioning as per international / national drawing standards and conventions.
  - Use chain, parallel, and coordinate dimensioning techniques appropriately in different drawing contexts.
  - Select and apply suitable dimensioning methods to ensure clarity, precision, and adherence to technical standards.
- **Geometrical and Tangency Constructions:**
  - Demonstrate the ability to construct **geometric shapes** with accuracy.
  - Apply tangency principles to accurately construct curves that are tangent to straight lines or other curves.
  - Show understanding of the use of geometrical and tangency constructions in the creation of complex technical drawings.

2. Be able to create and interpret orthographic projections, including converting pictorial views into orthographic views using first and third-angle methods, and understanding the applications of various projection techniques.

Delivery content:

The aim of this learning outcome is to provide the learners with the knowledge and skills to understand different **projection types** and their applications, with a focus on orthographic projection and its principles. The learner should also be able to apply first and third angle projection methods, correctly interpret and create projections, and convert pictorial views of objects into accurate orthographic views, including those with **complex features**.

The learner must:

- **Introduction to Projections:**
  - Demonstrate understanding of different **projections types** their concepts, and applications.
  - Apply the principles of orthographic projection in technical drawing contexts, distinguishing it from perspective, isometric, and oblique projections.
- **Orthographic Projection Methods:**
  - Understand and apply the first angle and third angle projection methods, recognising their differences and appropriate contexts for use.
  - Identify and use the correct symbols for first and third angle projections in technical drawings.
  - Demonstrate the ability to correctly interpret and create projections using both first and third angle methods.
- **Conversion of Pictorial Views into Orthographic Views:**
  - Accurately convert pictorial views of objects containing plain surfaces into orthographic views, ensuring clarity and precision.
  - Convert objects with slanting and sloping surfaces into orthographic views, maintaining the correct angles and proportions.
  - Effectively convert pictorial views of objects with slots, ribs, and cylindrical surfaces into their corresponding orthographic views.
  - Demonstrate proficiency in translating complex shapes and features from pictorial to orthographic projections, ensuring accurate representation of dimensions and features.

3.	Be able to create and interpret isometric projections, including the use of isometric scales, conversion of orthographic views into isometric projections, and solving problems related to objects with lines, circles, and arcs.

Delivery content:

The aim of this learning outcome is to provide the learners with the skills and knowledge to understand isometric projections, including their application, key features, and differences between isometric and natural scales, and be able to accurately apply isometric scale for dimensioning. The learner should also demonstrate the ability to create isometric views and projections of objects, including those with lines, circles, and arcs, and convert orthographic views into accurate isometric projections while maintaining geometric relationships.

The learner must:

- **Introduction to Isometric Projections:**
  - Demonstrate an understanding of the concept of isometric projection and its applications in technical drawing.
  - Identify the key features of an isometric projection, such as the 30-degree angles and the equal scaling along all axes.
- **Isometric Scale and Natural Scale:**
  - Explain the difference between isometric scale and natural scale, and when each is applied in technical drawings.
  - Apply the isometric scale to accurately represent dimensions and proportions in isometric drawings.
  - Convert natural scale dimensions into isometric scale to ensure correct representation in isometric projections.
- **Isometric View and Isometric Projection:**
  - Distinguish between isometric view and isometric projection, explaining their roles in visualising three-dimensional objects in two-dimensional drawings.
  - Create accurate isometric views and projections, maintaining correct angles and proportions in the representation of objects.
- **Illustrative Problems with Objects Containing Lines, Circles, and Arcs:**
  - Solve problems related to the creation of isometric projections of objects with straight lines, ensuring correct angles and positioning in the drawing.

- Accurately represent objects containing circles and arcs in isometric projections, using correct techniques to convey the curvature in a three-dimensional context.
- Demonstrate proficiency in creating isometric projections of objects with a combination of straight lines, circles, and arcs, ensuring clarity and precision.

- **Conversion of Orthographic Views into Isometric View/Projection:**
  - Convert orthographic views into isometric projections, maintaining accurate proportions and angles.
  - Identify and apply appropriate techniques for converting different **types of orthographic view** into isometric projections.
  - Ensure that the conversion process preserves the geometric relationships and dimensions of the object, providing a clear and accurate representation in isometric projection.

4. Be able to produce accurate free-hand sketches of engineering / construction elements, including components and orthographic and isometric views, using appropriate paper and grids for clarity and precision.

Delivery content:

The aim of this learning outcome is to provide the learners with the skills and knowledge to accurately sketch engineering / construction elements. Additionally, the learner should create free-hand orthographic and isometric sketches, ensuring correct proportions, scaling, and the use of appropriate graph or isometric grid paper for clarity and accuracy.

The learner must:

- **Free Hand Sketches of Engineering / Construction Elements:**
  - Accurately sketch the thread profiles of bolts, nuts, studs, and set screws, ensuring correct shape, dimension, and detail representation.
  - Demonstrate proficiency in sketching washers, including the correct shapes and proportions.
  - Illustrate locking arrangements in free-hand sketches, capturing the key design features and functional aspects.
  - Accurately sketch construction elements.
- **Free Hand Sketches of Orthographic Views:**

- Create free-hand orthographic sketches on squared graph paper, accurately representing the object from multiple **types of orthographic views**.
- Maintain proper proportions and scale in orthographic views, ensuring clarity and accuracy in the representation of object dimensions.
- Use graph paper effectively to maintain alignment and precision when sketching orthographic views.

- **Free Hand Sketches of Isometric Views:**
  - Accurately sketch isometric views on isometric grid paper, representing three-dimensional objects in proportion and with correct angles (30-degree angles).
  - Demonstrate clear understanding of isometric projection principles, ensuring the isometric sketch captures depth, height, and width accurately.
  - Use the isometric grid paper effectively, maintaining consistent scaling and alignment in the representation of isometric objects.

5. Be able to navigate and utilise the Computer-Aided Drafting / Drawing (CAD) interface effectively, including understanding system requirements, components and file management, and apply basic setup functions for new drawings.

Delivery content:

The aim of this learning outcome is to provide the learners with the skills and knowledge to understand the concept and significance of Computer-Aided Drafting / Drawing (CAD), identify system requirements, and navigate the CAD interface, including key components such as toolbars and the command window. The learner should also demonstrate the ability to manage files, set up new drawings with proper units and limits, and use functions like undo/redo for efficient drawing creation and editing.

The learner must:

- **Computer Aided Drafting / Drawing (CAD) Concept:**
  - Understand the concept of Computer-Aided Drafting / Drawing and its significance in modern engineering and design processes.
  - Identify the various types of CAD software available, their specific applications, and how they differ from one another.
- **System Requirements and Understanding the Interface:**

- Identify the hardware and system requirements for running CAD software effectively.
- Demonstrate an understanding of the CAD software interface, recognising key components and how they interact to support drafting tasks.

- **Components of the CAD Software:**
  - Recognise and describe the functions of the title bar, standard toolbar, and menu bar in the software.
  - Identify and explain the purpose of the object properties toolbar, draw toolbar, modify toolbar, and cursor crosshair in the drafting process.
  - Understand and utilise the command window and status bar for efficient interaction with the software.
  - Identify the drawing area, coordinate referencing, and their roles in facilitating accurate drawing and navigation.
- **File Features:**
  - Demonstrate the ability to create a new file and save it in the appropriate format for future use.
  - Open an existing drawing file, understanding file management techniques within CAD software.
  - Create and manage templates for standardisation of drawing setups.
  - Close software correctly while saving or discarding changes as necessary.
- **Setting Up a New Drawing:**
  - Set up new drawings with appropriate units, ensuring correct measurement standards are applied.
  - Define drawing limits, grid settings, and snap functions to improve drawing precision and control.
  - Use the undo and redo functions effectively to manage changes during the drawing process, ensuring workflow efficiency.

6. Be able to create, modify, and dimension basic entities in Computer-Aided Drafting / Drawing (CAD), effectively use editing tools, apply appropriate text styles, and set up printing parameters for a professional and accurate technical drawing.

Delivery content:

The aim of this learning outcome is to provide the learners with the skills and knowledge to demonstrate proficiency in creating basic entities, specifying points using various coordinate systems, and applying modify and edit commands to edit and organise

drawings in CAD software. Additionally, the learner must effectively apply dimensioning techniques, insert and format text, and configure plotting parameters for accurate and professional drawings.

The learner must:

- **Drawing Basic Entities:**
  - Create **basic entities** with correct dimensions and positioning.
  - Demonstrate proficiency in drawing a variety of geometric shapes and objects using the appropriate tools within CAD software.
- **Method of Specifying Points:**
  - Accurately use absolute coordinates to specify points in the drawing.
  - Apply relative Cartesian coordinates to place points based on a reference point in the drawing.
  - Utilise polar coordinates to specify points using distance and angle for more complex positioning.
- **Modify and Edit Commands:**
  - Use **modify commands** to edit drawing entities with precision.
  - Apply offset, array, and block commands to create repetitive elements and patterns.
  - Utilise layer management tools to organise drawing elements and enhance clarity.
- **Dimensioning:**
  - Apply linear, horizontal, vertical, aligned, and rotated dimensions for accurate representation of object sizes.
  - Use baseline, continuous, diameter, radius, and angular dimensions to indicate the relationships and measurements of different drawing components.
  - Adjust the dimension scale variable to maintain consistent scaling across different drawing views and elements.
  - Edit dimensions to maintain clarity and accuracy in the drawing after modifications.
- **Text:**
  - Insert single-line text with appropriate formatting for clarity and legibility.
  - Use multiline text to create paragraphs or notes within the drawing, maintaining consistent style and format.

- **Standard Sheet Sizes and Plotting Parameters:**
  - Select appropriate standard sheet sizes for the drawing based on the drawing's scale and purpose.
  - Set **plotting parameters** to prepare the drawing for printing.
  - Use plot preview to ensure correct layout before final printing, making any necessary adjustments for accuracy.

7. Be able to create, modify, dimension, and format 2D and 3D drawings using CAD software, including the design of building components and the printing / plotting of drawings.

Delivery content:

The aim of this learning outcome is to provide the learners with the skills and knowledge to demonstrate proficiency in using CAD commands to draw, edit, and format 2D and 3D **building components**. The learner should also be able to create isometric and 3D drawings of simple objects and effectively print and plot these drawings with correct paper settings, ensuring accuracy and clarity in the final output.

The learner must:

- **Draw, Format, Edit, and Modify Commands:**
  - Demonstrate proficiency in using CAD commands for drawing, editing, and modifying 2D and 3D objects.
  - Apply appropriate formatting techniques to ensure clarity and accuracy in drawings.
- **2D Drawings of Building Components:**
  - Create accurate 2D drawings of **building components**.
  - Draw staircases with correct proportions and dimensions.
  - Design reinforced concrete (R.C.C.) T-beams and slabs, ensuring adherence to structural design standards.
- **Isometric Drawings:**
  - Develop isometric drawings of simple objects, maintaining correct angles and proportions using isometric techniques.
  - Use CAD tools effectively to represent depth, height, and width in the isometric view.
- **3D Drawings:**

- Create 3D drawings of simple objects, accurately representing them in three-dimensional space.
- Use CAD commands for creating and modifying 3D objects, ensuring correct dimensions and proportions.

- **Printing and Plotting:**
  - Print and plot the above 2D and 3D drawings using appropriate paper sources and settings on drawing sheets.
  - Select suitable **plotting parameters** to ensure accurate reproduction of the drawings.

8. Be able to plan buildings based on cost estimation, adhere to local building legislation and regulations, and design efficient layouts for various building types, considering functional and aesthetic aspects.

Delivery content:

The aim of this learning outcome is to provide the learners with the skills and knowledge to plan buildings based on an approximate plinth area rate, ensuring cost efficiency while adhering to local building legislation and regulations. Additionally, the learner must strategically design building orientations and openings for optimal functionality and develop line plans for specific building types such as schools, student accommodation, market complexes etc. ensuring each design meets its unique functional requirements.

The learner must:

- **Planning of Buildings Based on Plinth Area Rate:**
  - Develop building plans based on an approximate plinth area rate, ensuring that the design meets specific cost constraints.
  - Accurately estimate the cost of construction based on the area of the building and incorporate budgetary considerations into the planning process.
  - Ensure that the design remains functional and efficient within the specified cost limitations.
- **Awareness of Local Building Legislation and Regulations:**
  - Demonstrate knowledge of the local building legislation and regulations.
  - Apply relevant building codes and regulations when planning buildings, ensuring compliance with safety, environmental, and zoning / locational requirements.

- Incorporate legal requirements such as setbacks, floor area ratio, and permissible building heights in the planning process.

- **Orientation of Building and Location of Openings:**
  - Plan the orientation of buildings to optimise natural lighting, ventilation, and energy efficiency.
  - Strategically position doors, windows, and ventilators to enhance the functionality and liveability of the building.
  - Ensure that the living areas are appropriately located for comfort, privacy, and ease of movement.
- **Planning of Specific Building Types:**
  - Develop line plans for the following types of buildings, considering their specific functional requirements:
    - School buildings for urban or rural areas, ensuring efficient classroom layouts and spaces for learning.
    - Student accommodation with adequate private space, common areas, and utilities.
    - Market / commercial complexes, ensuring proper circulation, accessibility, and functional zones for vendors and customers.
    - Medical facilities, ensuring a layout that facilitates efficient patient care, waiting areas, and medical storage.
  - Ensure the design addresses the specific needs of the building types while maintaining functional and space-efficient layouts.

9. Be able to prepare detailed plans, elevations, and sectional elevations of buildings using CAD software, based online diagrams and given specifications, in compliance with local building standards and regulations.

Delivery content:

The aim of this learning outcome is to provide the learners with the skills and knowledge to create detailed plans, elevations, and sectional views for a single-storey R.C. roof slab building and a double-storey permanent residential buildings with an R.C.C. staircase using CAD, ensuring accurate representation of all structural components. Additionally, the learner must prepare approval drawings for a residential building, adhering to local building legislation and regulations, including necessary site plans and compliance with building codes and regulations.

The learner must:

- **Plan, Elevation, and Sectional Elevation of Single-Storeyed R.C. Roof Slab Building:**
  - Create a detailed plan at window sill level for a single-storey reinforced concrete (R.C.) roof slab building using CAD software.
  - Develop corresponding elevation and sectional views based on the provided line diagram and specifications.
  - Ensure accuracy in the representation of building components, dimensions, and structural features in the plan and elevations.
- **Detail Drawing of Double-Storeyed Residential Building with R.C.C. Staircase:**
  - Prepare a detailed drawing of a double-storey residential building, including the R.C.C. staircase, from the given line diagram and specifications.
  - Include all necessary dimensions, structural elements, and features for accurate construction representation.
  - Use CAD commands to properly scale, align, and detail the staircase and building components.
- **Preparation of Approval Drawing for Residential Building:**
  - Prepare approval drawings for a residential building, ensuring compliance with local building legislation and regulations.
  - Include necessary components such as site plan, index plan, and any other required documentation in the drawing set.
  - Ensure that the approval drawing meets all legal requirements, including dimensions, building codes, and layout specifications.

10. Be able to create detailed plans, elevations, and sections of an inclined roof building using CAD commands, based on given line diagrams and specifications.

Delivery content:

The aim of this learning outcome is to provide the learners with the skills and knowledge to accurately create detailed plans, elevations, and sections of an inclined roof building using CAD, ensuring proper representation of the wooden structure and roofing materials. The learner must effectively use CAD tools to convert line diagrams into detailed, dimensioned drawings while maintaining correct roof design, material specifications, and structural elements.

The learner must:

- **Detail Drawing of Inclined Roof Building:**
  - Accurately create a detailed plan, elevation, and sectional views of an inclined roof building (gable or hip roof style) using CAD.
  - Represent the wooden structure and the roofing material correctly, ensuring the proper scale and dimensions as per the given specifications.
  - Use CAD tools effectively to depict the structural elements, roof slopes, and connection details.
- **Roof Design and Detailing:**
  - Apply appropriate CAD commands to show the inclined roof's design, including the pitch, rafters, and other supporting structures.
  - Detail the roof covering and its integration with the wooden structure.
  - Ensure that roof components are accurately drawn, considering material specifications and structural requirements.
- **Conversion of Line Diagram into Detailed Drawing:**
  - Convert the provided line diagram into a fully dimensioned and detailed CAD drawing, including all necessary elevations and sections.
  - Accurately interpret the given specifications to ensure the drawing meets construction and material standards.
- **Use of CAD Commands:**
  - Effectively utilise **CAD commands** to create accurate drawings of the inclined roof building.
  - Use layer management and object properties tools to organise and define different building components of the drawing for clarity and precision.

11. Be able to create detailed drawings of various types of culverts, including half foundation plans, half top plans, cross-sectional elevations, and longitudinal sections using both manual drawing techniques and CAD software.

Delivery content:

The aim of this learning outcome is to provide the learners with the skills and knowledge to create accurate half foundation and top plans, cross-sectional elevations, and longitudinal sections for various types of culverts, ensuring correct dimensions and component representation. The learner must demonstrate proficiency in both manual

drawing techniques and CAD software, producing detailed and organised drawings while adhering to structural guidelines.

The learner must:

- **Half Foundation and Half Top Plan for Different Culverts:**
  - Accurately draw half foundation and half top plans for the following types of culverts:
    - Hume pipe culvert with right-angled wing wall (manual drawing).
    - Hume pipe culvert with splayed wing wall (using CAD software).
    - RCC slab culvert with right-angled wing wall (using CAD software).
    - RCC slab culvert with splayed wing wall (manual drawing).
  - Ensure correct scale, dimensions, and representation of **culvert components**.
- **Cross-Sectional Elevation:**
  - Create detailed cross-sectional elevation drawings for each of the culverts, highlighting key **culverts components**.
  - Ensure accuracy in scaling and alignment, particularly in the depiction of vertical and horizontal dimensions.
- **Longitudinal Section:**
  - Accurately draw the longitudinal section of each culvert type, ensuring proper representation of the overall structure and flow direction.
  - Use appropriate cross-sections to maintain consistency between different **views** in both manual and digital formats.
- **Use of Manual Drawing Techniques:**
  - Demonstrate proficiency in manual drawing techniques for culvert designs, ensuring clarity, precision, and adherence to structural guidelines.
  - Apply appropriate symbols and line weights for clarity and readability in manual drawings.
- **Use of CAD Software for Drawing:**
  - Effectively use CAD software to create detailed drawings of Hume pipe and RCC slab culverts with both right-angled and splayed wing walls.
  - Utilise relevant **CAD commands** to produce clear and accurate culvert designs.

○ Apply layer management and object properties to organise different elements of the drawings for clarity and professional presentation.
12. Be able to create detailed drawings of irrigation structures, plumbing and sanitary connections, and septic tank systems using both CAD software and manual drawing techniques, based on given specifications.
Delivery content: The aim of this learning outcome is to provide the learners with the skills and knowledge to create drawings of various structures, including a vertical drop type fall, siphon aqueduct, and septic tank, ensuring accurate dimensions, materials, and reinforcement details. The learner must also manually draw a canal siphon and plumbing layout for a two-roomed building, ensuring proper scaling, alignment, and adherence to functional and regulatory standards. The learner must: • **Vertical Drop Type Fall (Sarada Type) Drawing:** ○ Create a detailed drawing of a vertical drop type fall (Sarada Type) based on provided specifications using CAD software. ○ Accurately represent the **structural features of the fall** adhering to technical drawing standards. ○ Ensure that the drawing includes all relevant details for construction and installation, such as flow channels and necessary reinforcement. • **Canal Siphon Drawing:** ○ Manually draw a canal siphon based on the given specifications, ensuring the correct representation of the siphon's layout and function. ○ Accurately depict the dimensions, angles, and materials used for the siphon, following the design requirements for efficient water flow. ○ Include necessary structural components like inlets, outlets, and supports in the drawing. • **Siphon Aqueduct Drawing:** ○ Use CAD software to create a detailed drawing of a siphon aqueduct based on the given specifications. ○ Represent the **key features of the siphon aqueduct**. ○ Ensure accurate scaling and dimensioning of the **aqueduct components.** • **Plumbing and Sanitary Connections for a Two-Roomed Building:**

- Manually create a plumbing and sanitary layout for a two-roomed building, ensuring all connections and fittings are correctly represented.
- Accurately depict the location of water supply lines, drainage systems, water closets, and other essential plumbing components.
- Ensure proper alignment and scaling of fixtures to reflect realistic plumbing layouts that meet functionality and efficiency requirements.

- **Septic Tank Drawing for Up to 50 Users:**
  - Using CAD software, create a detailed drawing of a septic tank designed for up to 50 users, including the soak pit and necessary connections from the water closet.
  - Accurately represent the dimensions, materials, and layout of the septic tank and soak pit system, ensuring compliance with local regulations and design standards.
  - Include all necessary **plumbing connections**, to ensure the septic tank operates efficiently and safely.

13. Be able to use Architecture software to effectively modify and model various building components, create site plans, and prepare detailed approval drawings for a residential building, including its 3D view, based on given specifications.

Delivery content:

The aim of this learning outcome is to provide the learners with the skills and knowledge to accurately modify and create building components such as walls, doors, and windows, incorporating proper dimensions, levels, and annotations. The learner must model ramps, railings, stairs, and site components, and prepare a complete approval drawing for a double-storey residential building, ensuring compliance with design standards and using appropriate tools for 3D views, scale adjustments, and modifications. **This learning outcome must be achieved with different software, to that used for learning outcomes: 7, 8, 9 and 10.**

The learner must:

- **Basics - Modify and Create Building Components:**
  - Modify and create walls, doors, windows, and other components accurately using appropriate tools.
  - Apply correct dimensions, section views, levels, and text annotations to enhance the clarity and detail of the drawing.

- Use appropriate grid lines and view settings to organize and structure the design.
- Create and manage rooms, floors, and roofs to meet design requirements.

- **Modelling - Ramp, Railing, and Stairs:**
  - Model ramps, railings, and stairs using specific tools, ensuring that the designs are functional and adhere to design codes.
  - Ensure correct placement, dimensions, and alignment of these components in the 3D model.
- **Site Design - Topography and Site Components:**
  - Create and modify topographical surfaces for site plans, incorporating parking components and site-specific elements.
  - Accurately place site components such as trees, pathways, and landscaping features.
- **Modification Tools:**
  - Utilise **modification tools** to modify and adjust the model components efficiently.
  - Apply linework and paint tools to enhance the visual representation and ensure consistent styling across the design.
- **Scale and Units:**
  - Set appropriate scale and units for the project to ensure accurate measurements and drawings.
  - Adjust scale settings as needed for different views, maintaining consistency across the project.
- **3D Views:**
  - Create and manipulate 3D views of the building model to provide a realistic representation of the design.
  - Use appropriate tools to adjust and control the view, such as camera positioning and visual styles, to improve presentation.
- **Preparation of Approval Drawing - Double Storey Residential Building:**
  - Prepare an approval drawing for a double-storey residential building, including floor plans, sections, elevations, and 3D views.
  - Ensure the drawing is in compliance with local building standards and includes necessary annotations, dimensions, and details.

- Incorporate the appropriate tools to finalize the drawing for approval submission, ensuring accuracy and professionalism in the presentation.

14. Be able to model and analyse structural systems using appropriate software, including the creation of 2-D models, application of loads and supports, and performing analysis for continuous beams subjected to various loading conditions.

Delivery content:

The aim of this learning outcome is to provide the learners with the skills and knowledge to use appropriate software to create accurate 2-D structural models, defining geometry, material properties, and load conditions while applying appropriate support and boundary conditions. The learner must analyse a continuous beam with multiple spans under various loads, interpreting the results to assess internal forces and deflections, and ensure model accuracy through verification techniques.

The learner must:

- **2-D Modelling of Structures:**
  - Utilise appropriate functions to create 2-D structural models efficiently.
  - Define the geometry of the structure, including dimensions, shapes, and connections.
  - Assign material properties and cross-sectional details accurately to each structural component.
  - Apply appropriate **support conditions** to ensure correct boundary conditions for the model.
  - Assign **loads and** load combinations according to design specifications.
- **Analysis of a Continuous Beam:**
  - Create a 2-D model of a continuous beam with more than two spans using appropriate software.
  - Apply different **load** conditions to the continuous beam.
  - Conduct the analysis of the structure to determine **internal forces** and deflections.
  - Interpret the analysis results to evaluate the performance of the continuous beam under applied loads.
- **Modelling and Analysis Techniques:**
  - Demonstrate proficiency in adjusting and refining the model as needed during the analysis process.

- Use the software's analysis capabilities to perform complex structural calculations for beams with multiple spans.
- Verify the accuracy of the model and the results through checks and validation techniques.

15. Be able to produce detailed drawings with necessary reinforcement schedules for **structural elements** based on supplied hand sketches.

Delivery content:

The aim of this learning outcome is to provide the learners with the skills and knowledge to produce detailed drawings of **structural elements** with accurate dimensions, reinforcement placement, and material specifications. The learner must also provide clear reinforcement schedules, including bar sizes, lengths, and spacing, ensuring all elements are detailed according to design requirements and construction standards.

The learner must:

- **Drawing of Slab, Beam, and Lintel:**
  - Accurately draft slab, beam, and lintel details, including dimensions, reinforcement placement, and materials.
  - Include the necessary details of the overhang, ensuring its proper integration with the slab and beam.
  - Provide a clear reinforcement schedule, including bar sizes, lengths, and quantities, based on the structural requirements.
- **Drawing of Columns, Column-Beam Connections, and Footings:**
  - Draft detailed drawings of columns, specifying dimensions, reinforcement layout, and material specifications.
  - Accurately represent column-beam connections with and without splicing, ensuring clear depiction of reinforcement details.
  - Produce drawings for isolated footings, including their dimensions, reinforcement, and connection to columns.
  - Provide a detailed reinforcement schedule for the columns, column-beam connections, and footings, indicating bar sizes, spacing, and lengths.
- **Drawing of Staircase and Retaining Walls:**
  - Draft detailed drawings of a staircase, including dimensions, steps, reinforcement layout, and material specifications.

- Create detailed drawings of cantilever and counterfort retaining walls, specifying dimensions, reinforcement details, and material specifications.
- Include the deflected shapes of sections at different locations for the retaining walls, illustrating the displacement at various points.
- Provide detailed reinforcement schedules for the retaining walls, staircase, and any other required structural elements, showing all necessary bars, lengths, and spacing.

- **Reinforcement Schedules and Bar Detailing:**
  - Accurately detail reinforcement bars for all structural elements, ensuring correct sizes, lengths, and spacing are indicated as per design specifications.
  - Provide complete schedules for all elements, ensuring clarity and ease of interpretation for construction.

Scope of Training

The Scope of Training identifies areas that must be covered during the delivery of this unit. This is the minimum that is expected but tutors are expected to include other areas, knowledge of which will benefit their learners, based on location, types of work available and from the tutors own professional experience.

Requirements		
Types of lines	Continuous Dashed	Centre lines Etc.
Drawing components	Borders Hidden features	Object outlines
Engineering scales	Plain scales	Diagonal scales
Geometric shapes	Arcs Circles	Polygons
Projection types	Orthographic Perspective	Isometric Oblique
Complex features	Slanting surfaces and slopes Slots	Cylindrical shapes
Types of orthographic view	Elevations Front	Top Side
Basic entities	Lines	Ellipses

	Circles Arcs Polygons	Rectangles Multiline Polylines
Modify commands	Trim Extend	Delete Copy
Plotting parameters	Paper size Paper units Drawing orientation	Plot scale Plot offset Plot area
Building components	Doors Windows Footings Staircases	R.C.C. T-beams Roof Walls
CAD commands	Line Polyline Offset	Trim Hatch
Culvert components	The wing walls Pipe features	Slab features Structural elements
Views	Plan Elevation	(Cross) section
Structural features of the fall	Drop height Materials	Dimensions
Key features of the siphon aqueduct	Structural layout Material specifications	Flow direction
Aqueduct components	Arches Supports	Siphon pipes
Plumbing connections	Inlet and outlet pipes Baffle walls	Venting systems
Modification tools	Align Split Trim	Offset Match Type
Support conditions	Fixed Pinned	Roller
Loads	Uniform distributed load	Point load
Internal forces	Bending moments	Shear forces

Structural elements	Slabs	Footings
	Beams	Retaining walls
	Columns	