

**REPUBLIC OF KENYA**

**COMPETENCY BASED MODULAR CURRICULUM**

**FOR**

**HIGHWAY ENGINEERING**

**KNQF LEVEL: 6**

**ISCED PROGRAMME CODE: 0732 554 A**

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# FOREWORD

Provision of quality education and training is fundamental to the Government’s overall strategy for socio-economic development. Quality education and training contribute to achievement focused on Kenya’s development blueprint and sustainable development goals.

Reforms in the education and training sector are necessary for achievement of Kenya Vision 2030 and meeting the provisions the Constitution of Kenya. The education sector had to be aligned to the Constitution and this resulted in formulation of the Policy Framework for Reforming Education and Training (Sessional Paper No. 1 of 2019). A key feature of this policy is the change in the design and delivery of TVET training. This policy document requires that training in TVET be competency based, curriculum development be industry led, certification be based on demonstration of competence and mode of delivery that allows for multiple entry and exit in TVET programs.

These reforms demand that Industry takes a leading role in curriculum development to ensure the curriculum addresses its competence needs. It is against this background that this Curriculum has been developed. For trainees to build their skills on foundational hands-on activities of the occupation, units of learning are grouped in modules. This has eliminated duplication of content and streamlined exemptions based on skills acquired as a trainee progresses in the up-skilling process, while at the same time allowing trainees to be employable in the shortest time possible through the acquisition of part qualifications.

It is my conviction that this curriculum will play a great role towards development of competent human resource for the Construction sector’s growth and sustainable development.

**PRINCIPAL SECRETARY**

**STATE DEPARTMENT FOR TVET**

**MINISTRY OF EDUCATION**

**PREFACE**

Kenya Vision 2030 aims to transform Kenya into a newly industrializing middle-income country, providing high-quality life to all its citizens by the year 2030. Kenya intends to create globally competitive and adaptive human resource base to meet the requirements of a rapidly industrializing economy through lifelong education and training. TVET has a responsibility to facilitate the process of inculcating knowledge, skills, and worker behaviour necessary for catapulting the nation to a globally competitive country, hence the paradigm shift to embrace Competency-Based Education and Training (CBET).

TVET ACT, CAP 210A and Sessional Paper No. 1 of 2019 on Reforming Education and Training in Kenya for Sustainable Development emphasized the need to reform curriculum development, assessment, and certification. This called for a shift to CBET to address the mismatch between skills acquired through training and skills needed by industry, as well as increase the global competitiveness of the Kenyan labour force.

This curriculum has been developed in adherence to the Kenya National Qualifications Framework and CBETA standards and guidelines. The curriculum is designed and organized into Units of Learning with Learning Outcomes, suggested delivery methods, learning resources, and methods of assessing the trainee’s achievement. In addition, the units of learning have been grouped in modules to concretize the skills acquisition process and streamline upskilling.

I am grateful to all expert trainers and everyone who played a role in translating the Occupational Standards into this competency-based modular curriculum.

# ACKNOWLEDGEMENT

This curriculum has been designed for competency-based training and has independent units of learning that allow the trainee flexibility in entry and exit. In developing the curriculum, significant involvement and support were received from expert trainers, institutions and organizations.

I recognize with appreciation the role of the Construction National Sector Skills Committee (NSSC) in ensuring that competencies required by the industry are addressed in the curriculum. I also thank all stakeholders in the Construction sector for their valuable input and everyone who participated in developing this curriculum.

I am convinced that this curriculum will go a long way in ensuring that individuals aspiring to work in the Construction Sector acquire competencies to perform their work more efficiently and effectively.

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# ABBREVIATIONS AND ACRONYMS

2D- Two Dimensions

3D- Three Dimensions

AP- Arithmetic Progression

BoQ- Bill of quantities

CAD - Computer Aided Design

CESMM- Civil engineering Standard Method of Measurement

CBET - Competency Based Education and Training

CBR- Carlifornia Bearing Ratio

CD - Compact Disk

CPU - Central Processing Unit

CV - Curriculum Vitae

DPM - Damp Proof Membrane

DVD - Digital Versatile Disk

DVI - Digital Visual Interface

EMCA - Environmental Management and Coordination Act

EPS - Expanded Polystyrene

HDMI - High Definition Multimedia Interface

ICT - Information Communication Technology

IOT - Internet of Things

GIS- Geomatics Information Science

GP- Geometric Progression

GPS- Global Positioning System

ISCED - International Standard Classification of Education

MITM - Man in the Middle

NNP - Nyeri National Polytechnic

ODE- Ordinary Differential Equations

PhD - Doctor of Philosophy

POE- Portfolio of Evidence

PPEs - Personal Protective Equipment

RAM - Random Access Memory

SMM - Standard Method of Measurement

SMP- Standard For Mathematics Practice.

TD- Technical Drawing

TVET - Technical Vocational Education and Training

URI - Uniform Resource Identifier

USB - Universal Serial Bus

VGA - Video Graphics Array

CPM - Critical Path Method

PERT - Program Evaluation Review Technique

CIDB - Construction Industry Development Board

HVAC - Heating, Ventilation and Air Conditioning

# KEY TO ISCED UNIT CODE



# COURSE OVERVIEW

The Highway Engineering Technician Level 6 consists of competencies that a trainee must achieve to enable them to work in the Construction Sector. It entails performing traffic survey,conducting material testing, carrying out highway engineering survey, designing road structures, carrying out road construction works, designing highway engineering structures, and supervising highway engineering projects.

**Units of Learning**

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit of Learning Code** | **Unit of Learning Title** | **Duration**  **in**  **Hours** | **Credit Factor** |
| 0611 551 01A | Digital Literacy | 40 | 4.0 |
| 0031 541 02A | Communication Skills | 40 | 4.0 |
| 0732 541 03A | Construction Material Science 1 | 50 | 5.0 |
| 0732 551 04A | Civil Works I | 100 | 10.0 |
| 0732 551 05A | Site Survey | 150 | 15.0 |
|  | **TOTAL** | **380** | **38.0** |
|  | **MODULE 11** |  |  |
| 0417 541 06A | Work Ethics and Practices | 40 | 4.0 |
| 0732 551 07A | Materials Testing Preparation | 60 | 6.0 |
| 0732 541 08A | Technical Drawings | 120 | 12.0 |
| 0732 541 09A | Construction Material Science II | 80 | 8.0 |
| 0732 541 10A | Mathematics Principles | 100 | 10.0 |
|  | **TOTAL** | **400** | **40.0** |
|  | **MODULE III** |  |  |
| 0732 551 11A | Engineering Survey I | 80 | 8.0 |
| 0732 541 12A | Workshop Technology Practices | 50 | 5.0 |
| 0732 551 13A | Material Testing I | 60 | 6.0 |
| 0732 551 14A | Execute Road Construction Works I | 60 | 6.0 |
| 0732 551 15A | Measurement Estimation And  Costing Principles I | 60 | 6.0 |
| 0732 551 16A | Structural Analysis  Principles 1 | 110 | 11.0 |
| 0732 541 17A | Algebra and Geometry | 50 | 5.0 |
|  |  | **470** | **47.0** |
|  | **MODULE IV** |  |  |
| 0413 541 18A | Entrepreneurial Skills | 40 | 4.0 |
| 0732 551 19A | Materials Testing II | 60 | 6.0 |
| 0732 551 20A | Road Construction Works II | 50 | 5.0 |
| 0732 551 21A | Structural Analysis Principles II | 110 | 11.0 |
| 0732 551 22A | Engineering Survey II | 80 | 8.0 |
| 0732 541 23A | Trigonometry and Complex Numbers | 80 | 8.0 |
|  | **TOTAL** | **420** | **42.0** |
|  | **MODULE V** |  |  |
| 0732 551 24A | Structural Analysis Principles III | 80 | 8.0 |
| 0732 551 25A | Road Structures Design I | 70 | 7.0 |
| 0732 551 26A | Traffic Survey Performance | 75 | 7.5 |
| 0732 541 27A | Calculus and Differential Methods | 70 | 7.0 |
|  | **TOTAL** | **295** | **29.5** |
|  | **MODULE VI** |  |  |
| 0732 551 28A | Measurement, Estimation and Costing of Works II | 60 | 6.0 |
| 0732 551 29A | Road Structures Design II | 70 | 7.0 |
| 0732 551 30A | Highway Engineering Structures Design I | 150 | 15.0 |
| 0732 551 31A | Hydraulic Principles | 120 | 12.0 |
| 0732 551 32A | Research Project I | 20 | 2.0 |
| 0732 541 33A | Vectors, Matrices and Data Analysis | 50 | 5.0 |
|  | **TOTAL** | **470** | **47.0** |
|  | **MODULE VII** |  |  |
| 0732 551 34A | Highway Engineering Structures Design II | 150 | 15.0 |
| 0732 551 35A | Highway Engineering Projects supervision | 120 | 12.0 |
| 0732 551 36A | Measurement, Estimation and Costing of Works III | 60 | 6.0 |
| 0732 551 38A | Research Project 11 | 40 | 4.0 |
|  | Industrial Attachment | 480 | 48 |
|  | TOTAL | **370** | **37.0** |
|  | **TOTAL** | **2885** | **288.5** |

**Entry Requirements**

An individual entering this course should have any of the following minimum requirements:

1. Kenya Certificate of Secondary Education (KCSE) mean grade **C- (minus)**
2. Any other qualification equivalent as determined TVETA

**Trainer Qualification**

A trainer for any of the Units of Competency in this course must:

1. Have Higher national Diploma, Bachelor degree or its equivalent in Civil engineering and Highway Engineering.
2. Be registered by TVETA.

**Industry Training**

An individual enrolled in this course will be required to undergo Industry training for a minimum period of 480 hours in Construction sector. The industrial training may be taken after completion of all units for those pursuing the full qualification or be distributed equally in each unit for those pursuing part qualification. In the case of dual training model, industrial training shall be as guided by the dual training policy.

**Assessment**

The course shall be assessed formatively and summatively:

1. During formative assessment all performance criteria shall be assessed based on performance criteria weighting.
2. Number of formative assessments shall minimally be equal to the number of elements in a unit of competency.
3. During summative assessment basic and common units may be integrated in the core units or assessed as discrete units.
4. Theoretical and practical weight shall 40:60 for each unit of learning.
5. Formative and summative assessments shall be weighted at 60% and 40% respectively in the overall unit of learning score

For a candidate to be declared competent in a unit of competency, the candidate must meet the following conditions:

1. Obtained at least 40% in theory assessment in formative and summative assessments.
2. Obtained at least 60% in practical assessment in formative and summative assessment where applicable.
3. Obtained at least 50% in the weighted results between formative assessment and summative assessment where the former constitutes 60% and the latter 40% of the overall score.
4. Assessment performance rating for each unit of competency shall be as follows:

|  |  |
| --- | --- |
| **MARKS** | **COMPETENCE RATING** |
| 80 -100 | Attained Mastery |
| 65 - 79 | Proficient |
| 50 - 64 | Competent |
| 49 and below | Not Yet Competent |
| Y | Assessment Malpractice/irregularities |

1. Assessment for Recognition of Prior Learning (RPL) may lead to award of part and/or full qualification.

**Certification**

A candidate will be issued with a Certificate of Competency upon demonstration of competence in a core Unit of Competency. To be issued with Kenya **National TVET Certificate** in Highway Engineering the candidate must demonstrate competence in all the Units of Competency as given in the qualification pack. A Statement of Attainment certificate may be issued upon demonstration of competence in a certifiable element within a unit.

The certificates will be issued by the Qualification Awarding Institution

# MODULE 1

## DIGITAL LITERACY

**UNIT CODE:** 0611 551 01A

**UNIT DURATION:** 40 Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Apply Digital Literacy**

**Unit Description**

This unit covers the competencies required to demonstrate digital literacy. It involves operating computer devices, solving tasks using the Office suite, managing data and information, performing online communication and collaboration, applying cybersecurity skills, performing online jobs and job entry techniques.

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| **Learning Outcomes** | **DURATION (HOURS)** |
| 1. Operate Computer Devices | **6** |
| 1. Solve Tasks Using Office Suite | **14** |
| 1. Manage Data and Information | **6** |
| 1. Perform Online Communication and Collaboration | **4** |
| 1. Apply Cyber security Skills | **4** |
| 1. Perform Online Jobs | **4** |
| 1. Apply job entry techniques. | **2** |
| **TOTAL** | 40 HO**URS** |

**Learning Outcomes, Content, and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested**  **Assessment Methods** |
| --- | --- | --- |
| 1. Operate computer devices | * 1. Meaning and importance of digital literacy   2. Functions and Uses of Computers   3. Classification of computers   4. Components of a computer system   5. Computer Hardware      1. The System Unit E.g. Motherboard, CPU, casing      2. Input Devices e.g. Pointing, keying, scanning, voice/speech recognition, direct data capture devices.      3. Output Devices e.g. hardcopy output and softcopy output      4. Storage Devices e.g. main memory e.g. RAM, secondary storage (Solid state devices, Hard Drives, CDs & DVDs, Memory cards, Flash drives      5. Computer Ports e.g. HDMI, DVI, VGA, USB type C etc.   6. Classification of computer software   7. Operating system functions   8. Procedure for turning/off a computer   9. Mouse use techniques   10. Keyboard Parts and Use Techniques   11. Desktop Customization   12. File and Files Management using an operating system   13. Computer Internet Connection Options       1. Mobile Networks/Data Plans       2. Wireless Hotspots       3. Cabled (Ethernet/Fiber)       4. Dial-Up       5. Satellite   14. Computer external devices management       1. Device connections       2. Device controls (volume controls and display properties) | * Observation * Written assessment * Oral assessment * Practical assessment |
| 1. Solve tasks using Office suite | * 1. Meaning and Importance of Word Processing   2. Examples of Word Processors   3. Working with word documents      1. Open and close word processor      2. Create a new document      3. Save a document      4. Switch between open documents   4. Enhancing productivity      1. Set basic options/preferences      2. Help resources      3. Use magnification/zoom tools      4. Display, hide built-in tool bar      5. Using navigation tools   5. Typing Text   6. Document editing (copy, cut, paste commands, spelling and Grammar check)   7. Document formatting      1. Formatting text      2. Formatting paragraph      3. Formatting styles      4. Alignment      5. Creating tables      6. Formatting tables   8. Graphical objects      1. Insert object (picture, drawn object)      2. Select an object      3. Edit an object      4. Format an object   9. Document Print setup      1. Page layout,      2. Margins set up      3. Orientation.   10. Word Document Printing   11. Meaning & Importance of electronic spreadsheets   12. Components of Spreadsheets   13. Application areas of spreadsheets   14. Using spreadsheet application.       1. Parts of Excel screen: ribbon, formula bar, active cell, name box, column letter, row number, Quick Access Toolbar.       2. Cell Data Types       3. Block operations       4. Arithmetic operators (formula bar (-, +, \*, /).       5. Cell Referencing   15. Data Manipulation       1. Using Functions (Sum, Average, Sum IF, Count, Max, Max, IF, Rank, Product, mode etc.)       2. Using Formulae       3. Sorting data       4. Filtering data       5. Visual representation using charts   16. Worksheet printing   17. Electronic Presentations   18. Meaning and Importance of electronic presentations   19. Examples of Presentation Software   20. Using the electronic presentation application       1. Parts of the PowerPoint screen (slide navigation pane, slide pane, notes, the ribbon, quick access toolbar, and scroll bars).       2. Open and close presentations       3. Creating Slides (Insert new slides, duplicate, or reuse slides.)       4. Text Management (insert, delete, copy, cut and paste, drag and drop, format, and use spell check).       5. Use magnification/zoom tools       6. Apply or change a theme.       7. Save a presentation       8. Switch between open presentations   21. Developing a presentation       1. Presentation views       2. Slides       3. Master slide   22. Text       1. Editing text       2. Formatting       3. Tables   23. Charts       1. Using charts       2. Organization charts   24. Graphical objects       1. Insert, manipulate       2. Drawings   25. Prepare outputs   Applying slide effects and transitions   * 1. Check and deliver      1. Spell check a presentation      2. Slide orientation      3. Slide shows, navigation   2. Print presentations (slides and handouts) | * Observation * Portfolio of Evidence * Project * Written assessment * Practical assessment * Oral assessment |
| 1. Manage Data and Information | * 1. Meaning of Data and information   2. Importance and Uses of data and information   3. Types of internet services      1. Communication Services      2. Information Retrieval Services      3. File Transfer      4. World Wide Web Services      5. Web Services      6. Automatic Network Address Configuration      7. Newsgroup      8. Ecommerce   4. Types of Internet Access Applications   5. Web browsing concepts   Key concepts  Security and safety   * 1. Web browsing      1. Using the web browser      2. Tools and settings      3. Clearing Cache and cookies      4. URIs      5. Bookmarks      6. Web outputs   2. Web based information      1. Search      2. Critical evaluation of information      3. Copyright, data protection   3. Downloads Management   4. Performing Digital Data Backup (Online and Offline)   5. Emerging issues in internet | * Observation * Portfolio of Evidence * Practical assessment * Project * Written assessment * Oral assessment |
| 1. Perform online communication and collaboration | * 1. Netiquette principles   2. Communication concepts      1. Online communities      2. Communication tools      3. Email concepts   3. Using email      1. Sending email      2. Receiving email      3. Tools and settings      4. Organizing email   4. Digital content copyright and licenses   5. Online collaboration tools      1. Online Storage (Google Drive)      2. Online productivity applications (Google Docs & Forms)      3. Online meetings (Google Meet/Zoom)      4. Online learning environments      5. Online calendars (Google Calendars)      6. Social networks (Facebook/Twitter - Settings & Privacy)   6. Preparation for online collaboration   Common setup features  Setup   * 1. Mobile collaboration      1. Key concepts      2. Using mobile devices      3. Applications      4. Synchronization | * Observation * Portfolio of Evidence * Project * Written assessment * Practical assessment * Oral assessment |
| 1. Apply cybersecurity skills | * 1. Data protection and privacy      1. Confidentiality of data/information      2. Integrity of data/information      3. Availability of data/information   2. Internet security threats      1. Malware attacks      2. Social engineering attacks      3. Distributed denial of service (DDoS)      4. Man-in-the-middle attack (MitM)      5. Password attacks      6. IoT Attacks      7. [Phishing Attacks](https://onlinedegrees.sandiego.edu/top-cyber-security-threats/#phishing-attacks)      8. [Ransomware](https://onlinedegrees.sandiego.edu/top-cyber-security-threats/#ransomware)   3. Computer threats and crimes   4. Cybersecurity control measures      1. Physical Controls      2. Technical/Logical Controls (Passwords, Pins, Biometrics)      3. Operational Controls   5. Laws governing protection of ICT in Kenya      1. The Computer Misuse and Cybercrimes Act No. 5 of 2018      2. The Data Protection Act No. 24 Of 2019 | * Observation * Portfolio of Evidence * Project * Written assessment * Practical assessment * Oral assessment |
| 1. Perform Online Jobs | * 1. Introduction to online working   2. Types of online Jobs   3. Online job platforms      1. Remo task      2. Data annotation tech      3. Cloud worker      4. Upwork      5. Oneforma      6. Appen   4. Online account and profile management   5. Identifying online jobs/job bidding   6. Online digital identity   7. Executing online tasks   8. Management of online payment accounts. | * Observation * Portfolio of Evidence * Project * Written assessment * Practical assessment * Oral assessment |
| 1. Apply job entry techniques | * 1. Types of job opportunities      1. Self-employment      2. Service provision      3. product development      4. salaried employment   2. Sources of job opportunities   3. Resume/ curriculum vitae      1. What is a CV      2. How long should a CV be      3. What to include in an AC      4. Format of CV      5. How to write a good CV      6. Don’ts of writing a CV   4. Job application letter      1. What to include      2. Addressing a cover letter      3. Signing off a cover letter   5. Portfolio of Evidence      1. Academic credentials      2. Letters of commendations      3. Certification of participations      4. Awards and decorations   6. Interview skills      1. Listening skills      2. Grooming      3. Language command      4. Articulation of issues      5. Body language      6. Time management      7. Honesty   7. Generally knowledgeable in current affairs and technical area | * Observation * Oral assessment * Portfolio of evidence * Third party report * Written assessment |

**Suggested Methods Instruction**

* 1. Instructor-led facilitation using active learning strategies
  2. Demonstration by trainer
  3. Practical work by trainees
  4. Viewing of related videos
  5. Group discussions
  6. Project
  7. Role play
  8. Case study

**Recommended Resources for 25 Trainees**

| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | Recommended publisher | 8 pcs | 1:3 |
|  | Samples of CVs | Various formats | 5 | 1:5 |
|  | Internet connection | Reliable | - | - |
|  | White board | For trainer’s use | 1 | - |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 72 Square Meter | 1 | 1:25 |
|  | Computer Lab | 96 Square Meter | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
|  | Ink | Assorted Colours for trainer’s use | 500ml per term | - |
|  | White board Marker | Refillable type | 10 pcs per term | - |
|  | Printing papers | sufficient | - | - |
| **D** | **Tools and Equipment** |  |  |  |
|  | Computers | Latest version with:  Windows/Linux/Macintosh Operating System, Microsoft Office Software, Google Workspace Account, Antivirus Software | 25 | 1:1 |
|  | Projector | Latest version | 1 | 1:25 |
|  | External storage media | Latest version | 25 | 1:1 |
|  | Laptop | Intel core i5 | 25 | 1:1 |
|  | printers | Latest version | 2 | 1:13 |

## COMMUNICATION SKILLS

**UNIT CODE:** 0031 541 02A

**UNIT DURATION:** 40 hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Apply Communication Skills**

**Unit Description**

This unit covers the competencies required to apply communication skills. It involves applying communication channels, written communication skills, non-verbal skills, oral communication skills and group communication skills.

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| **Learning Outcomes** | **DURATION (HOURS)** |
| 1. Apply communication channels. | **10** |
| 1. Apply written communication skills. | **12** |
| 1. Apply non-verbal skills. | **4** |
| 1. Apply oral communication skills. | **4** |
| 1. Apply group communication skills. | **10** |
| **TOTAL** | **40 HOURS** |

**Learning Outcomes, Content, and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Apply communication channels | * 1. Communication process   2. Principles of effective communication   3. Channels/medium/modes of communication   4. Factors to consider when selecting a channel of communication   5. Barriers to effective communication   6. Flow/patterns of communication   7. Sources of information   8. Organizational policies | * Oral questions * Written assessment * Observation * Portfolio of Evidence * Practical assessment * Third party report |
| 1. Apply written communication skills | * 1. Types of written communication   2. Elements of communication   3. Organization requirements for written communication | * Oral assessment * Written assessment * Observation * Portfolio of Evidence * Practical assessment * Third party report |
| 1. Apply non-verbal communication skills | * 1. Utilize body language and   2. gestures   3. Apply body posture   4. Apply workplace dressing code | * Oral assessment * Written assessment * Observation * Portfolio of Evidence * Practical assessment * Third party report |
| 1. Apply oral communication skills | * 1. Types of oral communication pathways   2. Effective questioning techniques   3. Workplace etiquette   4. Active listening | * Oral assessment * Written assessment * Observation * Portfolio of Evidence * Practical assessment * Third party report |
| 1. Apply group discussion skills | * 1. Establishing rapport   2. Facilitating resolution of issues   3. Developing action plans   4. Group organization techniques   5. Turn-taking techniques   6. Conflict resolution techniques   7. Team-work | * Oral assessment * Written assessment * Observation * Portfolio of Evidence * Practical assessment |

**Suggested Methods of Instruction**

1. Discussion
2. Roleplaying
3. Simulation
4. Direct instruction
5. Demonstration
6. Field trips

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | Recommended publisher | 8 pcs | 1:3 |
|  | Report writing templates | Various formats | 25 | 1:1 |
|  | Internet connection | Reliable | - | - |
|  | White board | For trainer’s use | 1 | - |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 72 Square Meter | 1 | 1:25 |
|  | Computer Lab | 96 Square Meter | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
|  | Ink | Assorted Colours for trainer’s use | 500ml per term | - |
|  | Flash cards | Sufficient | - | - |
|  | White board Marker | Refillable type | 10 pcs per term | - |
|  | Flip charts | Sufficient | - | - |
|  | Printing papers | sufficient | - | - |
| **D** | **Tools and Equipment** |  |  |  |
|  | Computers | Latest version | 25 | 1:1 |
|  | Projector | Latest version | 1 | 1:25 |
|  | External storage media | Latest version | 25 | 1:1 |
|  | Mobile phones | Latest version | 25 | 1:1 |
|  | printers | Latest version | 2 | 1:13 |

## CONSTRUCTION MATERIAL SCIENCE I

**UNIT CODE: 0732 541 03A**

**Duration of Unit:** **50** Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply construction material science I

**UNIT DESCRIPTION**

This unit describes the competence in applying Construction materials science. It involves identifying essential construction materials and their properties, selecting quality construction materials, testing construction materials and demonstrating knowledge in the handling and use of construction materials.

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| **Learning Outcomes** | **DURATION (HOURS)** |
| 1. To Identify essential construction materials | **20** |
| 1. To Identify properties of construction materials | **20** |
| 1. To Select quality construction materials | **10** |
| **TOTAL** | **50 HOURS** |

**Learning Outcomes, Content and Suggested Assessment Methods:**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Identify essential construction materials | * 1. Bill of quantities and working drawings      1. Building      2. Roadworks      3. Roadworks      4. Interpretation   2. Construction materials identification:      1. Stones      2. bricks      3. clay and clay products      4. lime      5. cement      6. timber and timber products      7. metals and alloys      8. paints and varnishes      9. roofing materials      10. Aggregates      11. Glass and glass products | * Observation * Oral questioning * Written tests * Practical’s |
| 1. Identify properties of construction materials | 1. Physical properties of construction materials    * 1. Porosity      2. Surface texture      3. Strength      4. Density      5. Thermal conductivity      6. Wear and tear    1. Chemical properties of construction materials       1. Corrosion resistance       2. Chemical resistance    2. Mechanical properties of construction materials       1. Toughness       2. Hardness       3. Fatigue       4. Stress and strain       5. Creep and stress rapture       6. Strength: | * Observation * Oral questioning * Written tests * Practical’s |
| 1. Select quality construction materials | * 1. Cost implications of construction materials   2. Quality of construction materials   3. Selection criteria of construction materials.      1. Cost      2. Availability      3. Project requirement | * Observation * Oral questioning * Written tests * Practical’s |
| 1. Test construction materials | * 1. Sampling of construction materials      1. Random,      2. Systematic,      3. Convenience,      4. Cluster,      5. Stratified   2. Test parameters identification:      1. Compression      2. Weathering      3. Durability      4. Water absorption      5. Impurity tests      6. Tensile tests      7. Workability      8. Plasticity      9. Aggregates crushing value   3. Optimum moisture content | * Observation * Oral questioning * Written tests * Practical’s |
| 1. Handle construction materials | * 1. Terms and concepts      1. Storage      2. Material Staging      3. Transportation      4. Material Protection      5. Quality Control and Inspection      6. Lifting and Hoisting      7. Inventory Management      8. Site Logistics   2. Identification of construction material      1. Determining the type,      2. Properties,      3. Suitability of materials used in building and construction   3. Construction safety requirement’s      1. Personal Protective Equipment (PPE)      2. Material Handling Training      3. Proper Storage of Materials      4. Handling Specific Materials with Care      5. Inspect Tools and Equipment Regularly      6. Safe Transportation on Site      7. Safety Signage and Communication      8. Minimize Dust and Hazardous Emissions   4. Handling of construction materials      1. Manual Handling of Materials      2. Mechanical Handling with Equipment      3. Storage and Stacking      4. Material-Specific Handling Guidelines      5. Transportation of Materials on Site      6. Waste and Recycling Management      7. Minimizing Waste and Damage | * Observation * Oral questioning * Written tests * Practical’s |
| 1. Use construction materials | * 1. Construction materials, tools and equipment assembly      1. Construction Materials      2. Construction Tools      3. Construction Equipment      4. Assembly Techniques   2. Preparation of construction materials      1. Concrete Preparation      2. Glass Preparation      3. Wood and Timber Preparation      4. Steel and Reinforcement Bar (Rebar) Preparation      5. Ceramic Tile Preparation   3. Proper Storage and Organization   4. The construction process:      1. Site Preparation and Foundations      2. Structural Framework      3. Flooring      4. Walls and Partitions      5. Roofing      6. Doors and Windows      7. Exterior Finishes      8. Interior Finishes      9. Plumbing and Electrical Systems      10. HVAC and Insulation      11. Landscaping and Site Work   5. Use of construction material:      1. Concrete: Foundations and Structural Elements; Decorative Concrete; Pavements and Sidewalks:      2. Steel: Structural Framing, Reinforcement for Concrete (Rebar); Cladding and Roofing:      3. Wood (Timber): Framing and Support Structures; Finishes and Aesthetics; Temporary Structures:      4. Bricks and Blocks: Wall Construction: Aesthetic and Facade Elements; Fire-Resistant Barriers:      5. Glass:      6. Ceramic Tiles and Stone      7. Asphalt      8. Aggregate (Gravel, Sand)      9. PVC and Plumbing Materials      10. and Finishes | * Observation * Oral questioning * Written tests * Practical’s |

**Suggested Methods of Delivery**

1. Projects
2. Group discussions
3. Direct instruction
4. Practical’s
5. Third party reports

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Material science reference books | For trainee’s use | 14 | 1:2 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Lecture room | 9m by 8m | 1 | 1:25 |
|  | Material testing laboratory | 9m by 8m | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Whiteboard markers | For trainer’s use | 2 pc | 1:1 |
|  | Lime | For trainee’s use | Sufficient | 1:5 |
|  | Cement | For trainee’s use | Sufficient | 1:5 |
|  | Coarse and fine aggregate | For trainee’s use | Sufficient | 1:5 |
| **D** | **Tools and Equipment** | | | |
|  | Slump test tools | For trainee’s use | 5 pcs | 1:5 |
|  | Compaction factor test tools & equipment | For trainee’s use | 5 pcs | 1:5 |

## CIVIL WORKS I

**UNIT CODE:** 0732 551 04A

**UNIT DURATION:** 100 Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Carry out Civil Works

**Unit Description**

This unit describes the competencies required in carry out civil works. It involves carrying out site preliminary work, performing civil temporary works, executing substructure works

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| Learning Outcomes | **DURATION (HOURS)** |
| 1. To carry out site preliminary works | **20** |
| 1. To perform civil temporary works | 40 |
| 1. To execute substructure works | **40** |
| **TOTAL** | 100 **HOURS** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Carry out site preliminary works | * 1. Site survey:      1. Use of surveying equipment      2. Topographical survey      3. Geotechnical investigation   2. Site boundary:      1. Boundary identification      2. Surveying techniques      3. Marking and fencing   3. Site clearance:      1. Adherence to standard procedures      2. Removal of vegetation      3. Debris and obstacle removal      4. Soil and topsoil management      5. Site layout:      6. Adherence to construction standards for site layout      7. Use of surveying tools      8. Marking Reference Points      9. Setting Out Structures and Features   4. Site preliminary report:      1. Site survey findings      2. Geotechnical assessment      3. Environmental impact analysis      4. Utility and infrastructure assessment      5. Site clearance and preparation status   5. Site utilities:      1. Temporary washrooms      2. Source of water      3. Storage      4. Site office | * Practical * Projects * Portfolio of evidence * Written tests |
| 1. Perform civil temporary works | * 1. Trench timbering:      1. Site assessment      2. selection of timbering materials      3. Construction of trench timbering      4. Installation of protective systems      5. Monitoring and inspection      6. Safe dismantling procedures   2. Formwork/shuttering construction and dismantling:      1. Types of formwork materials      2. Design and installation      3. Reinforcement integration      4. Safety considerations      5. Concrete pouring and curing      6. Stripping or dismantling of formwork   3. Scaffold erection and dismantling:      1. Adherence to job requirements      2. Scaffold design and planning      3. Erection of scaffold      4. Dismantling of scaffold      5. Inspection and maintenance   4. Shores erection and dismantling:      1. Need based on job requirement.      2. Shore design and planning      3. Erection of shores      4. Safety precautions | * Practical * Projects * Portfolio of evidence * Written tests |
| 1. Execute substructure works | * 1. Types of Foundation:      1. Strip footing      2. Pad footing      3. Raft   2. Setting out      1. Understanding project requirements      2. Site preparation      3. Surveying equipment      4. Marking layout:      5. Alignment and levels:   3. Excavation of foundation:      1. Setting Out the Excavation Area      2. Excavation Process; depth and width, slope stability, & handling excavated material:      3. Dealing with Groundwater   4. Laying of foundation:      1. Foundation type      2. Reinforcement placement      3. Concrete pouring:   5. Structural elements:      1. Column,      2. Beam,      3. Staircase, &      4. Slab. | * Practical * Projects * Portfolio of evidence * Written tests |

**Suggested Methods of Instruction**

1. Practical
2. Role playing
3. Demonstrations
4. Viewing of related videos
5. Group Discussion
6. Projects
7. Direct Instruction

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Structural drawings & Site layout | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Calculator | For trainee’s use | 25 pcs | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Assorted colour of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
|  | Steel reinforcements | For trainee’ use | 5 pcs | 1:5 |
|  | concrete | For trainee’ use | 1MT | 1:5 |
|  | Pegs | For trainee’s use | 25pcs | 1:1 |
|  | Timber | For trainee’s use | 25fts | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Rulers, protractors and compasses, | For trainers and trainee’s use | 25pcs | 1:1 |
|  | Surveying equipment: dumpy level total station etc | For trainers and trainee’s use | 5 pcs | 1:5 |
|  | Scientific Calculator | For trainers and trainee’s use | 25pcs | 1:1 |
|  | Scaffold | For trainee’s use | 5pcs | 1:5 |
|  | Bar bender | For trainee’s use | 5pcs | 1:5 |
|  | Hacksaw | For trainee’s use | 5pcs | 1:5 |
|  | Bar cutter | For trainee’s use | 5pcs | 1:5 |
|  | Measuring tape | For trainee’s use | 5pcs | 1:5 |
|  | Builder’s line | For trainee’s use | 5pc s | 1:5 |
|  | Jembe | For trainee’s use | 5pc s | 1:5 |
|  | Spade | For trainee’s use | 5pc s | 1:5 |
|  | Wheelbarrow | For trainee’s use | 5pc s | 1:5 |

## SITE SURVEY

**UNIT CODE:** 0732 551 05A

**UNIT DURATION: 150** Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Carry Out Site Survey

**Unit Description**

This unit specifies the competencies required to carrying out site survey**.** It involves undertaking preliminary site survey, setting out civil structures and establishing survey control points.

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| Learning Outcomes | **DURATION (HOURS)** |
| 1. To undertake preliminary site survey | **30** |
| 1. To Set out civil structures | **60** |
| 1. To Establish survey control points | **60** |
| **TOTAL** | **150 HOURS** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Undertake preliminary site survey | * 1. Preliminary site survey plan      1. Purpose and Objectives      2. Site Analysis      3. Data Collection Methods      4. Resources and Equipment      5. Data Management      6. Constraints and Limitations      7. Risk Assessment      8. Survey Plan Layout      9. Coordination with Stakeholders      10. Preliminary Cost Estimation      11. Legal and Regulatory      12. Documentation and Reporting   2. Survey resources:      1. Human resources      2. Tools; Driving hammers, Pegs, measuring tapes, Cutting tools, Equipment Electric Distance Measurement (EDM) machines, Theodolite (CWT), Total Station (TS), Dumpy level, Levelling staff      3. Stationery; Surveyors filed notebooks, Pencil, Grid papers.      4. Legal documents; Field permits & Registration certificates      5. Power back-ups      6. Location maps   3. Working drawings:      1. Topographic maps      2. Site plan      3. Profile drawings   4. Site conditions:      1. Topography      2. Soil type and profiles      3. Vegetation      4. Settlements      5. Drainage      6. Weather conditions      7. Utility services; underground electric cables, pipe lines & data cables      8. Water table   5. Original ground level (ogl)      1. Procedure for Establishing Original Ground Level (OGL)      2. Data Collection Techniques for OGL      3. Documentation of OGL Measurements      4. Standards and Accuracy Requirements      5. Integration of OGL Data with Design Plans      6. Compliance with Job Requirements      7. Review and Validation of OGL Data      8. Reporting and Presentation of OGL Data      9. Legal and Regulatory Documentation   6. Reference points:      1. Procedure for Establishing Reference Points      2. Types of Reference Points Used      3. Criteria for Reference Point Placement      4. Methods of Marking and Identifying Reference Points      5. Accuracy and Precision Standards      6. Integration of Reference Points with Project Plans      7. Verification and Validation of Reference Points      8. Documentation of Reference Points Data   7. Preliminary survey report:      1. Compilation of Survey Data      2. Analysis of Survey Findings      3. Accuracy and Validation of Collected Data      4. Presentation of Topographical and Geotechnical Information      5. Identification of Site Constraints and Environmental Factors      6. Conclusions Based on Data Analysis      7. Recommendations for Project Planning      8. Documentation of Results with Visual Aids (maps, charts, diagrams) | * Projects * Reports * Written Tests * Practical |
| 1. Set out civil structures | * 1. Setting out tools and equipment:      1. Strings      2. Tape measures      3. Ranging rods      4. Pegs      5. Cutting tools      6. Driving tools      7. Angle measuring tools      8. Plumb bob      9. Marking tools and equipment   2. Calibration of setting out equipment:      1. Calibration Process      2. Manufacturer’s Manual      3. Documentation and Records      4. Common Calibration Issues      5. Training and Best Practices   3. Proposed alignment:      1. Understanding Job Specifications      2. Site Assessment and Surveying      3. Alignment Methods and Techniques      4. Drafting and Planning      5. Review and Approval Process   4. Horizontal and vertical alignment.:      1. Definition of Horizontal and Vertical Alignment      2. Surveying Methods for Alignment      3. Tools and Equipment for Setting Out      4. Establishing Control Points      5. Techniques for Horizontal Alignment      6. Techniques for Vertical Alignment      7. Factors Affecting Alignment      8. Verification and Quality Assurance   5. Computation of alignment data:      1. Data Collection Methods      2. Types of Alignment Data      3. Mathematical Principles Involved      4. Software and Tools for Computation      5. Adjusting for Measurement Errors      6. Interpreting Computed Data      7. Documentation and Reporting of Results   6. Setting out tools and equipment are maintenance:      1. Regular Inspection and Assessment      2. Cleaning Procedures      3. Calibration and Adjustment      4. Lubrication of Moving Parts      5. Repair and Replacement of Worn Components      6. Storage Best Practices      7. Following Manufacturer’s Guidelines      8. Documentation of Maintenance Activities | * Written tests * Reports * Practical * Projects |
| 1. Establish survey control points | * 1. Survey tools and equipment      1. Dumpy level, tilting levels and automatic levels      2. Levelling staff      3. Tilting levels      4. Automatic levels      5. Tape measure      6. Pegs      7. Ranging rods   2. Calibration of Survey tools and equipment:      1. Types of Survey Tools Requiring Calibration      2. Calibration Standards and Procedures      3. Calibration Tools and Instruments      4. Following Manufacturer’s Guidelines      5. Recording Calibration Data   3. Site survey control points;      1. TBM (temporary benchmark)      2. BM (permanent benchmark)      3. Arbitrary   4. Levelling works:      1. Temporary adjustment;      2. Booking levels;      3. Calculation of reduced levels, &      4. Arithmetic checks | * Written tests * Observations * Reports * Practical |

**Suggested Methods of instruction**

1. Group Discussion
2. Direct Instruction
3. Demonstration
4. Practical
5. Projects
6. Role playing
7. Viewing of related videos

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Topographic maps | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Traffic Data | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Survey maps | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Site plans | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Geological and soil maps | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  |  |  |  |  |
|  |  |  |  |  |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Surveyors field note books | For trainer’s use | 1 pc | 1:25 |
|  | pencils | For trainer’s use | 1 pc | 1:25 |
|  | Grid papers | For trainer’s use | 1 pc | 1:25 |
| **D** | **Tools and Equipment** | | | |
|  | Driving hammers | For trainee’s use | 5 pcs | 1:5 |
|  | pegs | For trainee’s use | sufficient | 1:1 |
|  | Measuring tapes | For trainee’s use | 5 | 1:5 |
|  | Cutting tools | For trainee’s use | 1 | 1:25 |
|  | theodolites | For trainee’s use | 5 pcs | 1 |
|  | Total stations | For trainee’s use | 5 pcs | 1:5 |
|  | Dumpy level | For trainee’s use | 5 pcs | 1:5 |
|  | Levelling staff | For trainee’s use | 5 pcs | 1:5 |

# MODULE 11

## WORK ETHICS AND PRACTICES

**UNIT CODE:** 0031 541 06A

**UNIT DURATION:** 40 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Apply work ethics and practices.**

**Unit Description**

This unit covers competencies required to demonstrate employability skills. It involves the ability to: conduct self-management, promote ethical work practices and values, promote teamwork, manage workplace conflicts, maintain professional and personal development, apply problem-solving, and promote customer care.

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| Learning Outcomes | **DURATION (HOURS)** |
| 1. Apply self-management skills | **10** |
| 1. Promote ethical practices and values | **4** |
| 1. Promote Teamwork | **10** |
| 1. Maintain professional and personal development | **10** |
| 1. Apply Problem-solving skills | **4** |
| 1. Promote Customer care. | **2** |
| **TOTAL** | 40 **HOURS** |

**Learning Outcomes, Content, and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Apply self-management skills | * 1. Self-awareness   2. Formulating personal vision, mission, and goals   3. Healthy lifestyle practices   4. Strategies for overcoming work challenges   5. Emotional intelligence   6. Coping with Work Stress.   7. Assertiveness versus aggressiveness and passiveness   8. Developing and maintaining high self-esteem   9. Developing and maintaining positive self-image   10. Time management   11. Setting performance targets   12. Monitoring and evaluating performance targets | * Observation * Written assessment * Oral assessment * Third party reports * Portfolio of evidence * Project * Practical |
| 1. Promote ethical work practices and values | * 1. Integrity   2. Core Values, ethics and beliefs   3. Patriotism   4. Professionalism   5. Organizational codes of conduct   6. Industry policies and procedures | * Observation * Written assessment * Oral assessment * Third party reports * Portfolio of evidence * Project * Practical |
| 1. Promote Teamwork | * 1. Types of teams   2. Team building   3. Individual responsibilities in a team   4. Determination of team roles and objectives   5. Team parameters and relationships   6. Benefits of teamwork   7. Qualities of a team player   8. Leading a team   9. Team performance and evaluation   10. Conflicts and conflict resolution   11. Gender and diversity mainstreaming   12. Developing Healthy workplace relationships   13. Adaptability and flexibility   14. Coaching and mentoring skills | * Observation * Written assessment * Oral assessment * Third party reports * Project * Practical |
| 1. Maintain professional and personal development | * 1. Personal vs professional development and growth   2. Avenues for professional growth   3. Recognizing career advancement   4. Training and career opportunities   5. Assessing training needs   6. Mobilizing training resources   7. Licenses and certifications for professional growth and development   8. Pursuing personal and organizational goals   9. Managing work priorities and commitments   10. Dynamism and on-the-job learning | * Observation * Written assessment * Oral assessment * Third party reports * Portfolio of evidence * Project * Practical |
| 1. Apply Problem-solving skills | * 1. Causes of problems   2. Methods of solving problems   3. Problem-solving process   4. Decision making   5. Creative thinking and critical thinking process in development of innovative and practical solutions | * Observation * Written assessment * Oral assessment * Third party reports * Portfolio of evidence * Project * Practical |
| 1. Promote Customer Care | * 1. Identifying customer needs   2. Qualities of good customer service   3. Customer feedback methods   4. Resolving customer concerns   5. Customer outreach programs   6. Customer retention | * Observation * Written assessment * Oral assessment * Third party reports * Portfolio of evidence * Project * Practical |

**Suggested Methods of Instruction**

1. Instructor lead facilitation of theory using active learning strategies.
2. Demonstrations
3. Simulation/Role play
4. Group Discussion
5. Presentations
6. Projects
7. Case studies
8. Assignments

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | Recommended publisher | 8 pcs | 1:3 |
|  | Report writing templates | Various formats | 25 | 1:1 |
|  | Internet connection | Reliable | - | - |
|  | White board | For trainer’s use | 1 | - |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 72 Square Meter | 1 | 1:25 |
|  | Computer Lab | 96 Square Meter | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
|  | Ink | Assorted Colours for trainer’s use | 500ml per term | - |
|  | Flash cards | Sufficient | - | - |
|  | White board Marker | Refillable type | 10 pcs per term | - |
|  | Flip charts | Sufficient | - | - |
|  | Printing papers | sufficient | - | - |
| **D** | **Tools and Equipment** |  |  |  |
|  | Computers | Latest version | 25 | 1:1 |
|  | Projector | Latest version | 1 | 1:25 |
|  | External storage media | Latest version | 25 | 1:1 |
|  | Mobile phones | Latest version | 25 | 1:1 |
|  | printers | Latest version | 2 | 1:13 |

## 

## MATERIALS TESTING PREPARATION

**UNIT CODE: 0732 551 07A**

**UNIT DURATION:** 60Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: prepare for materials testing

**Unit Description**

This unit describes the competencies required in preparing for materials testing. It involves organizing for material testing, sampling construction materials and preparing samples for testing.

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| Learning Outcomes | **DURATION (HOURS)** |
| 1. To Organize for material testing | **20** |
| 1. To Sample construction materials | **40** |
| 1. To Prepare samples for testing | **40** |
| **TOTAL** | 60 **HOURS** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Organize for material testing | * 1. Preliminary site investigation      1. Purpose and importance      2. Methods of investigation      3. Stages of site investigation      4. Site assessment tools   2. Types of material tests      1. Mechanical tests      2. Chemical tests      3. Non-destructive testing   3. Material laboratory personnel      1. Roles and responsibilities (lab technicians, quality control etc)      2. Required qualifications and certifications      3. Safety protocols and training   4. Laboratory equipment maintenance      1. Types of laboratory equipment      2. Routine maintenance procedures   5. Testing equipment      1. types and uses | 1.practical  2.Projects  3.Portfolio of evidence  4.Third party reports  5. Written tests |
| 1. Sample construction materials | * 1. Sources of construction materials      1. Natural sources      2. Manufactured materials      3. Recycled materials   2. Sampling procedures      1. Purpose of sampling in construction      2. Types of sampling methods      3. Equipment used for sampling   3. Sampling tools and equipment      1. Types and uses   4. Sampling is carried out as per job requirement      1. Understanding project specifications and requirements      2. Customizing sampling plans for specific materials      3. Quality control and assurance considerations   5. Samples analysis      1. Laboratory testing methods      2. Interpreting test results      3. Comparison against industry standards and specifications      4. Reporting and documentation of findings | 1.practical  2.Projects  3.Portfolio of evidence  4.Third party reports  5. Written tests |
| 1. Prepare samples for testing | * 1. Sample tests      1. Methods of sampling   2. Standard manuals and procedures      1. Overview of the sampling process      2. Preparation before collection      3. Techniques for effective sample collection   3. **Sample testing tools and apparatus**      1. Types and uses   4. Samples collection      1. Purpose and importance of standard manuals      2. Types of standard manuals      3. Key organizations that publish standards | 1.practical  2.Projects  3.Portfolio of evidence  4.Third party reports  5. Written tests |

**Suggested Methods of Instruction**

1. Role playing
2. Viewing of related videos
3. Discussion
4. Direct Instruction
5. Practicals
6. Projects

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
| 1. 1 | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Soil testing manual | For trainee’s use | 14 | 1:2 |
| B | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Material testing lab | For trainer’s use | 1 pc | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Assorted colour of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
|  | Masking Tape | For trainee’s use | 1pc | 25:1 |
|  | Drawing stationery | For trainee’s use | 25 pcs per stationery | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | moulds | For trainee’s use | 5 pcs | 1:5 |
|  | Tamping rods | For trainee’s use | 5 pcs | 1:1 |
|  | br test machine | For trainee’s use | 2 | 1:10 |
|  | Rammer | For trainee’s use | 1 | 1:25 |
|  | Riffle box | For trainee’s use | 5 pcs | 1 |
|  | Casagrande machine | For trainee’s use | 5 pcs | 1:5 |
|  | Penetrometer | For trainee’s use | 5 pcs | 1:5 |
|  | Weighing machine | For trainee’s use | 5 pcs | 1:5 |
|  | Oven | For trainee’s use | 1 | 1:25 |
|  | Measuring cylinder | For trainee’s use | 5 | 1:5 |
|  | Cone cups | For trainee’s use | 5 | 1:5 |
|  | Bowl | For trainee’s use | 5 | 1:5 |
|  | Stirring stick | For trainee’s use | 5 | 1:5 |
|  | Crushing machine | For trainee’s use | 1 | 1:25 |
|  | Moisture bags | For trainee’s use | 5 bags | 1;5 |
|  | Funnels | For trainee’s use | 5 | 1:5 |
|  | Standard sieves | For trainee’s use | 5 | 1:5 |
|  | spade | For trainee’s use | 5 | 1:5 |
|  | trowel | For trainee’s use | 5 | 1:5 |
|  | Jembe | For trainee’s use | 5 | 1:5 |
|  | Mattock | For trainee’s use | 5 | 1:5 |
|  | Circular cutter | For trainee’s use | 5 | 1:5 |
|  | Spatula | For trainee’s use | 5 | 1:5 |
|  | chisel | For trainee’s use | 5 | 1:5 |

## TECHNICAL DRAWING

**UNIT CODE: 0732 551 08A**

**UNIT DURATION: 120 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Prepare and Interpret Technical Drawings

**Unit Description**

This unit covers the competencies required to prepare and interpret technical drawings. It involves competencies to select, use and maintain drawing equipment and materials. It also involves application of Computer Aided Drafting and Design Packages in Producing plane Geometry Drawings, Solid Geometry Drawings, Pictorial and Orthographic drawings.

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| Learning Outcomes | **DURATION (HOURS)** |
| 1. Select, use and maintain drawing equipment and materials | **10** |
| 1. Produce plane geometry drawings | **10** |
| 1. Produce solid geometry drawings | **40** |
| 1. Produce orthographic and pictorial drawings | **60** |
| **TOTAL** | **120 HOURS** |

**Learning Outcomes, Content and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Use and maintain drawing equipment and materials | * 1. Identification of Drawing Equipment      1. Types of drawing tools      2. Selection criteria based on tasks      3. Types of CADD software and installation      4. Proper usage techniques   2. Identification of Drawing Materials      1. Types of drawing materials      2. Properties of materials      3. Selection criteria based on tasks   3. Use of Drawing Equipment      1. Standard conventions for use      2. Maintenance procedures      3. Common issues and troubleshooting   4. **Introduction to AutoCAD**      1. Overview of CAD and its applications      2. Understanding the AutoCAD interface      3. Basic tools and navigation      4. Setting up a workspace and layout   5. **Creating and Saving Drawings**      1. Starting a new drawing      2. Understanding drawing units and scale      3. Saving, opening, and organizing drawings   6. Use of Drawing Materials      1. Workplace procedures      2. Handling techniques      3. Storage requirements   7. Waste Disposal      1. Procedures for disposal.      2. Environmental regulations      3. Recycling options | * Practical tests * Project * Portfolio of evidence * Third party report * Written tests |
| 1. Produce plane geometry drawings | 1. Identification of Drawing Lines (TD)    * 1. Types of lines and their meanings      2. Line thickness and styles      3. Applications of different line types 2. Basic Drawing Tools (AutoCAD)    * 1. **Line, Circle, Rectangle, Polygon**: Creating basic shapes      2. **Polyline and Spline**: Drawing connected lines and curves      3. **Arc and Ellipse**: Adding curved shapes      4. Snap, Grid, and Ortho modes for precision 3. **Modifying** Tools **(AutoCAD)**    * 1. **Move, Copy, Rotate, Mirror**: Positioning and duplicating objects      2. **Trim, Extend, Fillet, Chamfer**: Editing edges and intersections      3. **Offset, Array (Rectangular, Polar)**: Repeating objects 4. Dimensioning and Lettering (TD)    * 1. Techniques for dimensioning      2. Standards for lettering styles      3. Importance of clarity in drawings 5. Annotating **Drawings (AutoCAD)**    * 1. **Text**: Adding and formatting text      2. **Dimensions**: Applying dimensioning tools for measurements      3. **Hatching**: Filling areas with patterns 6. Construction of Geometric Forms    * 1. Basic geometric shapes (triangles, squares, etc.)      2. Complex geometric forms (polygons, curves)      3. Applications in real-world scenarios 7. Measurement of Angles    * 1. Tools for measuring angles (protractors, compasses)      2. Techniques for bisecting angles      3. Accuracy and precision in measurements 8. Construction of Angles    * 1. Types of angles (acute, obtuse, right)      2. Trigonometric principles applied to angles      3. Tools for angle construction | * Practical tests * Project * Portfolio of evidence * Third party report * Written tests |
| 1. Produce solid geometry drawings | * 1. Interpretation of Surface Development      1. Definition and significance of surface development      2. Standard conventions for representation      3. Examples of surface development   2. Development of Surfaces      1. Techniques for developing surfaces      2. Applications in design and manufacturing      3. Importance of accuracy in development   3. Section Development      1. Techniques for sectioning objects      2. Standard conventions for sectional views      3. Tools used for creating sections   4. Production of Solid Geometry Drawings      1. Techniques for creating solid drawings      2. Software tools for solid geometry      3. Examples of solid geometry applications   5. Interpretation of Solid Geometry      1. Understanding 3D representations      2. Application in engineering and architecture      3. Importance of visualization in design   6. Basic **3D Tools (AutoCAD)**      1. Understanding the 3D workspace      2. Basic solid shapes: Box, Cylinder, Sphere      3. Extruding and revolving objects   7. **Layouts** and **Plotting (AutoCAD)**      1. Creating layout tabs for printing      2. Using viewports to control drawing views      3. Setting up plot and printing options | * Practical tests * Project * Portfolio of evidence * Third party report * Written tests |
| 1. Produce orthographic and pictorial drawings | * 1. Identification of Symbols and Abbreviations      1. Common symbols in technical drawing      2. Interpretation of symbols      3. Creating a symbols glossary   2. Identification of Pictorial Views      1. Types of pictorial views      2. Techniques for creating pictorial views      3. Tools for pictorial drawing   3. Production of Isometric Drawings      1. Techniques for isometric projection      2. Tools for isometric drawing      3. Applications in product design   4. Production of Orthographic Drawings      1. First and third angle projection techniques      2. Techniques for achieving accuracy      3. Review of standards for orthographic views   5. Dimensioning of Orthographic Elevations      1. Standard dimensioning practices      2. Tools and techniques      3. Common errors | * Practical tests * Project * Portfolio of evidence * Third party report * Written tests |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstration
4. Group discussion
5. Direct instructions

**Recommended Resources for 25 Trainees**

| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Technical drawing reference books | For trainee’s use | 14 | 1:2 |
|  | Rulers, protractors and compasses, set-squares | For trainer’s use | 2 pcs each | 2:1 |
|  | A3 drawing papers | For trainee’s use | 25 pcs | 1:1 |
|  | Building Drawings samples | For both trainer’s and trainee’ use | 25 pcs | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Technical Drawing room | 9m by 8m | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Assorted colour of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
|  | Masking Tape | For trainee’s use | 1pc | 25:1 |
|  | Drawing stationery | For trainee’s use | 25 pcs per stationery | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Technical Drawing Instruments | For trainee’s use | 25 pcs | 1:1 |
|  | Computer installed with relevant CAD packages | For trainee’s use | 13 pcs | 1:2 |
|  | Drawing Board | For trainee’s use | 25 pcs | 1:1 |

## CONSTRUCTION MATERIALS SCIENCE II

**UNIT CODE: 0722 551 09A**

**UNIT DURATION: 80 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply Construction Materials Science II

**Unit Description**

This unit describes the competence in Applying Construction Materials Science. It involves Applying Environmental Factors Considerations, applying construction walling units, applying construction timber and timber products, applying construction clay products, applying construction metal products, applying construction plastics and Rubber products, applying construction paints and varnishes, applying construction glass and Applying construction concrete.

**Summary of Learning Outcomes**

1. Apply Environmental Factors Considerations
2. Apply construction walling units
3. Apply construction timber and timber products
4. Apply construction clay products.
5. Apply construction metal products.
6. Apply construction plastics and Rubber products.
7. Apply construction paints and varnishes
8. Apply construction glass
9. Apply construction concrete

**Learning Outcomes, Content and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Apply Environmental Factors Considerations | * 1. **Environmental safety observations**      1. Safety Regulations for Construction Materials      2. Material Handling and Storage Safety Measures      3. Personal Protective Equipment (PPE) for working with hazardous materials (e.g., asbestos, silica)      4. Safe handling and transportation of chemicals (e.g., paints, varnishes)      5. Hazardous material identification and labelling in construction      6. Workplace safety audits for construction sites   2. **Environmental Pollution Observations**      1. Pollution Generated by Construction Materials      2. Regulations to Control Material-Induced Pollution         1. Air pollution         2. Water pollution         3. Soil contamination         4. Noise pollution)         5. Regulatory frameworks for reducing pollution   3. **Environmental Application of Sustainable Resource Use**       1. Sustainable Material Selection in Construction      2. Resource Efficiency and Waste Minimization         1. Use of recycled materials         2. Materials with low embodied energy         3. Reducing material wastage         4. Circular economy in material usage   4. **Current Practices in Relation to Resource Usage**      1. Trends in Resource Management in Construction      2. Impact of Resource Consumption on the Environment      3. Energy-efficient materials and construction practices      4. Water conservation practices in material production      5. Minimizing carbon footprint      6. Best practices for waste reduction   5. **Environmental Legal Provisions for Environmental Concerns**      1. Environmental Legislation in Construction Materials   Environmental Protection Acts   * + 1. Compliance with International and Local Environmental Standards   Regulatory standards for sustainable material certifications   * + 1. Environmental impact assessments (EIA) in material sourcing and production     2. Enforcement of building codes related to environmental protection   1. **Specific Environmental Programs in Construction**      1. Government and Industry Initiatives for Environmental Sustainability      2. Green Building      3. Water and energy conservation programs in the construction sector   2. **Monitoring Activities on Environmental Programs**      1. Monitoring and Evaluation of Environmental Programs         1. Tools and techniques for environmental monitoring         2. Environmental audits on material sourcing and usage Tracking key performance indicators      2. Reporting and Compliance in Environmental Performance         1. Reporting frameworks for environmental compliance         2. Use of technology (e.g., GIS, IoT) for environmental program monitoring | * Direct Observation * Demonstration with Oral Questioning * Written tests |
| 1. Apply construction walling units | * 1. **Construction Walling Units**       1. Introduction and definition of terms      2. Types of Walling Units         1. Building stones         2. Brick units         3. Soil stabilized blocks         4. EPS         5. Prefabricate walling units      3. Criteria for Selecting Walling units      4. Applications of different walling units:         1. Load-bearing walls         2. Non-load-bearing walls      5. Factors influencing walling unit selection:         1. Structural requirements         2. Aesthetic considerations         3. Climate considerations)      6. Sustainability in choosing walling materials   2. **Properties of walling units**       1. Physical properties      2. Chemical properties      3. Mechanical properties   3. **Applications of Construction Walling Units**      1. Brick masonry techniques         1. Types of bonds         2. Mortar selection | * Direct Observation * Demonstration with Oral Questioning * Written tests |
| 1. Apply construction timber and timber products | * 1. **Timber Conversion**      1. Introduction      2. Timber species      3. Classification of timber      4. Mode of growth and cellular structure of tree      5. Conversion and seasoning of timber   2. **Timber Preservation**      1. Methods of Timber Preservation      2. Importance of Timber      3. Factors affecting timber      4. Applications of preserved timber      5. Regulations and standards for timber preservation   3. **Timber and Timber Products**      1. Types of timber products         1. Solid wood products         2. Composite products      2. Properties of Timber and Timber Products         1. Physical and mechanical properties         2. Strength characteristics         3. Thermal and acoustic insulation         4. Moisture behaviour      3. Applications in construction | * Direct Observation * Demonstration with * Oral Questioning * Written tests |
| 1. Apply construction clay products | * 1. **Clay Products Selection**      1. Types of Clay Products in Construction         1. Bricks         2. Tiles         3. Ceramic and terracotta products      2. Selection Criteria for Clay Products   2. **Clay Products Properties**      1. Physical Properties         1. Density and weight         2. Thermal insulation         3. Acoustic insulation         4. Water absorption      2. Mechanical properties         1. Compressive strength         2. Bending and tensile strength      3. Durability and weathering         1. Freeze-thaw resistance         2. Resistance to chemical attack         3. Fire resistance | * Direct Observation * Demonstration with Oral Questioning * Written tests |
| 1. Apply construction metal products principles | * 1. Metal products selection      1. Definitions      2. Types of metals   2. Properties of metals      1. Texture      2. Colour      3. Density      4. Strength      5. Fire resistance      6. Sound insulation   3. Applications of metal products      1. Advantages of metals      2. Deterioration of metals      3. Maintenance of metal products | * Direct Observation * Demonstration with Oral Questioning * Written tests |
| 1. Apply construction plastics and Rubber products | * 1. **Plastics and Rubber Products Selection**      1. Introduction and definition of terms      2. Types of plastics         1. Principal constituents of plastics         2. Methods of obtaining shapes of plastics         3. Properties of plastics         4. Selection Criteria for Plastics      3. Types of rubber         1. Properties of rubber         2. Uses of rubbers         3. Selection Criteria for rubber   2. **Plastics and Rubber Products Properties**      1. Mechanical Properties      2. Thermal properties      3. Chemical properties   3. **Plastics and Rubber Products**      1. PVC pipes      2. Polythene sheeting      3. Acrylic sheets      4. Rubber roofing materials      5. Rubber expansion joints | * Direct Observation * Demonstration with Oral Questioning * Written tests |
| 1. Apply construction paints and varnishes | * 1. **Paints and Varnishes Selection**      1. Definition of terms      2. Differences between paints and varnishes      3. Types of paints (oil-based, water-based, epoxy, etc.)      4. Types of varnishes (alkyd, polyurethane, acrylic)      5. Ingredients for manufacture of paints and varnishes   2. **Paints and Varnishes Properties**      1. Adhesion      2. Colour      3. Durability      4. Opacity      5. Drying time   3. **Paints and Varnishes Products**      1. Application of Paints      2. Application of Paints         1. primer coat         2. base coat         3. finish coat | * Direct Observation * Demonstration with Oral Questioning * Written tests |
| 1. Apply construction glass principles | * 1. **glass product selection**      1. Introduction and definition of terms      2. Types of glass      3. Manufacturing of glass   2. **Properties of glass**      1. Durability      2. Lightweight      3. Chemical resistance      4. Density      5. Strength      6. Fire resistance      7. Sound insulation   3. **Glass Products**      1. Float glass      2. Tinted glass      3. Reflective glass      4. Tempered glass      5. Patterned glass | * Direct Observation * Demonstration with Oral Questioning * Written tests |
| 1. Apply construction concrete principles | * 1. **Concrete Mixing**      1. Introduction and definition of terms      2. Manufacturing process of concrete         1. Batching         2. Mixing         3. Transporting         4. Placing         5. Compacting         6. Curing         7. finishing   **6Introduction to Concrete Mixing**   * + 1. Components of concrete: cement, aggregates, water, and additives     2. Different types of concrete: ready-mix, site-mixed, precast, etc.     3. Basic mixing principles (by volume or by weight)     4. Mix Design and Proportioning     5. Concrete mix design basics (w/c ratio, aggregate proportions)     6. Importance of water-cement ratio     7. Adjusting mix for different work requirements (e.g., high strength, quick setting)     8. Types of Mixes Based on Application     9. Standard mixes     10. Special concrete mixes (e.g., lightweight concrete, high-performance concrete)   1. **Tools and Equipment for Mixing**      1. Hand mixing vs machine mixing      2. Use of concrete mixers (types of mixers, efficiency)      3. Safety procedures during mixing (PPE, mixing equipment handling)   2. **Concrete Properties**      1. Mechanical Properties      2. Compressive strength      3. Workability      4. Durability Properties      5. Chemical resistance      6. Density      7. Fire resistance      8. Sound insulation | * Direct Observation * Demonstration with Oral Questioning * Written tests |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussions
5. Direct instructions

**Recommended Resources for 25 Trainees**

| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Rulers | For trainer’s use | 2 pcs each | 2:1 |
|  | Stationaries | For trainee’s use | 25 pcs | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Classroom/Material testing workshop | 9m by 8m | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Assorted color of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
|  | Cement, lime, aggregates, natural stones, soil, glass, timber, steel, plastics, rubber, paints and vanishes | For trainee’s use | Sufficient |  |
| **D** | **Tools and Equipment** | | | |
|  | Scientific Calculators | For trainee’s use | 25 pcs | 1:1 |
|  | Computers | For trainee’s use | 13 pcs | 1:2 |
|  | Soil Testing Equipment | For trainee’s use | 5 pcs | 1:5 |
|  | Concrete Testing Equipment; Sieves, slump apparatus, rebound hammer, le hotelier apparatus, glass plate | For trainee’s use | 3 pcs | 1:8 |
|  | Compression testing machines | For trainee’s use | 3 pcs | 1:8 |
|  | Bitumen Testing Equipment | For trainee’s use | 3 pcs | 1:8 |
|  | Sampling Tools: trowel, spade, bucket, wheelbarrow, riffle box | For trainee’s use | 3 pcs | 1:8 |
|  | Tensile testing machine | For trainee’s use | 3 pcs | 1:8 |

## MATHEMATICAL PRINCIPLES

**UNIT CODE: 0541 551 10A**

**UNIT DURATION:** 100Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **apply mathematical principles**

**Unit Description**

This unit describes the competencies required in applying basic mathematics. It involves applying basic arithmetic, applying basic algebra, and applying trigonometry, performing geometrical calculations, carrying out mensuration, applying statistics and applying linear graphs.

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| Learning Outcomes | **DURATION (HOURS)** |
| 1. To apply arithmetical principles | **14** |
| 1. To perform trigonometry calculations | **20** |
| 1. To perform geometric calculations | **16** |
| 1. To carry out mensuration calculations | **10** |
| 1. To perform statistical calculations | **20** |
| 1. To apply linear graph | **20** |
|  | **100** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply arithmetical principles | * 1. **Whole Numbers and Fractions**      1. Identifying whole numbers      2. Understanding simple fractions      3. Operations with fractions (addition, subtraction, multiplication, division)   2. **Decimals and Percentages**      1. Understanding decimals and their applications      2. Converting between fractions, decimals, and percentages      3. Calculating percentages (discounts, increases, etc.)   3. **Place Value and Rounding**      1. Understanding place value (units, tens, hundreds, etc.)      2. Rounding off numbers (to nearest whole number, tenths, etc.)   4. **Arithmetic Percentages and Proportions**      1. Understanding ratios and proportions      2. Solving problems involving percentages   5. **Decimal and Standard Form**      1. Expressing numbers in decimal form      2. Converting numbers to standard form (scientific notation) | * Practical * Projects * Portfolio of evidence * Third party reports * Written tests |
| 1. Perform Algebraic calculations | * 1. **Indices**      1. Understanding the concept of indices (exponents)      2. Performing calculations with indices   2. **Linear Equations**      1. Representing linear equations in various forms (slope-intercept, standard)      2. Solving linear equations   3. **Using Scientific Calculators**      1. Familiarization with the scientific calculator      2. Solving mathematical problems as per the manufacturer’s manual   4. **Simultaneous Equations**      1. Understanding simultaneous equations      2. Methods for solving simultaneous equations (substitution, elimination)   5. **Algebraic Equations**      1. Solving simple algebraic equations      2. Formulating simple algebraic equations based on word problems | * Practical * Projects * Portfolio of evidence * Third party reports * Written tests |
| 1. Perform Trigonometry calculations | * 1. **Trigonometric Rules**      1. Identifying key trigonometric rules (sine, cosine, tangent)      2. Understanding right-angle triangles   2. **Applying Trigonometric Rules**      1. Using trigonometric ratios to find unknown sides/angles      2. Solving real-world problems using trigonometry   3. **Performing Trigonometric Calculations**      1. Calculating values using trigonometric functions      2. Application of the sine, cosine, and tangent function | * Practical * Projects * Portfolio of evidence * Third party reports * Written tests |
| 1. Perform geometric calculations | * 1. **Identifying Geometric Figures**      1. Recognizing different geometric shapes (triangles, circles, polygons)      2. Understanding properties of geometric figures   2. **Calculating Areas**      1. Area formulas for various figures (rectangle, triangle, circle, etc.)      2. Applying formulas to calculate areas   3. **Pythagoras’ Theorem**      1. Understanding the Pythagorean theorem      2. Solving problems using the theorem | * Practical * Projects * Portfolio of evidence * Third party reports * Written tests |
| 1. Carry out Mensuration calculations | * 1. **Units of Measurement**      1. Identifying different units of measurement (length, area, volume)      2. Understanding the significance of units in calculations   2. **Unit Conversion**      1. Converting units (e.g., centimeters to meters, square feet to square meters)      2. Application of conversion in problems   3. **Perimeters and Areas**      1. Calculating perimeters of geometric figures      2. Area calculations using correct formulas   4. **Volume and Surface Area**      1. Formulas for volume and surface area of solids (cylinder, cube, sphere)      2. Solving volume and surface area problems   5. **Area of Irregular Figures**      1. Techniques for calculating areas of irregular shapes      2. Using decomposition methods for area calculation | * Practical * Projects * Portfolio of evidence * Third party reports * Written tests |
| 1. Perform statistical calculations | * 1. **Data Identification**      1. Understanding grouped vs. ungrouped data      2. Characteristics of different data types   2. **Organizing Data**      1. Techniques for organizing ungrouped data      2. Using frequency tables to represent data   3. **Calculating the Median**      1. Understanding median in data sets      2. Calculating the median for both grouped and ungrouped data   4. **Data Representation**      1. Representing data in chart form (bar charts, histograms, pie charts)      2. Interpreting data from visual representations | * Practical * Projects * Portfolio of evidence * Third party reports * Written tests |
| 1. Apply linear graphs | * 1. **Identifying Information**      1. Understanding given data sets and problems      2. Extracting relevant information for graphing   2. **Choosing Appropriate Scale**      1. Selecting appropriate scales for graphs      2. Understanding the impact of scale on graph interpretation   3. **Labeling Axes**      1. Properly labeling graph axes      2. Understanding the significance of labels in data representation   4. **Plotting Linear Graphs**      1. Techniques for plotting linear graphs      2. Connecting points and interpreting lines   5. **Graph Analysis**      1. Analyzing trends and patterns from plotted graphs      2. Drawing conclusions based on graph data | * Practical * Projects * Portfolio of evidence * Third party reports * Written tests |

**Suggested Methods of Instruction**

1. Role playing
2. Viewing of related videos
3. Discussion
4. Direct Instruction
5. Practicals
6. Projects

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Mathematical table | For trainee’s use | 25 pcs | 1:1 |
|  | Mathematical set | For trainee’ use | 25 pcs | 1:1 |
|  | SMP Table | For trainee’ use | 25 pcs | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Assorted colour of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
| **D** | **Tools and Equipment** | | | |
|  | Rulers, protractors and compasses, | For trainee’s use | 25pcs | 1:1 |
|  | Scientific Calculator | For trainee’s use | 25pcs | 1:1 |

# MODULE III

## ENGINEERING SURVEY I

**ISCED CODE: 0732 551 11A**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: carry out Civil Engineering survey I

**Unit Description**

This unit specifies the competencies required to carry out civil engineering survey**.** It involves; Perform Curve Ranging and traversing works.

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| **Learning Outcomes** | **DURATION (HOURS)** |
| 1. Perform Curve Ranging | 40 |
| 1. Perform traversing works. | 40 |
| TOTAL | 80 |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Perform curve ranging | * 1. Description of tools and equipment for curve ranging   2. Description of principles of curve ranging   3. Determining methods of overcoming obstacles encountered in curve ranging.   4. Computing data for setting out curves | * + - * Observation       * Oral questioning       * Projects       * Written tests       * Third party       * Portfolio  1. **tests** 2. **Third party** 3. **Portfolio** |
| 1. Perform traversing works | * 1. Theodolite traversing      1. Principles of Theodolite Traversing      2. Methods of Theodolite Traversing      3. Field Procedures      4. Computations and Adjustments   2. Compass traversing      1. Principles of Compass Traversing      2. Field Procedures      3. Calculating bearings and azimuths      4. Adjusting traverses (Bowditch's rule, transit rule)      5. Calculating coordinates   3. Calibration of tools      1. Importance of Calibration   4. Determination of horizontal and vertical angles      1. Stadia Method      2. Calculation of coordinates      3. Data collection and analysis      4. Documentation of data | * + - * Observation       * Oral questioning       * Projects       * Written tests       * Third party       * Portfolio |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussions
5. Direct instructions

**Recommended Resources for 25 Trainees**

| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Rulers, protractors and compasses, set-squares | For trainer’s use | 2 pcs each | 2:1 |
|  | Surveyors filed notebooks | For trainee’s use | 25 pcs | 1:1 |
|  | Grid papers | For both trainer’s and trainee’ use | 25 pcs | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Drafting room | 9m by 8m | 1 | 1:25 |
|  | Computer rooms | 9m by 8m | 1 | 1:25 |
|  | Computers with surveying software | For trainers and trainees | 13 | 2:1 |
|  | Plotter | For trainers and trainees | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Assorted colour of whiteboard markers | For trainer and trainee’s use | 25 pcs per stationery | 1:1 |
|  | Masking Tape | For trainee’s use | 1pc | 25:1 |
|  | Drawing stationery | For trainee’s use | 25 pcs per stationery | 1:1 |
|  | pencils | For trainee’s use | 25 pcs per stationery | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Technical Drawing Instruments | For trainee’s use | 25 pcs | 1:1 |
|  | Drawing Board | For trainee’s use | 25 pcs | 1:1 |
| 1. a | Assorted Surveying Equipment | For Trainer and trainees use | 8 pcs | 3:1 |

## WORKSHOP TECHNOLOGY PRACTICES

**UNIT CODE: 0719 551 12A**

**UNIT DURATION: 50 Hours**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate Workshop Technology practices

**Unit Description**

This unit describes the competencies required to demonstrate workshop technology skills. It involves demonstrating workshop safety awareness, demonstrating masonry skills, demonstrating carpentry skills, performing electrical operations and managing workshop waste.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **SNO** | **LEARNING OUTCOMES** | **DURATION (hours)** |
|  | To demonstrate workshop safety awareness | **4** |
|  | To demonstrate masonry skills | **15** |
|  | To demonstrate carpentry skills | **15** |
|  | To perform electrical operations | **10** |
|  | To manage workshop waste | **6** |
|  | **TOTAL** | **50** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Demonstrate workshop safety awareness | * 1. Personal Protective Equipment:      1. Dust coat/overall      2. Safety boots      3. Helmet      4. Safety gloves      5. Safety goggles      6. Reflector jackets      7. Hear muffs      8. Face musk   2. Personal safety rules and regulations (Occupational Safety and Health (OSH) Act 2012);      1. Proper Usage of PPE      2. PPE Maintenance      3. Incident Reporting      4. Roles and Responsibilities   3. Workshop machine, tools and equipment safety procedures (Occupational Safety and Health (OSH) Act 2012);      1. Proper Use of Machines and Tools      2. Inspection and Maintenance      3. Safety Guards and Devices      4. Safe Handling and Storage      5. Training and Awareness   4. Workplace safety practices (Occupational Safety and Health (OSH) Act 2012);      1. Hazard Identification:      2. Safe Work Practices      3. Training and Awareness      4. Safety Signage and Communication      5. Incident Reporting and Investigation   5. Appropriate fire extinguishers:      1. Identify the Extinguisher Class:      2. Operating the Fire Extinguisher (PASS Technique)      3. Fire Extinguisher Location and Accessibility      4. Training and Awareness | * Observation * Written Tests * Oral Questioning * Portfolio of evidence * Third Party Report   Interviews |
| 1. Demonstrate masonry skills | * 1. Workshop safety hazards:      1. Fire      2. Explosion      3. Fumes and gases      4. Electric shock      5. Spilt oil/water   2. Masonry tools, equipment and consumable materials: Fabrication tools and equipment      1. Wire brush      2. Saws      3. Hammers      4. Trowels      5. Mason square      6. Builder’s line      7. Tape measure      8. Floats      9. shovel      10. Levels      11. Plumb bob      12. Drilling machines      13. Wheel barrows   3. Working drawings:      1. structural      2. architectural      3. mechanical      4. electrical   4. Setting out      1. Understanding Design Plans      2. Surveying and Measurement      3. Marking and Layout      4. Verification and Adjustment   5. Masonry procedures:      1. Understanding Job Specifications      2. Preparation of Materials and site      3. Setting Out and Layout      4. Laying Masonry Units      5. Building Up Layers (Courses)      6. Curing Process   6. Masonry works finishes:      1. Review Job Specifications      2. Surface Preparation      3. Finishing Techniques      4. Curing Process   7. Masonry works tests:      1. Understanding Testing Requirements      2. Types of Tests for Masonry Works      3. Visual Inspection      4. Structural Stability Tests      5. Corrective Actions | * Observation * Written Tests * Oral Questioning * Portfolio of evidence * Third Party Report   Interviews |
| 1. Demonstrate carpentry skills | * 1. Workshop safety hazards:      1. Fire      2. Explosion      3. Fumes and gases      4. Electric shock      5. Spilt oil/water   2. Carpentry tools, equipment:      1. planes      2. saws      3. chisels      4. clamps      5. vices      6. gauges      7. files      8. drills      9. screw drivers      10. spanners   3. Consumable materials:      1. Blocks      2. Adhesives      3. Sand paper      4. Electric cables      5. Conduits      6. Patress      7. Couplers      8. Switches      9. bulbs      10. Switch boxes      11. Stones      12. Sand      13. Cement      14. Timber      15. Lime      16. Hoop iron      17. Reinforcement bars      18. Jointing cement      19. Clips      20. Sheet metal      21. nails   4. Working drawings      1. Structural      2. Architectural      3. Mechanical      4. Electrical   5. Setting out:      1. Review Design Plans and Specifications      2. Preparation for Setting Out      3. Measurement and Marking      4. Alignment and Checking      5. Setting Out Joinery Components   6. Carpentry procedures:      1. Review Job Specifications      2. Preparation and Planning      3. Site Assessment      4. Setting Out      5. Cutting and Shaping Materials      6. Assembly and Installation      7. Finishing Touches | * Observation * Written Tests * Oral Questioning * Portfolio of evidence * Third Party Report * Interviews |
| 1. Perform electrical operations | * 1. 4..   2. Safety requirements in the workshop environment as per OSHA 2012:      1. Workplace assessment      2. Personal Protective Equipment (PPE)      3. Personal Protective Equipment (PPE)      4. Safe Work Practices      5. Tool Safety      6. Training and Competence   3. Working drawings:      1. Architectural      2. Mechanical      3. Electrical   4. Electrical tools, equipment and consumable materials:      1. Pliers      2. Tester      3. Draw wire      4. Bending spring      5. Electric meters      6. Ladder      7. Drilling machine      8. Screw drivers      9. Hammer   5. Power supply source      1. Assessment of Power Needs      2. Selection of Power Supply Sources      3. Installation and Setup      4. Testing Power Sources   6. IEE regulations on Basic electrical circuits installation and maintenance:      1. Familiarization with IEE Regulations.      2. Planning the Installation      3. Installation Procedures      4. Testing Electrical Circuits      5. Circuit Protection | * Observation * Written Tests * Oral Questioning * Portfolio of evidence * Third Party Report * Interviews |
| 1. Manage workshop waste | |  | | --- | | * 1. PPEs:      1. Dust coat      2. Helmet      3. Gloves   2. Waste management tools and equipment: Dust bin      1. Shovel      2. Brooms      3. Dust blower      4. Dust pan      5. Wheel barrow      6. trowel   3. Waste collection as per environmental management authority guidelines:      1. Understanding Environmental Management Authority Guidelines      2. Developing a Waste Management Plan      3. Implementing Waste Segregation      4. Establishing Collection Procedures      5. Handling Hazardous Waste      6. Training and Awareness Programs   4. Solid waste disposal as per NEMA guidelines:      1. Understanding NEMA Guidelines      2. Waste Management Plan      3. Waste Segregation      4. Waste Segregation      5. Waste Segregation   5. Waste management procedures      1. Reduce      2. Recycle      3. reuse | | * Observation * Written Tests * Oral Questioning * Portfolio of evidence * Third Party Report * Interviews |

**Suggested Methods of Instruction**

1. Practical
2. Role playing
3. Demonstrations
4. Viewing of related videos
5. Group Discussion
6. Projects
7. Direct Instruction

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Workshop technology reference books | For both trainer & trainee’s use | 14 | 1:2 |
|  | Working drawings: Structural, architectural, mechanical & electrical drawings | For trainee’s use | 25 pcs | 1:1 |
|  | Building Drawings samples | For both trainer’s and trainee’ use | 25 pcs | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Carpentry workshop having carpentry tools and equipment | 8m by 14m | 1 | 1:25 |
|  | Electrical workshop with electrical tools and equipment. | 8m by 14m | 1 | 1:25 |
|  | Masonry workshop with masonry tools and equipment. | 8m by 14m | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Whiteboard marker pens | For trainee’s use | 10 pcs | 10:1 |
|  | Masking Tape | For trainee’s use | 1pc | 25:1 |
|  | Drawing stationery | For trainee’s use | 25 pcs per stationery | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Masonry tools & equipment | For trainee’s use | Sufficient | 1:1 |
|  | Carpentry tools & equipment | For trainee’s use | Sufficient | 1:1 |
|  | Carpentry tools & equipment | For trainee’s use | Sufficient | 1:1 |

## 

## MATERIAL TESTING I

**UNIT CODE: 0732 551 13A**

**UNIT DURATION:** 60Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Conduct Material Testing

**Unit Description**

This unit specifies the competencies required to Conduct Material Testing. It involves performing soils tests and performing concrete Tests.

**Summary of Learning Outcomes**.

|  |  |
| --- | --- |
| Learning Outcomes | **DURATION (HOURS)** |
| 1. Perform soil tests | **20** |
| 1. Perform concrete tests | 40 |
| **TOTAL** | 60 **HOURS** |

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | Content | **Suggested Assessment Methods** |
| 1. Perform soil tests | * 1. Soils tests Identification      1. Standard manuals and procedures      2. Soil testing tools and apparatus.      3. Obtaining soil samples      4. Soil Tests   2. Soil Classification Tests      1. Atterberg Limits Test      2. Grain Size Distribution (Sieve Analysis)      3. Hydrometer Analysis   3. Compaction Tests      1. Standard Proctor Test      2. Modified Proctor Test   4. Shear Strength Tests      1. Direct Shear Test      2. Triaxial Compression Test   5. Permeability Tests      1. Constant Head Test      2. Falling Head Test      3. Consolidation Tests      4. Oedometer Test   6. Compaction Characteristics Tests      1. California Bearing Ratio (CBR) Test      2. Unconfined Compression Test   7. Moisture Content Tests      1. Oven Drying Method      2. Rapid Moisture Content Test  |  | | --- | | * 1. Results analysis and Reports preparation   2. Maintenance of soils tests equipment | | * Written tests * Observation * Oral question * Third party |
| 1. Perform concrete tests | * 1. Concrete Tests  |  | | --- | | * + 1. Workability Tests     2. Slump Test     3. Vee Bee Test     4. Flow Table Test     5. Strength Tests     6. Compressive Strength Test (Cube and Cylinder Tests)     7. Flexural Strength Test     8. Split Tensile Strength Test     9. Durability Tests     10. Rapid Chloride Permeability Test     11. Water Absorption Test     12. Sulphate Resistance Test     13. Density and Specific Gravity Tests     14. Unit Weight Test     15. Specific Gravity Test     16. Non-Destructive Testing     17. Rebound Hammer Test     18. Ultrasonic Pulse Velocity Test     19. Penetration Resistance Test   1. Concrete testing tools   2. Concrete material tests.   3. Aggregates tests      1. **Physical Properties Tests**   2.4.1.1. Sieve Analysis (Grain Size Distribution)   * + - 1. Specific Gravity and Absorption       2. Bulk Density Test       3. Voids and Porosity Test     1. **Mechanical Properties Tests**        1. Aggregate Crushing Value (ACV) Test        2. Aggregate Impact Value (AIV) Test        3. Los Angeles Abrasion Test        4. Ten Percent Fines Value (TPFV) Test     2. **Soundness Tests**        1. Sodium Sulphate Soundness Test        2. Magnesium Sulphate Soundness Test     3. **Chemical Properties Tests**        1. Organic Impurities Test        2. Alkali-Silica Reactivity Test     4. **Moisture Content Tests**        1. Moisture Content Test (Oven Drying Method)     5. **Shape and Texture Tests**        1. Flakiness and Elongation Index Test        2. Shape Index Test   1. Cement tests      1. **Fineness Tests**      2. **Sieve Test**      3. **Air Permeability Test (Blaine's Test)**      4. **Consistency and Setting Time Tests**      5. **Vicat Needle Test**      6. **Initial and Final Setting Time Test**      7. Le Chatelier's Soundness Test   2. Chemical Properties Tests      1. pH Test      2. Loss on Ignition Test      3. Sulphur Trioxide Content Test   3. Heat of Hydration Tests   2.8.1 Heat of Hydration Test (Calorimetric Method)   * 1. Density and Specific Gravity Tests      1. Specific Gravity Test (Pycnometer Method)   2. Expansion and Soundness Tests   3. Le Chatelier Test (for soundness)   4. Autoclave Expansion Test   5. Concrete curing methods   6. Tests analysis and reporting   7. Maintain concrete testing equipment | | * Written tests * Observation * Oral question * Third party |

**Suggested Methods of Instruction**

1. Role playing
2. Viewing of related videos
3. Discussion
4. Direct Instruction
5. Practicals
6. Projects

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Soil testing manual | For trainee’s use | 14 | 1:2 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Material testing lab | For trainer’s use | 1 pc | 1:25 |
|  | concrete | For trainer’s use | sufficient | 1:1 |
|  | cement | For trainer’s use | sufficient | 1:1 |
| **C** | **Consumable materials** | | | |
|  | Assorted colour of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
|  | Masking Tape | For trainee’s use | 1pc | 25:1 |
|  | Drawing stationery | For trainee’s use | 25 pcs per stationery | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | moulds | For trainee’s use | 5 pcs | 1:5 |
|  | Tamping rods | For trainee’s use | 5 pcs | 1:1 |
|  | br test machine | For trainee’s use | 2 | 1:10 |
|  | Rammer | For trainee’s use | 1 | 1:25 |
|  | Riffle box | For trainee’s use | 5 pcs | 1 |
|  | Casagrande machine | For trainee’s use | 5 pcs | 1:5 |
|  | Penetrometer | For trainee’s use | 5 pcs | 1:5 |
|  | Weighing machine | For trainee’s use | 5 pcs | 1:5 |
|  | Oven | For trainee’s use | 1 | 1:25 |
|  | Measuring cylinder | For trainee’s use | 5 | 1:5 |
|  | Cone cups | For trainee’s use | 5 | 1:5 |
|  | Bowl | For trainee’s use | 5 | 1:5 |
|  | Stirring stick | For trainee’s use | 5 | 1:5 |
|  | Crushing machine | For trainee’s use | 1 | 1:25 |
|  | Moisture bags | For trainee’s use | 5 bags | 1;5 |
|  | Funnels | For trainee’s use | 5 | 1:5 |
|  | Standard sieves | For trainee’s use | 5 | 1:5 |
|  | spade | For trainee’s use | 5 | 1:5 |
|  | trowel | For trainee’s use | 5 | 1:5 |
|  | Jembe | For trainee’s use | 5 | 1:5 |
|  | Mattock | For trainee’s use | 5 | 1:5 |
|  | Circular cutter | For trainee’s use | 5 | 1:5 |
|  | Spatula | For trainee’s use | 5 | 1:5 |
|  | chisel | For trainee’s use | 5 | 1:5 |

## ROAD CONSTRUCTION WORKS I

**UNIT CODE: 0732 451 14A**

**UNIT DURATION:** 70Hours

**Relationship to Occupational Standards**

This unit addresses the unit of competency: execute road construction works I

**Unit Description**

This unit describes the competencies required in carry out pavement construction works. It involves Carrying out Earthwork Activities, constructing pavement layers, constructing transportation infrastructure and applying emerging trends in road construction.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/NO** | **LEARNING OUTCOMES** | **DURATION (hours)** |
|  | Carry out earthwork activities | **20** |
|  | Construct pavement layers | **20** |
|  | Construct transportation infrastructure | **20** |
|  | To apply emerging trends in road construction | **10** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Carry out earthwork activities | * 1. **Earthwork resources**      1. Plants and equipment’s      2. Overview of earthmoving equipment      3. Equipment maintenance and safety checks   2. **Site clearance**      1. Activities including Tree felling and stump removal, Boulders removal, Bush clearing      2. Importance of site clearance before construction      3. Waste management during site clearance   3. Drawings interpretation      1. Types of construction drawings      2. Reading and understanding symbols and legends      3. Key dimensions and specifications      4. Identifying critical details)   4. Setting out for earthworks      1. Definition and importance of setting out      2. Tools and equipment used      3. Techniques for accurate marking   5. Ground levels      1. Importance of understanding ground levels in earthworks      2. Techniques for measuring and recording ground levels   6. Volumes of cut and fill      1. Definition of cut and fill in earthworks      2. Methods for calculating volumes      3. Importance of balance between cut and fill   7. Disposal of waste      1. Types of waste generated in earthwork      2. Regulations and guidelines for waste disposal      3. Recycling and reuse options for excavated materials   8. Construction tools and equipment      1. Overview of common construction tools      2. Hand tools and their uses      3. Power tools and safety considerations | * Practical * Projects * Portfolio of evidence * Third party reports * Written tests |
| 1. Construct pavement layers | * 1. Road construction resources      1. Materials resources      2. Labor and workforce management      3. Equipment and machinery   2. Drawings interpretation      1. Types of construction drawings      2. Symbols and abbreviations used      3. Scale and measurement   3. Levelling activities      1. Types of leveling      2. Instruments used in levelling activities   4. **Profile layers** including Sub grade, Subbase, Base course, binder, Wearing course      1. Definitions and functions of each layer      2. Material specifications and selection      3. Construction techniques for each layer   5. Maintenance of road structure      1. Types of road maintenance      2. Inspection techniques and frequency      3. Common road defects and their remedies   6. Construction tools and equipment      1. Types of tools      2. Heavy machinery      3. Safety equipment and practices      4. Equipment maintenance and operation | * Practical * Projects * Portfolio of evidence * Third party reports * Written tests |
| 1. Construct transportation infrastructure | * 1. Resources      1. Material sourcing and procurement      2. Human resources management   2. Drawings      1. Types of engineering drawings      2. Reading and interpreting construction symbols   3. **Transportation infrastructure** including parking, walk ways, cyclist lanes, foot bridges, bus bays      1. Design principles for parking facilities      2. Walkway design standards and accessibility      3. Cycle lane planning and integration      4. Footbridge design considerations      5. Bus bay layout and traffic flow management   4. Leveling activities      1. Equipment and tools for levelling      2. Techniques for different terrain types      3. Establishing control points and benchmarks   5. Quality control operations      1. Quality assurance vs. quality control      2. Inspection methods and tool      3. Compliance with industry standards and regulation   6. Transportation infrastructure maintenance      1. Types of maintenance      2. Inspection protocols and techniques      3. Common maintenance challenges and solutions | * Practical * Projects * Portfolio of evidence * Third party reports * Written tests |
| 1. Apply emerging strategies for Road maintenance | * 1. Emerging trends:      1. Self-healing concrete in roads      2. Recycled plastic admixtures      3. Prefabricated plastic roads      4. BIM      5. Solar roads      6. Do-Nou technology      7. Cobbles   2. Road construction site:      1. Sustainable Practices      2. Automated Construction Processes      3. Advanced Technology      4. Enhanced Safety Measures   3. Road construction works:      1. Sustainable Construction Practices      2. Automated and Semi-Automated Equipment      3. Circular Economy Practices      4. Resilient Infrastructure Design | * Practical * Projects * Portfolio of evidence * Third party report * Written tests |

**Suggested Methods of Instruction**

1. Role playing
2. Viewing of related videos
3. Discussion
4. Direct Instruction
5. Practicals
6. Projects

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Structural drawings & Site layout | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Calculator | For trainee’s use | 25 pcs | 1:1 |
|  | Construction designs and drawings | For both trainer’s and trainee’ use | 25no | 1:1 |
|  | Sample contract documents | For both trainer’s and trainee’ use | 25no | 1:1 |
|  | AutoCAD | For both trainer’s and trainee’ use | 25no | 1:1 |
|  | ArchiCAD | For both trainer’s and trainee’ use | 25no | 1:1 |
|  | Civil3D | For both trainer’s and trainee’ use | 25no | 1:1 |
|  | Schedule of work | For trainee’s use | 25no | 1:1 |
|  | Standard manuals | For both trainer’s and trainee’ use | 25no | 1:1 |
|  | Contract documents | For both trainer’s and trainee’ use | 25no | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | 45site | For both trainer’s and trainee’ use | 1 | 1:25 |
|  | Material testing laboratory | For both trainer’s and trainee’ use | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Dust | For trainee’s use | sufficient | 1:1 |
|  | Cement | For trainee’ use | 5 pcs | 1:5 |
|  | concrete | For trainee’ use | sufficient | 1:1 |
|  | Bitumen | For trainee’s use | sufficient | 1:1 |
|  | Timber | For trainee’s use | sufficient | 1:1 |
|  | Gravel | For trainee’s use | sufficient | 1:1 |
|  | Soil | For trainee’s use | sufficient | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Concrete mixer | For trainee’s use | 5no | 1:5 |
|  | Welding machines | For trainers and trainee’s use | 5no | 1:5 |
|  | Concrete vibrator | For trainers and trainee’s use | 5no | 1:5 |
|  | Tape measures, | For trainee’s use | 5no | 1:5 |
|  | rulers | For trainee’s use | 5no | 1:5 |
|  | plumb bobs | For trainee’s use | 5no | 1:5 |
|  | Dumpy level | For trainers and trainee’s use | 5no | 1:5 |
|  | Molds | For trainers and trainee’s use | 5no | 1:5 |
|  | Tamping rods | For trainers and trainee’s use | 5no | 1:5 |
|  | CBR Machines | For trainers and trainee’s use | 1no | 1:25 |
|  | Crushing machines | For trainers and trainee’s use | 1no | 1:25 |
|  | saws | For trainee’s use | 5no | 1:5 |

## MEASUREMENTS, ESTIMATION AND COSTING PRINCIPLES 1

**UNIT CODE: 0732 551 15A**

**UNIT DURATION:** 60 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Perform measurements and cost estimation

**Unit Description**

This unit describes competencies required to Perform measurements and cost estimation. It involves; working up dimensions, taking off quantities, abstracting measured quantities and preparing tender documents.

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| **Learning Outcomes** | **DURATION (HOURS)** |
| 1. To Apply construction Superstructure work taking off principles | **20** |
| 1. To Abstract measured quantities | **20** |
| 1. To Prepare bill of quantities | **20** |
|  |  |
| **TOTAL** | **60** |

**Learning Outcomes, Content and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Apply Work up dimensions techniques | * 1. **Terms and concepts**       1. Timesing      2. Abstracting      3. Bill of Quantities      4. Working up      5. Taking off      6. Booking      7. Specifications   2. **Interpretation of Working Drawings**      1. Types of working drawings  1. Architectural 2. Structural 3. Electrical 4. Mechanical 5. Building    * 1. Drawing standards      2. Reading technical specifications    1. **Scaling of Dimensions**       1. Scale types       2. Conversion between scales       3. Scaling rules    2. **Timesing Dimensions as per SMM/CESMM**       1. Multiplying dimensions       2. Squaring of dimensions.       3. CESMM guidelines       4. SMM conventions | * Projects * Reports * Written Tests * Practical |
| 2. Apply substructure works taking off principles | * 1. **Documentation of Substructure Elements**      1. Identifying foundation types      2. Documenting footings, slabs, and beams      3. Understanding substructure details      4. Reading soil and foundation reports   2. **Quantification of Substructure Elements**      1. Techniques for measuring substructure quantities      2. Applying standard measurement units      3. Calculating material requirements      4. Earthworks      5. Concrete quantities      6. Formwork      7. Adjusting quantities for site conditions   3. **Booking Substructure Quantities**      1. Booking methods      2. Recording standards      3. Checklist for substructure elements | * Written * Report |
| 3 Abstract measured quantities | |  | | --- | | * 1. **Preparation of Abstracting Sheet**      1. Abstracting formats      2. Organizing measurements for clarity      3. Applying SMM/CESMM standards      4. Reviewing abstracting accuracy   2. **Transferring Descriptions to Abstracting Sheet**      1. Copying booked item descriptions      2. Maintaining accuracy and consistency      3. Following SMM/CESMM guidelines      4. Ensuring compliance with project requirements   3. **Transferring Squared Quantities to Abstracting Sheet**      1. Calculating squared quantities      2. Ensuring accurate documentation      3. Using standard formats      4. Double-checking calculations for accuracy   4. **Calculation of Net Quantities**      1. Techniques for calculating net quantities      2. Applying SMM/CESMM methods      3. Ensuring accuracy      4. Adjusting quantities based on project variations   5. **Running Through Dimensions**      1. Reviewing all dimensions      2. Correcting any errors      3. Ensuring measurements are accurate      4. Confirming dimensions align with drawings | | * Written * Observation * Report * Practical |
| 4 Prepare bill of quantities | |  | | --- | | * 1. **Preparation of Specifications**      1. Specifications preparations         1. Material         2. Workmanship      2. Following SMM/CESMM standards      3. Cross-referencing with drawings and designs   2. **Preparation of Schedule of Rates**      1. Calculating rates based on abstracted quantities      2. Applying standard costing guidelines      3. Ensuring accuracy in costing      4. Adjusting rates based on project constraints   3. **Preparation of Bill of Quantities**      1. Compiling BOQ based on working drawings      2. Ensuring BOQ is comprehensive and accurate      3. Following standard BOQ formats      4. Reviewing BOQ for consistency with specifications | | * Written * Observation * Report * Practical |

## STRUCTURAL ANALYSIS PRINCIPLES I

**UNIT CODE: 0732 551 16A**

**UNIT DURATION: 110 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competence: Apply structural analysis principles

**Unit Description**

This Unit describes the principles required to perform structural designs. It involves

Computing stresses and strain, describing composite materials, computing shear force and bending moments, determination of properties of sections and analysing forces in 2D frame structures.

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| Learning Outcomes | **DURATION (HOURS)** |
| 1. Compute stress and strain | **20** |
| 1. Describe composite materials | **20** |
| 1. Compute shear force and bending moments | **20** |
| 1. Determine properties of sections | **20** |
| 1. Analyse forces in 2D framed structures | **30** |
| **TOTAL** | **110** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Compute stress and strain | * 1. **Basic Concepts of Stress and Strain**      1. Definitions:         1. stress         2. strain         3. elastic         4. plastic regions      2. Types of stress         1. Tensile         2. Compressive         3. Shear      3. Types of strain   1.1.3.1. Longitudinal   * lateral   1. **Stress-Strain Relationship**      1. Hooke's Law and elastic modulus      2. Understanding yield point, ultimate strength, and rupture point      3. Analysis of ductile vs. brittle materials   2. **Stress and Strain Calculation Methods**      1. Calculating stress under axial loading      2. Strain calculations for deformable bodies      3. Real-world applications: columns, cables, and rods | * Practical tests * Project * Portfolio of evidence * Third party report * Written tests |
| 1. Describe composite materials | * 1. **Types and Properties of Composite Materials**      1. Fibre-reinforced, polymer matrix, metal matrix, and ceramic matrix composites      2. Physical and mechanical properties relevant to engineering   2. **Behaviour and Compatibility in Composite Structures**      1. Equilibrium and compatibility conditions in layered materials      2. Stress and strain transfer between materials      3. Potential failure modes and safety factors   3. **Analysis Techniques for Composite Structures**      1. Laminate theory basics and applications      2. Strength analysis in composite materials      3. Problem-solving examples for composite members | * Practical tests * Project * Portfolio of evidence * Third party report * Written tests |
| 1. Compute shear force and bending moments | * 1. **Types of Supports, Loads, and Reactions**      1. Identifying types of supports and their implications  1. Fixed 2. Roller 3. Hinge    * 1. Load types and their effects on beams 4. Concentrated 5. Distributed, 6. Variable loads    1. **Calculation of Shear Force and Bending Moment**       1. Shear force and bending moment equations of equilibrium       2. Real-world examples 7. Bridges 8. Cantilevered beams 9. Slabs    1. **Shear Force and Bending Moment Diagrams**       1. Diagram construction and interpretation for various load cases       2. Identifying critical points of maximum and minimum moments       3. Case studies 10. Simply supported beams 11. Overhanging beams | * Practical tests * Project * Portfolio of evidence * Third party report * Written tests |
| 1. Determine properties of sections | * 1. **Introduction to Geometric Properties of Sections**      1. Definitions   Area   1. Centroid 2. Moment of inertia    * 1. Common shapes and their geometrical properties 3. Rectangular 4. I-beams 5. T-section    1. **Calculation of Moment of Inertia and Radius of Gyration**       1. Methods for calculating moments of inertia for basic and composite sections       2. Radius of gyration and its applications in stability analysis | * Practical tests * Project * Portfolio of evidence * Third party report * Written tests |
| 1. Analyse forces in 2D framed structures | * 1. **Characteristics of 2D Framed Structures**      1. Differences between pin-jointed and rigid-jointed frames      2. Examples in trusses and frames   2. **Assumptions and Methods in Structural Analysis**      1. Static equilibrium assumptions and limitations      2. Methods: * method of joints * method of sections   1. **Analysis of Real-World 2D Frames**      1. Calculation of forces in truss members      2. Determining support reactions for different frame types      3. Practical examples  1. Roof trusses 2. Portal frames | * Practical tests * Project * Portfolio of evidence * Third party report * Written tests |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussions
5. Direct instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Graph book | For trainee’s use | 14 | 1:2 |
|  | Rulers, protractors and compasses, set-squares | For trainer’s use | 2 pcs each | 2:1 |
|  | A4 drawing papers | For trainee’s use | 25 pcs | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Classroom | 9m by 8m | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Assorted colour of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
| 1. D | **Tools and Equipment** | | | |
|  | Scientific calculator | For trainee’s use | 25 pcs | 1:1 |
|  | Computers installed with numerical analysis software’s | For trainee’s use | 13 pcs | 1:2 |

## APPLY ALGEBRA AND GEOMETRY

**UNIT CODE: 0732 541 17A**

UNIT TIME : 50 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply algebra and geometry

**Unit Description**

This unit describes the competencies required by a technician in order to apply a wide range of mathematical skills in their work; it involves applying algebra, coordinate geometry and binomial expansions.

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| **Learning Outcomes** | **DURATION (HOURS)** |
| 1. Apply algebra operations | 20 |
| 1. Apply Coordinate Geometry Principles | 20 |
| 1. Carry out Binomial Expansion | 10 |
| **TOTAL** | **50HOURS** |

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Apply algebra operations | 1. Indices Calculations    * 1. Laws of indices      2. Application of indices in expressions      3. Indicial Equations. 2. logarithmic calculations    * 1. Laws of Logarithms      2. Properties of logarithms (product, quotient, power rules)      3. Applications in solving logarithmic equations      4. Logarithmic Equations      5. Converting between logarithmic and exponential forms      6. Solving single and multiple logarithmic equations      7. Conversion of Bases      8. Converting logarithmic bases      9. Use of change of base formula 3. Use of Calculator    * 1. Solving algebraic problems using scientific calculators      2. Calculation of logarithmic and exponential expressions 4. Reduction of Equations    * 1. Simplifying algebraic expressions      2. Transformation into quadratic forms 5. Quadratic Equations    * 1. Factorization method      2. Quadratic formula      3. Completing the square 6. Simultaneous Linear Equations    * 1. Solving simultaneous equations in two and three unknowns      2. Graphical and algebraic methods (substitution, elimination) 7. Arithmetic Progression (AP) and Geometric Progression (GP)    * 1. Formula for nth term and sum of terms      2. Applications in real-life problem |  |
| 1. Apply Coordinate Geometry Principles | * 1. Cartesian Coordinates      1. Plotting points in the Cartesian plane      2. Distance between two points, midpoint formula   2. Polar Equations      1. Conversion between Cartesian and polar forms      2. Applications in analyzing circular motion   3. Equations of Tangent and Normal      1. Determining the equation of a tangent line at a point      2. Finding normal lines to curves   4. Slopes of Lines      1. Calculation of slopes using coordinates      2. Parallel and perpendicular lines   5. Graphs of Polar Equations      1. Plotting polar curves using polar coordinate      2. Identifying symmetry in polar graphs |  |
|  | * 1. Binomial Theorem      1. Expansion of (a + b) n using the binomial theorem      2. Binomial coefficients and their calculation   2. Pascal’s Triangle      1. Relationship between Pascal’s triangle and binomial coefficients   3. Binomial Series Coefficients      1. Expansion of binomial expressions with fractional and negative powers   4. Errors in Binomial Expansion      1. Use of binomial expansion to approximate values      2. Estimation of small changes   5. Real-life Applications      1. Use in financial calculations (compound interest)      2. Error minimization in physics and engineering problems |  |

**Suggested Methods of Instruction**

1. Role playing
2. Viewing of related videos
3. Discussion
4. Direct Instruction
5. Practicals
6. Projects

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Mathematical table | For trainee’s use | 25 pcs | 1:1 |
|  | Mathematical set | For trainee’ use | 25 pcs | 1:1 |
|  | SMP Table | For trainee’ use | 25 pcs | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Assorted colour of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
| **D** | **Tools and Equipment** | | | |
|  | Rulers, protractors and compasses, | For trainee’s use | 25pcs | 1:1 |
|  | Scientific Calculator | For trainee’s use | 25pcs | 1:1 |

**MATERIAL TESTING, I**

**UNIT CODE: 0732 551 09A**

**UNIT DURATION:** 60Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: prepare for materials testing

**Unit Description**

This unit describes the competencies required in preparing for materials testing. It involves organizing for material testing, sampling construction materials and preparing samples for testing.

**Summary of Learning Outcomes**

1. To Organize for material testing
2. To Sample construction materials
3. To Prepare samples for testing

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Organize for material testing | * 1. Preliminary site investigation      1. Purpose and importance      2. Methods of investigation      3. Stages of site investigation      4. Site assessment tools   2. Types of material tests      1. Mechanical tests      2. Chemical tests      3. Non-destructive testing   3. Material laboratory personnel      1. Roles and responsibilities (lab technicians, quality control etc)      2. Required qualifications and certifications      3. Safety protocols and training   4. Laboratory equipment maintenance      1. Types of laboratory equipment      2. Routine maintenance procedures   5. Testing equipment      1. types and uses | 1.practical  2.Projects  3.Portfolio of evidence  4.Third party reports  5. Written tests |
| 1. Sample construction materials | * 1. Sources of construction materials      1. Natural sources      2. Manufactured materials      3. Recycled materials   2. Sampling procedures      1. Purpose of sampling in construction      2. Types of sampling methods      3. Equipment used for sampling   3. Sampling tools and equipment      1. Types and uses   4. Sampling is carried out as per job requirement      1. Understanding project specifications and requirements      2. Customizing sampling plans for specific materials      3. Quality control and assurance considerations   5. Samples analysis      1. Laboratory testing methods      2. Interpreting test results      3. Comparison against industry standards and specifications      4. Reporting and documentation of findings | 1.practical  2.Projects  3.Portfolio of evidence  4.Third party reports  5. Written tests |
| 1. Prepare samples for testing | * 1. Sample tests      1. Methods of sampling   2. Standard manuals and procedures      1. Overview of the sampling process      2. Preparation before collection      3. Techniques for effective sample collection   3. **Sample testing tools and apparatus**      1. Types and uses   4. Samples collection      1. Purpose and importance of standard manuals      2. Types of standard manuals      3. Key organizations that publish standards | 1.practical  2.Projects  3.Portfolio of evidence  4.Third party reports  5. Written tests |

**Suggested Methods of Instruction**

1. Role playing
2. Viewing of related videos
3. Discussion
4. Direct Instruction
5. Practicals
6. Projects

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Soil testing manual | For trainee’s use | 14 | 1:2 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Material testing lab | For trainer’s use | 1 pc | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Assorted colour of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
|  | Masking Tape | For trainee’s use | 1pc | 25:1 |
|  | Drawing stationery | For trainee’s use | 25 pcs per stationery | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | moulds | For trainee’s use | 5 pcs | 1:5 |
|  | Tamping rods | For trainee’s use | 5 pcs | 1:1 |
|  | br test machine | For trainee’s use | 2 | 1:10 |
|  | Rammer | For trainee’s use | 1 | 1:25 |
|  | Riffle box | For trainee’s use | 5 pcs | 1 |
|  | Casagrande machine | For trainee’s use | 5 pcs | 1:5 |
|  | Penetrometer | For trainee’s use | 5 pcs | 1:5 |
|  | Weighing machine | For trainee’s use | 5 pcs | 1:5 |
|  | Oven | For trainee’s use | 1 | 1:25 |
|  | Measuring cylinder | For trainee’s use | 5 | 1:5 |
|  | Cone cups | For trainee’s use | 5 | 1:5 |
|  | Bowl | For trainee’s use | 5 | 1:5 |
|  | Stirring stick | For trainee’s use | 5 | 1:5 |
|  | Crushing machine | For trainee’s use | 1 | 1:25 |
|  | Moisture bags | For trainee’s use | 5 bags | 1;5 |
|  | Funnels | For trainee’s use | 5 | 1:5 |
|  | Standard sieves | For trainee’s use | 5 | 1:5 |
|  | spade | For trainee’s use | 5 | 1:5 |
|  | trowel | For trainee’s use | 5 | 1:5 |
|  | Jembe | For trainee’s use | 5 | 1:5 |
|  | Mattock | For trainee’s use | 5 | 1:5 |
|  | Circular cutter | For trainee’s use | 5 | 1:5 |
|  | Spatula | For trainee’s use | 5 | 1:5 |
|  | chisel | For trainee’s use | 5 | 1:5 |

**MATERIAL TESTING II**

**UNIT CODE: 0732 551 13A**

**UNIT DURATION:** 60Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Conduct Material Testing

**Unit Description**

This unit specifies the competencies required to Conduct Material Testing. It involves performing tests on alignment soils, concrete.

**Summary of Learning Outcomes**

1. Perform soil tests

2. Perform concrete tests

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Perform soil tests | * 1. **Soils tests Identification**      1. Standard manuals and procedures      2. Soil testing tools and apparatus.      3. Obtaining soil samples      4. Soil Tests   2. **Soil Classification Tests**      1. Atterberg Limits Test      2. Grain Size Distribution (Sieve Analysis)      3. Hydrometer Analysis   3. **Compaction Tests**      1. Standard Proctor Test      2. Modified Proctor Test   4. **Shear Strength Tests**      1. Direct Shear Test      2. Triaxial Compression Test   5. **Permeability Tests**      1. Constant Head Test      2. Falling Head Test      3. Consolidation Tests      4. Oedometer Test   6. **Compaction Characteristics Tests**      1. California Bearing Ratio (CBR) Test      2. Unconfined Compression Test   7. **Moisture Content Tests**      1. Oven Drying Method      2. Rapid Moisture Content Test  |  | | --- | | * 1. **Results analysis and Reports preparation**   2. **Maintenance of soils tests equipment** | | * Written tests * Observation * Oral question * Third party |
| 1. Perform concrete tests | * 1. Concrete Tests  |  | | --- | | * + 1. **Workability Tests**        1. Slump Test        2. Vee bee Test        3. Flow Table Test     2. **Strength Tests**        1. Compressive Strength Test (Cube and Cylinder Tests)        2. Flexural Strength Test        3. Split Tensile Strength Test     3. **Durability Tests**        1. Rapid Chloride Permeability Test        2. Water Absorption Test        3. Sulphate Resistance Test     4. **Density and Specific Gravity Tests**        1. Unit Weight Test        2. Specific Gravity Test     5. **Non-Destructive Testing**        1. Rebound Hammer Test        2. Ultrasonic Pulse Velocity Test        3. Penetration Resistance Test   1. Concrete testing tools   2. Concrete material tests.   3. Aggregates tests      1. **Physical Properties Tests** * Sieve Analysis (Grain Size Distribution) * Specific Gravity and Absorption * Bulk Density Test * Voids and Porosity Test   + 1. **Mechanical Properties Tests** * Aggregate Crushing Value (ACV) Test * Aggregate Impact Value (AIV) Test * Los Angeles Abrasion Test * Ten Percent Fines Value (TPFV) Test   + 1. **Soundness Tests** * Sodium Sulphate Soundness Test * Magnesium Sulphate Soundness Test   + 1. **Chemical Properties Tests** * Organic Impurities Test * Alkali-Silica Reactivity Test   + 1. **Moisture Content Tests** * Moisture Content Test (Oven Drying Method)   + 1. **Shape and Texture Tests** * Flakiness and Elongation Index Test * Shape Index Test   1. Cement tests      1. **Fineness Tests**      2. **Sieve Test**      3. **Air Permeability Test (Blaine's Test)**      4. **Consistency and Setting Time Tests**      5. **Vicat Needle Test**      6. **Initial and Final Setting Time Test**      7. Le Chatelier's Soundness Test   2. **Chemical Properties Tests**      1. pH Test      2. Loss on Ignition Test      3. Sulphur Trioxide Content Test   3. **Heat of Hydration Tests**      1. Heat of Hydration Test (Calorimetric Method)   4. **Density and Specific Gravity Tests**      1. Specific Gravity Test (Pycnometer Method)   5. **Expansion and Soundness Tests**   6. **Le Chatelier Test (for soundness)**   7. **Autoclave Expansion Test**   8. **Concrete curing methods**   9. **Tests analysis and reporting**   10. **Maintain concrete testing equipment** | | 1. Written tests 2. Observation 3. Oral question 4. Third party |

**Suggested Methods of Instruction**

1. Role playing
2. Viewing of related videos
3. Discussion
4. Direct Instruction
5. Practicals
6. Projects

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Soil testing manual | For trainee’s use | 14 | 1:2 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Material testing lab | For trainer’s use | 1 pc | 1:25 |
|  | concrete | For trainer’s use | sufficient | 1:1 |
|  | cement | For trainer’s use | sufficient | 1:1 |
| **C** | **Consumable materials** | | | |
|  | Assorted colour of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
|  | Masking Tape | For trainee’s use | 1pc | 25:1 |
|  | Drawing stationery | For trainee’s use | 25 pcs per stationery | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | moulds | For trainee’s use | 5 pcs | 1:5 |
|  | Tamping rods | For trainee’s use | 5 pcs | 1:1 |
|  | br test machine | For trainee’s use | 2 | 1:10 |
|  | Rammer | For trainee’s use | 1 | 1:25 |
|  | Riffle box | For trainee’s use | 5 pcs | 1 |
|  | Casagrande machine | For trainee’s use | 5 pcs | 1:5 |
|  | Penetrometer | For trainee’s use | 5 pcs | 1:5 |
|  | Weighing machine | For trainee’s use | 5 pcs | 1:5 |
|  | Oven | For trainee’s use | 1 | 1:25 |
|  | Measuring cylinder | For trainee’s use | 5 | 1:5 |
|  | Cone cups | For trainee’s use | 5 | 1:5 |
|  | Bowl | For trainee’s use | 5 | 1:5 |
|  | Stirring stick | For trainee’s use | 5 | 1:5 |
|  | Crushing machine | For trainee’s use | 1 | 1:25 |
|  | Moisture bags | For trainee’s use | 5 bags | 1;5 |
|  | Funnels | For trainee’s use | 5 | 1:5 |
|  | Standard sieves | For trainee’s use | 5 | 1:5 |
|  | spade | For trainee’s use | 5 | 1:5 |
|  | trowel | For trainee’s use | 5 | 1:5 |
|  | Jembe | For trainee’s use | 5 | 1:5 |
|  | Mattock | For trainee’s use | 5 | 1:5 |
|  | Circular cutter | For trainee’s use | 5 | 1:5 |
|  | Spatula | For trainee’s use | 5 | 1:5 |
|  | chisel | For trainee’s use | 5 | 1:5 |

**MATERIAL TESTING III**

**UNIT CODE: 0732 551 13A**

**UNIT DURATION:** 60Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Conduct Material Testing

**Unit Description**

This unit specifies the competencies required to Conduct Material Testing. It involves performing tests on alignment, structural steel, bitumen materials and timber.

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**Summary of Learning Outcomes**

1. Carry out structural steel tests
2. Perform bitumen tests
3. Perform timber tests

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Carry out structural steel tests | * 1. Sampling of steel for testing   2. Steel testing equipment   3. Steel test      1. Tensile tests      2. Brinell Hardness Test      3. Rockwell Hardness Test Bending Test (Ductility Test)   4. Results analysis and reporting   5. Maintenance of steel testing equipment | 1. Written tests 2. Observation 3. Oral question 4. Third party |
| 2. Perform bitumen tests | * 1. Bitumen tests identification      1. Penetration      2. Cleanliness      3. Viscosity      4. Ductility      5. Flash and Fire Point      6. Float Test      7. Loss on Heating      8. Specific Gravity      9. Softening Point      10. Spread Rate   2. Bitumen tests tools and apparatus   3. Bitumen sampling   4. Bitumen tests conduction   5. Perform the tests identified   6. Bitumen tests data analysis and reporting   7. Maintenance of bitumen tests an equipment | 1. Written tests 2. Observation 3. Oral question 4. Third party |
| 1. Perform timber tests | * 1. Timber tests identification   2. Timber testing tools and equipment   3. Sampling techniques   4. Timber testing      1. Tensile/Strength      2. Compressive      3. Shear      4. Size   5. Timber tests data analysis and reporting   6. Maintenance of timber tests tools and equipment | 1. Written tests 2. Observation 3. Oral question 4. Third party |

**Suggested Methods of Instruction**

1. Role playing
2. Viewing of related videos
3. Discussion
4. Direct Instruction
5. Practicals
6. Projects

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Soil testing manual | For trainee’s use | 14 | 1:2 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Material testing lab | For trainer’s use | 1 pc | 1:25 |
|  | timber | For trainer’s use | sufficient | 1:1 |
|  | bitumen | For trainer’s use | sufficient | 1:1 |
| **C** | **Consumable materials** | | | |
|  | Assorted colour of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
|  | Masking Tape | For trainee’s use | 1pc | 25:1 |
|  | Drawing stationery | For trainee’s use | 25 pcs per stationery | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | moulds | For trainee’s use | 5 pcs | 1:5 |
|  | Tamping rods | For trainee’s use | 5 pcs | 1:1 |
|  | br test machine | For trainee’s use | 2 | 1:10 |
|  | Rammer | For trainee’s use | 1 | 1:25 |
|  | Riffle box | For trainee’s use | 5 pcs | 1 |
|  | Casagrande machine | For trainee’s use | 5 pcs | 1:5 |
|  | Penetrometer | For trainee’s use | 5 pcs | 1:5 |
|  | Weighing machine | For trainee’s use | 5 pcs | 1:5 |
|  | Oven | For trainee’s use | 1 | 1:25 |
|  | Measuring cylinder | For trainee’s use | 5 | 1:5 |
|  | Cone cups | For trainee’s use | 5 | 1:5 |
|  | Bowl | For trainee’s use | 5 | 1:5 |
|  | Stirring stick | For trainee’s use | 5 | 1:5 |
|  | Crushing machine | For trainee’s use | 1 | 1:25 |
|  | Moisture bags | For trainee’s use | 5 bags | 1;5 |
|  | Funnels | For trainee’s use | 5 | 1:5 |
|  | Standard sieves | For trainee’s use | 5 | 1:5 |
|  | spade | For trainee’s use | 5 | 1:5 |
|  | trowel | For trainee’s use | 5 | 1:5 |
|  | Jembe | For trainee’s use | 5 | 1:5 |
|  | Mattock | For trainee’s use | 5 | 1:5 |
|  | Circular cutter | For trainee’s use | 5 | 1:5 |
|  | Spatula | For trainee’s use | 5 | 1:5 |
|  | chisel | For trainee’s use | 5 | 1:5 |

# MODULE IV

## ENTREPRENEURIAL SKILLS

**UNIT CODE: 0413 541 18A**

**UNIT DURATION:** 40 hours

**Relationship to occupational standards**

This unit addresses the unit of competency: **Apply Entrepreneurial skills**.

**Unit Description:**

This unit covers the competencies required to demonstrate an understanding of entrepreneurship. It involves demonstrating an understanding of financial literacy, applying entrepreneurial concepts identifying entrepreneurship opportunities, applying business legal aspects, and developing business innovative strategies and business plans.

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| Learning Outcomes | **DURATION (HOURS)** |
| 1. Apply financial literacy | **6** |
| 1. Apply the entrepreneurial concept | **4** |
| 1. Identify entrepreneurship opportunities | **6** |
| 1. Apply business legal aspects | **6** |
| 1. Innovate Business Strategies | **6** |
| 1. Develop a business plan | **12** |
| **TOTAL** | 40 **HOURS** |

**Learning Outcomes, Content and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Apply financial literacy | * 1. Personal finance management   2. Balancing between needs and wants   3. Budget Preparation   4. Saving management   5. Factors to consider when deciding where to save   6. Debt management   7. Factors to consider before taking a loan   8. Investment decisions   9. Types of investments   10. Factors to consider when investing money   11. Insurance services   12. insurance products available in the market   13. Insurable risks | 1. Observation 2. Project 3. Written assessment 4. Oral assessment 5. Third party report 6. Interviews |
| 2.Apply entrepreneurial concept | * 1. Difference between Entrepreneurs and Business persons   2. Types of entrepreneurs   3. Ways of becoming an entrepreneur   4. Characteristics of Entrepreneurs   5. salaried employment and self-employment   6. Requirements for entry into self-employment   7. Roles of an Entrepreneur in an enterprise   8. Contributions of Entrepreneurship | 1. Observation 2. Project 3. Written assessment 4. Oral assessment 5. Third party report |
| 3.Identify entrepreneurship opportunities | * 1. Sources of business ideas   2. Factors to consider when evaluating business opportunity   3. Business life cycle | 1. Observation 2. Project 3. Written assessment 4. Oral assessment 5. Third party report |
| 4.Apply business legal aspects | * 1. Forms of business ownership   2. Business registration and licensing processing   3. Types of contracts and agreements   4. Employment laws   5. Taxation laws | 1. Observation 2. Project 3. Written assessment 4. Oral assessment 5. Third party report |
| 5.Innovate business Strategies | * 1. Creativity in business   2. Innovative business strategies   3. Entrepreneurial Linkages   4. ICT in business growth and development | 1. Observation 2. Project 3. Written assessment 4. Oral assessment 5. Third party report |
| 6.Develop Business Plan | * 1. Business description   2. Marketing plan   3. Organizational/Management   4. plan   5. Production/operation plan   6. Financial plan   7. Executive summary   8. Business plan presentation   9. Business idea incubation | 1. Observation 2. Written assessment 3. Project 4. Oral assessment 5. Third party report |

**Suggested Methods of Instruction**

1. Direct instruction with active learning strategies
2. Project (Business plan)
3. Case studies
4. Field trips
5. Group Discussions
6. Demonstration
7. Question and answer
8. Problem solving
9. Experiential
10. Team training
11. Guest speakers

**Recommended Resources for 25 Trainees**

| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | Recommended publisher | 8 | 1:3 |
|  | Business plan templates | Recommended format | 25 | 1:1 |
|  | Internet connection | Reliable | - | - |
|  | White board | For trainer’s use | 1 | - |
|  | Case studies | Recommended formats | 5 | 1:5 |
|  | Video clips | Sufficient | - | - |
|  | Business journals | Recommended publisher | 5 | 1:5 |
|  | Newspapers and handouts | Recommended publisher | 5 | 1:5 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 72 Square Meter | 1 | 1:25 |
|  | Computer Lab | 96 Square Meter | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
|  | Ink | Assorted Colours for trainer’s use | 500ml per term | - |
|  | White board Marker | Refillable type | 10 pcs per term | - |
|  | Printing papers | sufficient | - | - |
|  | Writing materials | sufficient | 25 | 1:1 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Computers | Latest version | 10 | 1:3 |
|  | Projector | Latest version | 1 | 1:25 |
|  | External storage media | Latest version | 25 | 1:1 |
|  | Mobile phones | Latest version | 25 | 1:1 |
|  | Printers | Latest version | 2 | 1:13 |

## MATERIAL TESTING II

**UNIT CODE: 0732 551 19A**

**UNIT DURATION:** 60Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Conduct Material Testing

**Unit Description**

This unit specifies the competencies required to Conduct Material Testing. It involves performing tests on alignment, structural steel, bitumen materials and timber.

.

**Summary of Learning Outcomes**

1. Carry out structural steel tests
2. Perform bitumen tests
3. Perform timber tests

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Carry out structural steel tests | * 1. Sampling of steel for testing   2. Steel testing equipment   3. Steel test      1. Tensile tests      2. Brinell Hardness Test      3. Rockwell Hardness Test Bending Test (Ductility Test)   4. Results analysis and reporting   5. Maintenance of steel testing equipment | 1. Written tests 2. Observation 3. Oral question 4. Third party |
| 2. Perform bitumen tests | * 1. Bitumen tests identification      1. Penetration      2. Cleanliness      3. Viscosity      4. Ductility      5. Flash and Fire Point      6. Float Test      7. Loss on Heating      8. Specific Gravity      9. Softening Point      10. Spread Rate   2. Bitumen tests tools and apparatus   3. Bitumen sampling   4. Bitumen tests conduction   5. Perform the tests identified   6. Bitumen tests data analysis and reporting   7. Maintenance of bitumen tests an equipment | 1. Written tests 2. Observation 3. Oral question 4. Third party |
| 1. Perform timber tests | * 1. Timber tests identification   2. Timber testing tools and equipment   3. Sampling techniques   4. Timber testing      1. Tensile/Strength      2. Compressive      3. Shear      4. Size   5. Timber tests data analysis and reporting   6. Maintenance of timber tests tools and equipment | 1. Written tests 2. Observation 3. Oral question 4. Third party |

**Suggested Methods of Instruction**

1. Role playing
2. Viewing of related videos
3. Discussion
4. Direct Instruction
5. Practicals
6. Projects

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Soil testing manual | For trainee’s use | 14 | 1:2 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Material testing lab | For trainer’s use | 1 pc | 1:25 |
|  | timber | For trainer’s use | sufficient | 1:1 |
|  | bitumen | For trainer’s use | sufficient | 1:1 |
| **C** | **Consumable materials** | | | |
|  | Assorted colour of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
|  | Masking Tape | For trainee’s use | 1pc | 25:1 |
|  | Drawing stationery | For trainee’s use | 25 pcs per stationery | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | moulds | For trainee’s use | 5 pcs | 1:5 |
|  | Tamping rods | For trainee’s use | 5 pcs | 1:1 |
|  | br test machine | For trainee’s use | 2 | 1:10 |
|  | Rammer | For trainee’s use | 1 | 1:25 |
|  | Riffle box | For trainee’s use | 5 pcs | 1 |
|  | Casagrande machine | For trainee’s use | 5 pcs | 1:5 |
|  | Penetrometer | For trainee’s use | 5 pcs | 1:5 |
|  | Weighing machine | For trainee’s use | 5 pcs | 1:5 |
|  | Oven | For trainee’s use | 1 | 1:25 |
|  | Measuring cylinder | For trainee’s use | 5 | 1:5 |
|  | Cone cups | For trainee’s use | 5 | 1:5 |
|  | Bowl | For trainee’s use | 5 | 1:5 |
|  | Stirring stick | For trainee’s use | 5 | 1:5 |
|  | Crushing machine | For trainee’s use | 1 | 1:25 |
|  | Moisture bags | For trainee’s use | 5 bags | 1;5 |
|  | Funnels | For trainee’s use | 5 | 1:5 |
|  | Standard sieves | For trainee’s use | 5 | 1:5 |
|  | spade | For trainee’s use | 5 | 1:5 |
|  | trowel | For trainee’s use | 5 | 1:5 |
|  | Jembe | For trainee’s use | 5 | 1:5 |
|  | Mattock | For trainee’s use | 5 | 1:5 |
|  | Circular cutter | For trainee’s use | 5 | 1:5 |
|  | Spatula | For trainee’s use | 5 | 1:5 |
|  | chisel | For trainee’s use | 5 | 1:5 |

## ROAD CONSTRUCTION WORKS II

**UNIT CODE: 0732 551 20A**

**UNIT DURATION: 60 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Carry out road construction works

**Unit Description**

This unit specifies the competencies required to perform road construction works. Constructing Road drainage and hydraulic structures, constructing erosion prevention structures and Installing Road furniture

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| **Learning outcomes** | **Duration** |
| 1. Construct Road drainage and hydraulic structures | 20 |
| 1. Construct erosion prevention structures | 30 |
| 1. Install road furniture | 10 |

**Learning Outcomes, Content and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Construct Road drainage and hydraulic structures | * 1. Mobilization of Drainage Construction Resources      1. Identification of Required Resources (manpower, equipment, and materials)      2. Selection of Drainage Construction Machinery (e.g., excavators, compactors)      3. Procurement and Transportation of Construction Materials      4. Scheduling and Deployment of Resources   2. Determination of Drainage Positions      1. Site Surveys to Identify Drainage Pathways      2. Analysis of Topography and Hydrology for Proper Positioning      3. Factors Influencing Drainage Placement (e.g., water flow, gradient, accessibility)      4. Marking Out Drainage Lines and Structures   3. Legal Documents for Drainage Structures Construction      1. Acquisition of Permits and Approvals (e.g., NEMA, local authorities)      2. Compliance with Environmental and Construction Regulations      3. Legal Requirements for Land Use and Waterway Alteration      4. Documentation for Safety and Quality Assurance   4. Interpretation of Drawings      1. Types of Drainage Construction Drawings (plans, profiles, and sections)      2. Symbols, Scales, and Notations in Drainage and Bridge Drawings      3. Extracting Key Information (e.g., drainage alignment, dimensions, elevations)      4. Application of Drawings to Site Setting Out   5. Setting Out Construction Works      1. Objectives and Importance of Setting Out in Drainage Construction      2. Instruments and Tools for Setting Out (e.g., theodolites, total stations, GPS)      3. Establishing Lines, Levels, and Reference Points      4. Verification and Adjustment of Setting Out Accuracy   6. Construction of Culvert      1. Types of Culverts (e.g., box, pipe, arch culverts)      2. Materials for Culvert Construction (concrete, steel, stone)      3. Procedures for Culvert Installation (excavation, bedding, placing, backfilling)      4. Quality Control for Culvert Alignment and Stability   7. Construction Procedures for Drains      1. Types of Drains (e.g., open channels, lined drains, unlined drains)      2. Excavation and Shaping of Drain Channels      3. Placement of Lining Materials (e.g., concrete, stone pitching, precast elements)      4. Drain Compaction and Finishing Techniques   8. Construction of Drains and Gullies      1. Functions of Drains and Gullies in Water Management      2. Design Standards and Material Selection      3. Procedures for Gully Installation (e.g., excavation, placing, grating)      4. Connection of Gullies to Main Drainage Systems   9. Bridge Construction      1. Types of Bridges (e.g., beam, arch, truss, suspension)      2. Materials for Bridge Construction (concrete, steel, timber)      3. Bridge Foundation Construction (piling, abutments, and piers)      4. Decking and Superstructure Construction Methods   10. Construction of Drifts and Causeways       1. Purpose and Applications of Drifts and Causeways       2. Design Considerations (e.g., load-bearing capacity, water flow)       3. Materials and Procedures for Construction       4. Quality Control for Stability and Durability   11. Quality Control Operations       1. Standards for Drainage and Bridge Construction       2. Testing of Materials (e.g., concrete strength, compaction)       3. Inspection of Structures (culverts, drains, bridges, gullies)       4. Addressing Defects and Ensuring Compliance   12. Retaining Wall Construction Operations       1. Types of Retaining Walls (e.g., gravity walls, cantilever walls, gabion walls)       2. Materials for Retaining Wall Construction (concrete, stone, steel)       3. Construction Techniques for Retaining Walls (excavation, placing, compaction)       4. Stability and Load-Bearing Quality Checks   13. Backfilling Procedures       1. Purpose of Backfilling in Drainage and Bridge Construction       2. Selection of Backfill Materials (e.g., granular soil, aggregate)       3. Placement and Compaction Techniques for Backfill       4. Quality Assurance for Proper Compaction and Settlement | 1. Observation 2. Oral questioning 3. Projects 4. Written tests 5. Third party 6. Portfolio |
| 1. Construct erosion prevention structures | * 1. Types of Soil Erosion      1. Water Erosion: Surface runoff, rill erosion, and gully erosion      2. Wind Erosion: Impact on sandy and loose soils      3. Glacial Erosion: Erosion caused by glacial movement      4. Coastal Erosion: Erosion due to wave action along shorelines      5. Gravity Erosion: Mass wasting, including landslides and rockfalls      6. Causes and Impact of Soil Erosion on Infrastructure and the Environment   2. Mobilization of Construction Resources      1. Identification of Required Resources (materials, equipment, personnel)      2. Selection and Sourcing of Materials (e.g., geotextiles, rocks, vegetation)      3. Equipment Mobilization (e.g., bulldozers, excavators, compactors)      4. Coordination and Scheduling for Efficient Resource Deployment   3. Erosion Control Structures      1. Vegetative Structures: Grass planting, shrubs, and trees for erosion control      2. Structural Erosion Control: Retaining walls, riprap, and gabions      3. Drainage Structures: Culverts, drains, and channels for water management      4. Mechanical Structures: Silt fences, erosion mats, and barriers      5. Bioengineering Solutions: Combining vegetation and structural methods   4. Location of Erosion Prevention Structures      1. Site Assessment for Erosion Risk (e.g., slope, water flow, soil type)      2. Identifying High-Risk Areas (e.g., steep slopes, riverbanks, construction sites)      3. Strategic Placement of Structures to Minimize Erosion Impact      4. Factors Influencing Location (e.g., topography, hydrology, accessibility)   5. Interpretation of Drawings      1. Types of Erosion Control Drawings (e.g., site plans, cross-sections, details)      2. Symbols, Scales, and Notations for Erosion Control Structures      3. Extracting Relevant Information for Erosion Control Implementation      4. Application of Drawings to Site Setup and Construction   6. Standard Construction Manuals      1. Guidelines for Erosion Control Design and Construction (e.g., FHWA, ASTM)      2. Specifications for Materials and Techniques (e.g., soil stabilization, drainage)      3. Safety and Environmental Standards in Erosion Control      4. Reference Materials for Quality Control and Compliance   7. Construction of Erosion Prevention Structures      1. Excavation and Site Preparation for Structures (e.g., channel reshaping, trenching)      2. Installation of Erosion Control Materials (e.g., soil nails, retaining walls)      3. Methods for Building Vegetative Structures (e.g., seeding, mulching, planting)      4. Techniques for Constructing Drainage and Water Flow Control Structures   8. Quality Control Procedures      1. Standards for Materials Used in Erosion Control (e.g., strength, permeability, durability)      2. Inspection and Testing of Installed Structures (e.g., stability, proper installation)      3. Monitoring Erosion Control Effectiveness (e.g., vegetation health, soil retention)      4. Documentation and Reporting of Quality Control Results   9. Maintenance of Erosion Prevention Structures      1. Routine Inspection and Monitoring for Wear and Tear      2. Repair and Reinforcement Techniques for Damaged Structures      3. Vegetation Maintenance (e.g., reseeding, mulching)      4. Drainage Maintenance and Cleaning (e.g., clearing blockages, ensuring proper flow)   10. Legal and Statutory Requirements       1. Permits and Approvals for Erosion Control Works (e.g., environmental impact assessments)       2. Compliance with Local, National, and International Regulations (e.g., NEMA, EPA)       3. Requirements for Environmental Protection and Land Rehabilitation       4. Legal Documentation and Reporting for Erosion Control Projects | 1. Observation 2. Oral questioning 3. Projects 4. Written tests 5. Third party 6. Portfolio |
| 1. Install road furniture | * 1. Acquisition and Mobilization of Road Furniture Resources      1. Identification of Required Road Furniture (e.g., signs, barriers, traffic lights)      2. Sourcing and Procurement of Materials and Equipment      3. Mobilization of Resources (manpower, tools, machinery)      4. Scheduling and Logistics for Efficient Resource Deployment   2. Interpretation of Drawings      1. Types of Road Furniture Drawings (e.g., location plans, elevation views, installation details)      2. Symbols, Scales, and Notations in Road Furniture Drawings      3. Extracting Key Information for Installation (e.g., dimensions, positioning)      4. Application of Drawings to Site Setup and Installation   3. Standard Installation Manuals      1. Guidelines for Installation of Road Furniture (e.g., road signs, lighting systems)      2. Specifications for Materials and Construction Methods (e.g., sign posts, concrete bases)      3. Safety and Regulatory Standards for Road Furniture Installation      4. Maintenance of Installation Manuals for Ongoing Reference   4. Types of Road Furniture      1. Traffic Signs: Regulatory, warning, and informational signs (e.g., speed limits, direction signs)      2. Road Markings: Lane markings, pedestrian crossings, stop lines      3. Barriers and Guardrails: Safety barriers, guardrails for vehicles and pedestrians      4. Street Lighting: Illuminating roads, intersections, and pedestrian walkways      5. Traffic Signals and Control Systems: Signals for vehicle and pedestrian management      6. Other Road Furniture: Bus shelters, bollards, road studs, and information boards   5. Road Furniture Location Types      1. Strategic Location: Near intersections, pedestrian crossings, and busy junctions      2. Regulatory Placement: Locations where traffic control is required (e.g., speed limit signs, stop signs)      3. Visibility Considerations: Proper placement for maximum visibility and effectiveness      4. Safety Requirements: Clear and hazard-free placement, away from traffic obstructions      5. Aesthetic and Functional Factors: Considering aesthetics and integration into urban design   6. Installation of Road Furniture      1. Site Preparation for Installation (e.g., clearing, excavation, leveling)      2. Installation of Different Types of Road Furniture (e.g., mounting traffic signs, setting up barriers)      3. Fixing Methods for Sign Posts, Barriers, and Lighting Systems      4. Testing and Commissioning of Installed Road Furniture (e.g., functional checks for traffic lights)   7. Quality Control Procedures      1. Inspection of Installed Road Furniture for Compliance with Design Specifications      2. Testing of Materials and Equipment Used for Installation (e.g., durability, strength)      3. Ensuring Proper Alignment and Positioning of Road Furniture      4. Documentation and Reporting of Quality Control Results (e.g., inspections, certifications)   8. Maintenance Activities on Road Furniture      1. Routine Inspections and Monitoring (e.g., checking for wear, damage, or malfunction)      2. Repair and Replacement of Damaged or Malfunctioning Furniture (e.g., broken signs, defective lights)      3. Cleaning and Upkeep of Road Furniture (e.g., washing signs, repainting road markings)      4. Upgrading or Replacing Outdated Road Furniture   9. Legal and Statutory Requirements      1. Regulatory Framework for Road Furniture Installation and Maintenance (e.g., national road authority standards)      2. Compliance with Local and International Road Safety Standards      3. Required Permits for Installation of Certain Road Furniture      4. Environmental and Safety Considerations in Road Furniture Installation and Maintenance      5. Documentation and Reporting for Legal Compliance and Audits | 1. Observation 2. Oral questioning 3. Projects 4. Written tests 5. Third party 6. Portfolio |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussions
5. Direct instructions

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Road construction Works reference books | For trainee’s use | 14 | 1:2 |
|  | Rulers, protractors | For trainer’s use | 2 pcs each | 2:1 |
|  | Roads Drawings samples | For both trainer’s and trainee’ use | 25 pcs | 1:1 |
|  | Sample contract documents | For both trainer’s and trainee’ use | 25 pcs | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Workshop | 9m by 8m | 1 | 1:25 |
|  | Construction materials | For both trainer’s and trainee’ use | Adequate |  |
|  | Road construction site | For both trainer’s and trainee’ use | adequate |  |
| **C** | **Consumable materials** | | | |
|  | Assorted colour of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
|  | Masking Tape | For trainee’s use | 1pc | 25:1 |
| **D** | **Tools and Equipment** | | | |
|  | Assorted Construction Equipment ( Earth moving Equipment, Hauling Equipment, Excavating Equipment) | For trainee’s use | 25 pcs | 1:1 |
|  | Drawing Board | For trainee’s use | 25 pcs | 1:1 |

## STRUCTURAL ANALYSIS PRINCIPLES II

**UNIT CODE: 0732 541 21A**

**UNIT DURATION: 110 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competence: Apply structural analysis principles **II**

**Unit Description**

This Unit describes the principles required to perform structural designs. It involves

Computing theory of simple bending, computing horizontal shear stresses, analysing structural compression members, computing combined stresses and determining retaining walls forces.

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| Learning Outcomes | **DURATION (HOURS)** |
| 1. Compute Theory of simple bending | **20** |
| 1. Compute Horizontal shear stress distribution | **30** |
| 1. Analyse structural compression members | **20** |
| 1. Compute Combined stresses | **20** |
| 1. Determine retaining walls forces | **20** |
| TOTAL | **110** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Compute Theory of simple bending | * 1. Introduction to Simple Bending Theory      1. Neutral axis and bending stress in beam sections      2. Elastic bending and plastic bending differences   2. Derivation and Application of Bending Formula      1. Bending equation   C:\Users\User\AppData\Local\Temp\ksohtml10344\wps3.jpg   * 1. Practical Considerations in Simple Bending      1. Structural members subject to bending         1. Rectangular sections         2. T – sections         3. I – sections      2. Safety factors and design considerations for bending stress | 1. Practical tests 2. Project 3. Portfolio of evidence 4. Third party report 5. Written tests |
| 1. Compute Horizontal shear stress distribution | * 1. Fundamentals of Horizontal Shear Stress      1. Horizontal shear stress in beams under bending      2. Relationship between vertical load and horizontal shear   2. Shear Stress Distribution in Various Sections      1. Distribution analysis for rectangular, T-sections and I-sections   3. Practical Applications of Shear Stress Distribution      1. Plotting and interpreting shear stress distribution curves      2. Case examples in beams | 1. Practical tests 2. Project 3. Portfolio of evidence 4. Third party report 5. Written tests |
| 1. Analyse structural compression members | * 1. Compression Member Types and Buckling Analysis      1. Classification of columns         1. Short         2. Intermediate         3. Long      2. Euler's buckling theory and its application | 1. Practical tests 2. Project 3. Portfolio of evidence 4. Third party report 5. Written tests |
| 1. Compute Combined stresses | * 1. Stress Types and Their Implications in Columns      1. Direct stress and bending stress in columns      2. Combined axial and bending stress for eccentrically loaded columns   2. Assumptions and Considerations in Combined Stress Analysis      1. Effects of load eccentricity | 1. Practical tests 2. Project 3. Portfolio of evidence 4. Third party report 5. Written tests |
| 1. Determine retaining walls forces | * 1. Centre of Gravity and Stability in Retaining Walls      1. Determination of centre of gravity for uniform and non-uniform sections      2. Effects on stability and risk of overturning   2. Types of Pressure Acting on Retaining Walls      1. Active      2. Passive      3. Calculation of earth pressures   3. Lateral Thrust and Stability Analysis      1. Methods for calculating lateral thrust   Rankine’s theory   * + 1. Stability checks and design considerations for different wall types   rectangular walls  trapezoidal walls | 1. Practical tests 2. Project 3. Portfolio of evidence 4. Third party report 5. Written tests |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussions
5. Direct instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Graph book | For trainee’s use | 14 | 1:2 |
|  | Rulers, protractors and compasses, set-squares | For trainer’s use | 2 pcs each | 2:1 |
|  | A4 drawing papers | For trainee’s use | 25 pcs | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Classroom | 9m by 8m | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Assorted colour of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
| 1. D | **Tools and Equipment** | | | |
|  | Scientific calculator | For trainee’s use | 25 pcs | 1:1 |
|  | Computers installed with numerical analysis software’s | For trainee’s use | 13 pcs | 1:2 |

## ENGINEERING SURVEY II

**Unit code: 0732 551 22A**

**Duration: 80 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: carry out Civil Engineering survey I

**Unit Description**

This unit specifies the competencies required to carry out civil engineering survey**.** It involves; Perform Curve Ranging and traversing works.

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| Learning Outcomes | DURATION (HOURS) |
| 1. Conduct topographic survey |  |
| 1. Draft survey design | 40 |
|  | 40 |
|  | 80 HOURS |

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**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | Content | **Suggested Assessment Methods** |
| 1. Conduct topographic survey | * 1. Topographic tools and equipment      1. Basic Surveying Tools   2. Calibration of topographic tools and equipment      1. Theodolite calibration (collimation, leveling, trunnion axis)      2. Level calibration (sensitivity)      3. EDM equipment calibration   3. Horizontal distance determination      1. Direct Measurement:         1. Using a tape measure         2. Using an EDM device      2. Indirect Measurement:         1. Stadia method         2. Trigonometric method (using angles and vertical distances)   4. Vertical distance determination      1. Direct Measurement      2. Indirect Measurement   5. Topographic data collection   6. Maintenance of tools and equipment | 1. Observation 2. Oral questioning 3. Projects 4. Written tests 5. Third party 6. Portfolio |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussions
5. Direct instructions

**Recommended Resources for 25 Trainees**

| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Rulers, protractors and compasses, set-squares | For trainer’s use | 2 pcs each | 2:1 |
|  | Surveyors filed notebooks | For trainee’s use | 25 pcs | 1:1 |
|  | Grid papers | For both trainer’s and trainee’ use | 25 pcs | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Drafting room | 9m by 8m | 1 | 1:25 |
|  | Computer rooms | 9m by 8m | 1 | 1:25 |
|  | Computers with surveying software | For trainers and trainees | 13 | 2:1 |
|  | Plotter | For trainers and trainees | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Assorted color of whiteboard markers | For trainer and trainee’s use | 25 pcs per stationery | 1:1 |
|  | Masking Tape | For trainee’s use | 1pc | 25:1 |
|  | Drawing stationery | For trainee’s use | 25 pcs per stationery | 1:1 |
|  | pencils | For trainee’s use | 25 pcs per stationery | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Technical Drawing Instruments | For trainee’s use | 25 pcs | 1:1 |
|  | Drawing Board | For trainee’s use | 25 pcs | 1:1 |
| 1. a | Assorted Surveying Equipment | For Trainer nd trainees use | 8 pcs | 3:1 |

## 

## TRIGONOMETRY AND COMPLEX NUMBERS

**Unit code: 0732 551 23A**

**Duration: 80 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply Trigonometry and Complex Numbers

**Unit Description**

This unit describes the competencies required by a technician in order to apply a wide range of mathematical skills in their work; it involves applying Trigonometry and hyperbolic functions, complex numbers and power series

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| Learning Outcomes | **DURATION (HOURS)** |
| * Perform Trigonometry and hyperbolic functions | **20** |
| * Perform complex number operations | **20** |
| * Apply power series | **10** |
| **TOTAL** | **50 HOURS** |

**Learning Outcomes, Content, and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcomes** | **Content** | **Suggested Assessment Methods** |
| 1. Perform Trigonometry and hyperbolic functions | * 1. **Trigonometric Ratios**      1. Sine, Cosine, Tangent, Cosecant, Secant, Cotangent      2. Applications of right-angle trigonometry   2. **Trigonometric Identities**      1. Pythagorean identity, angle sum and difference identities      2. Double angle, half-angle identities   3. **Solving Trigonometric Equations**      1. Using trigonometric identities to solve equations      2. Real-world applications of trigonometric solutions   4. **Hyperbolic Functions**      1. Definitions of sinh, cosh, tanh      2. Hyperbolic identities   5. **Hyperbolic Equations**      1. Solving equations involving hyperbolic functions      2. Applications in engineering and physics | 1. Practical tests 2. Project 3. Portfolio of evidence 4. Third party report 5. Written tests |
| 1. Perform complex number operations | * 1. **Real and Imaginary Numbers**      1. Understanding complex numbers in the form a + bi   2. **Argand Diagram Representation**      1. Plotting complex numbers on the Argand plane      2. Polar and rectangular forms   3. **Polar Form of Complex Numbers**      1. Conversion between polar and rectangular forms      2. Modulus and argument of complex numbers   4. **Operations on Complex Numbers**      1. Addition, subtraction, multiplication, and division of complex numbers      2. Complex conjugates   5. **De Moivre’s Theorem**      1. Powers and roots of complex numbers      2. Application in solving polynomial equations | 1. Practical tests 2. Project 3. Portfolio of evidence 4. Third party report 5. Written tests |
| 1. Apply Power Series | * 1. Definition of series   2. Interval and radius of convergence   3. Operation of power series   4. Tylor and Maclurin’s   5. Applications of power series | * Practical tests * Project * Portfolio of evidence * Third party report * Written tests |

**Suggested Methods of Instruction**

1. Role playing
2. Viewing of related videos
3. Discussion
4. Direct Instruction
5. Practicals
6. Projects

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Mathematical table | For trainee’s use | 25 pcs | 1:1 |
|  | Mathematical set | For trainee’ use | 25 pcs | 1:1 |
|  | SMP Table | For trainee’ use | 25 pcs | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Assorted colour of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
| **D** | **Tools and Equipment** | | | |
|  | Rulers, protractors and compasses, | For trainee’s use | 25pcs | 1:1 |
|  | Scientific Calculator | For trainee’s use | 25pcs | 1:1 |

# MODULE V

## STRUCTURAL ANALYSIS PRINCIPLES III

**UNIT CODE: 0732 541 24A**

**UNIT DURATION: 80 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competence: Apply structural analysis principles

**Unit Description**

This Unit describes the principles required to perform structural designs. It involves

Computing slope and deflection, and analysing indeterminate structures.

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| Learning Outcomes | **DURATION (HOURS)** |
| 1. Compute slope and deflection | **40** |
| 1. Analyse indeterminate structures | **40** |
| **TOTAL** | **80** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Compute slope and deflection | 1. Theoretical Basis for Slope and Deflection    * 1. Assumptions in beam theory    1. Methods of determination of slope and deflection       1. Mohr’s Method (Moment area method)       2. Macaulay’s method | 1. Practical tests 2. Project 3. Portfolio of evidence 4. Third party report 5. Written tests |
| 1. Indeterminate structures | * 1. Identification of Determinate and inter-determinate structures   2.2 Analysis methods for indeterminate structures  2.2.1 Three moment theorem  2.2.2 Moment distribution method | 1. Written 2. Observation 3. Report 4. Practical |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussions
5. Direct instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Graph book | For trainee’s use | 14 | 1:2 |
|  | Rulers, protractors and compasses, set-squares | For trainer’s use | 2 pcs each | 2:1 |
|  | A4 drawing papers | For trainee’s use | 25 pcs | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Classroom | 9m by 8m | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Assorted colour of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
| 1. D | **Tools and Equipment** | | | |
|  | Scientific calculator | For trainee’s use | 25 pcs | 1:1 |
|  | Computers installed with numerical analysis software’s | For trainee’s use | 13 pcs | 1:2 |

## ROAD STRUCTURES I

**UNIT CODE: 0732 551 25A**

**UNIT DURATION:** 70Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Design Road Structures I

**Unit Description**

This unit specifies the competencies required to design basic pavement structures. It involves; conducting site visit, designing pavement structures and carrying out road geometric design.

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| **Learning Outcomes** | **DURATION (HOURS)** |
| 1. Conduct site visit | 20 |
| 2. Design pavement structures | 20 |
| 3. Carry out road geometric design | 30 |

**Learning Outcomes, Content and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1.Conduct site visit | * 1. **Identification of Location of Road Structures**      1. Pavements      2. Footpath      3. Parking      4. Culverts      5. Road furniture      6. Bridges      7. Hydraulic structures   2. **Site Visit Preparation**      1. Equipment and materials for site visit      2. Checklist of objectives and data requirements      3. logistics with relevant personnel   3. **Preliminary Site Visit**      1. Visual assessments of existing site conditions      2. Documenting preliminary observations      3. Potential challenges and opportunities   4. **On-site Data Collection**      1. Measurement of key site features (e.g., dimensions, elevations)      2. Soil samples.      3. Record of locations of existing utilities and infrastructure | 1. Projects 2. Reports 3. Written Tests 4. Practical |
| 2.Design pavement structures | * 1. Resource Mobilization      1. Geometric tools      2. Straight edge      3. Ruler      4. Compass      5. Protractor      6. Computers      7. Auto Cad Software      8. Civil 3D      9. ARCHI CAD      10. GIS   2. Traffic Load Estimation      1. Methods of traffic volume estimation- manual counts, automated counters, video-based analysis, GPS-Cellular, mobile devise, simulations, surveys and questionnaires.      2. Traffic volume and distribution (AADT, ADT)      3. Load analysis (e.g., axle loads, truck traffic)      4. Traffic forecasting and future planning   3. Pavement Type Determination      1. Flexible pavements      2. Rigid pavements      3. Composite pavements   4. Pavement Structure Design      1. Flexible pavement design (e.g. Road Note 31, Kenya road design Manual 2000, AASHTO, IRC)      2. Rigid pavement design (e.g., IRC, PCA)      3. Overlay design      4. Pavement rehabilitation and maintenance   5. Pavement Structural Drawings   6. Materials Schedules   7. Detailed Report and Specifications | 1. Written tests 2. Observation 3. Oral question 4. Third party |
| 3.Carry out road geometric design | * 1. Resource Mobilization   2. OGL Analysis   3. Horizontal and Vertical Alignment Design   4. Road Intersection Design      1. Y-junctions      2. T-junctions      3. Under-pass      4. Round about      5. Overpass      6. Cross junctions      7. Interchange   5. Drawings Production   6. Report Preparation | 1. Written 2. Observation 3. Report 4. Practical |
|  |  |  |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstration
4. Group discussion
5. Direct instructions
6. Site visits

**Recommended Resources for 25 Trainees**

| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Traffic Survey Data and Reports | For trainee’s use | 14 | 1:2 |
|  | Rulers, protractors and compasses, set-squares | For trainer’s use | 2 pcs each | 2:1 |
|  | Design Manuals (Road Design Manual, Road Note 31, Kenya Road manual 2000 etc.) | For trainee’s use | 25 pcs | 1:1 |
|  | Highway Drawings samples | For both trainer’s and trainee’ use | 25 pcs | 1:1 |
|  | Field Notebooks and Data Collection Sheets | For both trainer’s and trainee’ use | 25 pcs | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Computer rooms | 9m by 8m | 1 | 1:25 |
|  | Computers with, AutoCAD, Civil 3D or equivalent | For trainers and trainees | 13 pcs | 2:1 |
|  | Projectors | For trainers use | 1 pc | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Assorted color of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
|  | Drafting stationery | For trainee’s use | 25 pcs per stationery | 1:1 |

## TRAFFIC SURVEY PERFORMANCE

**UNIT CODE: 0732 551 26A**

**UNIT DURATION: 75 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Perform traffic survey

**Unit Description**

This unit specifies the competencies required to perform traffic survey. It involves Preparing for traffic survey, carrying out traffic counts, and preparing traffic survey report

**Summary of Learning Outcomes**

1. To prepare for traffic survey
2. To carry out traffic counts
3. To prepare traffic survey reports

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Prepare for traffic survey | * 1. Introduction to Traffic survey      1. GIS         1. Introduction to GIS         2. Applications of GIS         3. GIS vs Site location   Site Identification  Site analysis   * + 1. Topographical maps        1. Definition of topographical maps        2. Types of topographical maps        3. interpretation of topographic maps   1. Traffic Data Collection Methods      1. Manual counts (e.g., using clickers or tally sheets)      2. Automatic traffic recorders (ATRs)      3. Video analysis      4. Questionnaires      5. Interviews   2. Survey Planning and Design      1. Locations      2. Timing      3. personnel   3. Traffic Data Analysis Techniques      1. Basic statistical methods (e.g., mean, median, mode, standard deviation)      2. Traffic flow theory (e.g., speed-flow-density relationships)   4. Safety and Ethical Considerations | 1. Observation 2. Oral questioning 3. Projects 4. Written tests 5. Third party 6. Portfolio |
| 1. Carry out traffic counts | * 1. Traffic counting methods   2. Equipment and Materials used in traffic counts   3. Vehicle Classifications      1. vehicle types and axle load   4. Equipment Installation      1. traffic counting equipment (e.g., ATRs, cameras)      2. Traffic volumes established as per counts. | 1. Observation 2. Oral questioning 3. Projects 4. Written tests 5. Third party 6. Portfolio |
| 1. Prepare traffic survey reports | * 1. Data Validation and Quality Control      1. Standard data collection procedures and quality control measures      2. Identifying and addressing data errors or inconsistencies   2. Traffic Characteristics      1. Traffic volume, speed, and density      2. Analyzing traffic composition (e.g., vehicle types, axle loads)      3. Identifying peak traffic periods and trends   3. Road Characteristics      1. road design features (e.g., number of lanes, intersections, speed limits)   4. Report Writing Fundamentals      1. Introduction and background      2. Survey methodology and data collection      3. Data analysis and findings      4. Conclusions and recommendations | 1. Observation 2. Oral questioning 3. Projects 4. Written tests 5. Third party 6. Portfolio |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussions
5. Direct instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
| 1. | Traffic Survey reference books | For trainee’s use | 10 pcs | 1:3 |
| 2 | Flip Charts | For trainee’s use | 1 pc | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
| 1. | Whiteboards | For trainer’s use | 1 pc | 1:25 |
| 2. | Chalkboard | For trainer’s use | 1 pc | 1:25 |
| **C** | **Consumable materials** | | | |
| 1. | Traffic Count Sheets | For trainee’s use | 1 pc | 1:1 |
| **D** | **Tools and Equipment** | | | |
| 1. | Counter tubes and Flash lights | For trainer and trainee’s use | 25 pcs | 1:1 |
| 2. | Rader Identifiers | For trainer and trainee’s use | 5 | 1:5 |
| 3. | Camcorders | For trainer and trainee’s use | 5 pieces | 1:5 |
| 4. | Scientific Calculators | For trainee’s use | 25 | 1.1 |
| 5 | PPES (Helmets, Gum boots, Reflective jackets) | For Trainee’s use | 25 | 1:1 |

## CALCULUS AND DIFFERENTIAL METHODS

**UNIT CODE: 0732 541 27A**

**Duration: 50 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply Calculus and Differential methods

**Unit Description**

This unit describes the competencies required by a technician in order to apply a wide range of mathematical skills in their work; it involves applying calculus, ordinary differential equations and numerical methods.

|  |  |
| --- | --- |
| **Learning Out Comes** | **DURATION (HOURS)** |
| 1. Perform Calculus Operations | **20** |
| 1. Solve Ordinary differential equations | **20** |
| 1. Perform numerical methods | **10** |
| **TOTAL** | **50** |

**Learning Outcomes, Content, and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | Content | **Suggested Assessment Methods** |
| 1. Perform Calculus Operations | |  | | --- | | * 1. Differentiation of Algebraic Functions      1. Rules of differentiation (power, product, quotient, chain rules)   2. Differentiation of Trigonometric and Hyperbolic Functions      1. Derivatives of sine, cosine, tangent, sinh, cosh, etc.   3. Inverse Trigonometric Functions      1. Derivatives of arcsin, arcos, arctan   4. Rate of Change      1. First and second derivatives as rates of change      2. Real-life applications (velocity, acceleration)   5. Stationary Points      1. Maxima, minima, and points of inflection      2. Applications in optimization problems   6. Integration of Algebraic Functions      1. Definite and indefinite integrals      2. Application of integration in finding areas   7. Integration of Trigonometric and Hyperbolic Functions      1. Techniques of integration involving trigonometric functions      2. Integration by substitution   8. Integration of Logarithmic Functions      1. Finding the integral of logarithmic expressions   9. Applications of Calculus      1. Calculating areas under curves      2. Volume of solids of revolution | | * Practical tests * Project * Portfolio of evidence * Third party report * Written tests |
| 1. Solve Ordinary differential equations | * 1. First-Order Differential Equations      1. Methods of Solving first-order ODEs.         1. Separation of variables         2. Integrating factor   2. Second-Order Differential Equations      1. Homogeneous      2. Non-homogeneous second-order ODEs   3. Boundary Conditions      1. Applying initial or boundary conditions to solve ODEs   4. Applications of ODEs      1. Real-life applications in physics, engineering (e.g., motion of particles, electrical circuits) | * Practical tests * Project * Portfolio of evidence * Third party report   Written tests |
| 1. Perform numerical methods | * 1. Numerical Methods Identification      1. Overview of numerical analysis techniques   2. Roots of Polynomials      1. Solving polynomial equations using numerical methods (Newton-Raphson, bisection, and algebraic)   3. Interpolation and Extrapolation      1. Estimating values between or outside known data points using Lagrange’s interpolation   4. Numerical Integration      1. Approximate solutions to definite integrals using numerical techniques (Trapezoidal and Simpson’s rules | * Practical tests * Project * Portfolio of evidence * Third party report   Written tests |

**Suggested Methods of Instruction**

1. Role playing
2. Viewing of related videos
3. Discussion
4. Direct Instruction
5. Practicals
6. Projects

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Mathematical table | For trainee’s use | 25 pcs | 1:1 |
|  | Mathematical set | For trainee’ use | 25 pcs | 1:1 |
|  | SMP Table | For trainee’ use | 25 pcs | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Assorted colour of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
| **D** | **Tools and Equipment** | | | |
|  | Rulers, protractors and compasses, | For trainee’s use | 25pcs | 1:1 |
|  | Scientific Calculator | For trainee’s use | 25pcs | 1:1 |

# MODULE VI

## MEASUREMENTS, ESTIMATION AND COSTING PRINCIPLES II

**UNIT CODE:** 0732 551 28A

**UNIT DURATION:** 60 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Perform measurements and cost estimation II

**Unit Description**

This unit describes competencies required to Perform measurements and cost estimation. It involves; Applying superstructure works taking off principles

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| To Apply construction external work taking off principles | **20** |
| 2.To Abstract measured quantities | **20** |
| 3.To Prepare bill of quantities | **20** |
| **TOTAL** | **60** |

| **Learning Outcome** | Content | **Assessments methods** |
| --- | --- | --- |
| 1. Apply superstructure works taking off principles | * 1. Documentation of Superstructure Elements      1. Wall types      2. Slab and beam elements      3. Roofing components   2. Quantification of Superstructure Elements      1. Techniques for measuring superstructure quantities      2. Volume calculations      3. Structural elements      4. Openings (doors and windows)      5. Standard measurement methods      6. Adjusting quantities for design changes   3. Booking Superstructure Quantities      1. Recording superstructure elements      2. Measurement methods      3. Standard booking format      4. Cross-checking quantities | 1. Written 2. Observation 3. Report 4. Practical |
| 1. Abstract measured quantities | |  | | --- | | * 1. Preparation of Abstracting Sheet      1. Abstracting formats      2. Organizing measurements for clarity      3. Applying SMM/CESMM standards      4. Reviewing abstracting accuracy   2. Transferring Descriptions to Abstracting Sheet      1. Copying booked item descriptions      2. Maintaining accuracy and consistency      3. Following SMM/CESMM guidelines      4. Ensuring compliance with project requirements   3. Transferring Squared Quantities to Abstracting Sheet      1. Calculating squared quantities      2. Ensuring accurate documentation      3. Using standard formats      4. Double-checking calculations for accuracy   4. Calculation of Net Quantities      1. Techniques for calculating net quantities      2. Applying SMM/CESMM methods      3. Ensuring accuracy      4. Adjusting quantities based on project variations   5. Running Through Dimensions      1. Reviewing all dimensions      2. Correcting any errors      3. Ensuring measurements are accurate      4. Confirming dimensions align with drawings | |  |
| 1. Prepare bill of quantities | |  | | --- | | * 1. Preparation of Specifications      1. Specifications preparations * Material * Workmanship   + 1. Following SMM/CESMM standards     2. Cross-referencing with drawings and designs   1. Preparation of Schedule of Rates      1. Calculating rates based on abstracted quantities      2. Applying standard costing guidelines      3. Ensuring accuracy in costing      4. Adjusting rates based on project constraints   2. Preparation of Bill of Quantities      1. Compiling BOQ based on working drawings      2. Ensuring BOQ is comprehensive and accurate      3. Following standard BOQ formats      4. Reviewing BOQ for consistency with specifications | |  |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstration
4. Group discussion
5. Direct instructions
6. Site visits

**Recommended resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks |  | 25 pcs | 1:1 |
|  | White board | For trainer’s use | 1 | - |
|  | Standard Method of Measurement (SMM) | Latest edition | 25 | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | 72 Square Meter | 1 | 1:25 |
|  | Computer Lab | 96 Square Meter | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
|  | Ink | Assorted Colours for trainer’s use | 500ml per term. | - |
|  | White board Marker | Refillable type | 10 pcs per term | - |
|  | Dimension papers | A4 size | 25 | 1:1 |
|  | Billing papers | A4 size | 25 | 1:1 |
| **D** | **Tools and Equipment** |  |  |  |
|  | 1 Projector | appropriate | 1 | 1:25 |
|  | calculator | scientific | 25 | 1:1 |
|  | Laptop | Intel corei5 | 1 | 1:25 |
|  | PPEs | Trainer Use (dust coat) | 1 pc | - |
|  | Pen | Trainee | 1 pc | 1:1 |

## ROAD STRUCTURES DESIGN II

**UNIT CODE: 0732 551 29A**

**UNIT DURATION:** 70Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Design Road Structures

**Unit Description**

This unit specifies the competencies required to design basic pavement structures. It involves; designing drainage and hydraulic structures, designing pedestrian and cyclist paths and designing road furniture.

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| 1. Design drainage and hydraulic structures | **20** |
| 1. Design pedestrian and cyclist paths | 20 |
| 1. Design Road furniture | **30** |
| **TOTAL** | **70 HOURS** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcomes** | **Content** | **Suggested Assessment Method** |
| 1.Design drainage and hydraulic structures | * 1. Surface Run-off Estimation   2. Drainage Structures Design      1. Water bars      2. Ditches      3. French drains      4. Culverts      5. Under drains   3. Hydraulic Structures Design      1. Bridges      2. Dams      3. Reservoirs      4. Pipelines      5. Canals      6. Aqueducts      7. Weirs      8. Turbines      9. Pumps      10. Flood control structures   4. Retaining Walls Design      1. Gravity      2. Cantilever      3. Embedded      4. Reinforced      5. Counterfort      6. Buttress   5. Construction Materials Determination | 1. Written 2. Observation 3. Report 4. Practical |
| 2.Design pedestrian and cyclist paths | * 1. Resource Mobilization   2. Pedestrian and Cyclist Traffic Estimation   3. Pedestrian and Cyclist Path Location   4. Pedestrian and Cyclist Path Design   5. Drawings Production   6. Report and Material Specifications | 1. Written 2. Observation 3. Report 4. Practical |
| 3.Design Road furniture | |  | | --- | | * 1. Resource Mobilization   2. Road Furniture Type Determination      1. Road markings      2. Information signs      3. Warning signs      4. Street lights      5. Traffic lights      6. Guard rails   3. Road Furniture Location   4. Road Furniture Design   5. Drawings Production   6. Report and Material Specifications | | 1. Written 2. Observation 3. Report 4. Practical |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstration
4. Group discussion
5. Direct instructions
6. Site visits

**Recommended Resources for 25 Trainees**

| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Traffic Survey Data and Reports | For trainee’s use | 14 | 1:2 |
|  | Rulers, protractors and compasses, set-squares | For trainer’s use | 2 pcs each | 2:1 |
|  | Design Manuals (Road Design Manual, Road Note 31, Kenya Road manual 2000 etc.) | For trainee’s use | 25 pcs | 1:1 |
|  | Highway Drawings samples | For both trainer’s and trainee’ use | 25 pcs | 1:1 |
|  | Field Notebooks and Data Collection Sheets | For both trainer’s and trainee’ use | 25 pcs | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Computer rooms | 9m by 8m | 1 | 1:25 |
|  | Computers with, AutoCAD, Civil 3D or equivalent | For trainers and trainees | 13 pcs | 2:1 |
|  | Projectors | For trainers use | 1 pc | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Assorted color of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
|  | Drafting stationery | For trainee’s use | 25 pcs per stationery | 1:1 |

## HIGHWAY ENGINEERING STRUCTURES DESIGN I

**UNIT CODE: 0732 551 30A**

**UNIT DURATION:** 150 Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Design highway Engineering Structures I

**Unit Description**

This unit specifies the competencies required to design civil engineering structures. It involves

Designing reinforced concrete structures

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| Learning Outcomes | **DURATION (HOURS)** |
| Design of reinforced concrete structures | **150** |
| **TOTAL** | **150** |

**Learning Outcomes, Content and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Design reinforced concrete structures | * 1. Terms and concepts      1. Designing      2. Reinforced Cement concrete      3. Reinforcement      4. Design philosophy   2. Design resources   3. BS 8110 for reinforced concrete, BS 6399 – Loads   4. Use of BS standard codes, BS 8110 for reinforced concrete, BS 6399 – Loads   5. Design of concrete structures      1. Introduction to loading and design analysis      2. Beam design: bending shear and deflection.      3. Slab design-, one way spanning and two way spanning, depth of slab, main and secondary reinforcement areas, critical shear stresses, detailing requirement.      4. Bending shear and deflection.      5. Column design- short and slender columns, compression failure, buckling, combinations of buckling and compressions.      6. Foundation design-loading, critical bending reinforcement, critical shear stress, reinforcement details,   6. Preparation of working drawings for structural members   7. Current building standards- EURO CODES | 1. Projects 2. Reports 3. Written Tests 4. Practical |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstration
4. Group discussion
5. Direct instructions
6. Site visits

**Recommended Resources for 25 Trainees**

| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Textbooks on Structural Design | For trainee’s use | 14 | 1:2 |
|  | Rulers | For trainer’s use | 2 pcs each | 2:1 |
|  | Excel design sheets | For trainee’s use | 25 pcs | 1:1 |
|  | Building Drawings samples | For both trainer’s and trainee’ use | 25 pcs | 1:1 |
|  | Design manuals (BS 8110 for reinforced concrete, BS 6399 – Loads) | For both trainer’s and trainee’ use | 25 pcs | 1:1 |
|  | Material Specification Samples | For both trainer’s and trainee’ use | 25 pcs | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Training room | 9m by 8m | 1 | 1:25 |
|  | Computer lab | 9m by 8m | 1 | 1:25 |
|  | Computers with design software (AutoCAD Civil 3D, REVIT, StaadPro, Etabs or equivalent) | For trainer and trainee use | 25 | 1:1 |
|  | Projector | For trainers use | 1 pc | 1:25 |
|  | Plotters | For trainers and trainees use | 1 pc | 1:25 |
|  | Printers | For trainers and trainees use | 1 pc | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Assorted colour of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
|  | Pens, pencils, erasers | For trainee’s use | 1pc | 25:1 |
|  | A3 printing papers |  |  |  |
| **D** | **Tools and Equipment** | | | |
|  | Bar bending schedules | For trainee’s use | 25 pcs | 1:1 |
|  | Steel Bending Equipment | For trainee’s use | 25 pcs | 1:1 |

## HYDRAULIC PRINCIPLES

**UNIT CODE: 0732 551 31A**

**Unit Duration: 120 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply hydraulic principles

**Unit Description:**

This unit describes competencies required to apply hydraulic principles. It involves; Applying hydrostatic concept, applying hydrodynamics concepts, applying hydrology concept, determining discharge and applying hydraulic machine concept

**Summary of Learning Out Comes**

|  |  |
| --- | --- |
| Learning Outcomes | DURATION (HOURS) |
| 1. Apply hydrostatic concept | 20 |
| 1. Apply hydrodynamics concepts | 30 |
| 1. Apply hydrology concept | 20 |
| 1. Determine discharge | 30 |
| 1. Apply hydraulic machine concept | 20 |
|  | 120 |

1. **Learning Outcomes, Content and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Apply hydrostatic concept | * 1. Introduction to hydrostatic concepts   2. Definition of terms      1. Viscosity, density, specific gravity and surface tension   3. Properties of fluids      1. Compressibility      2. Elasticity      3. Capillarity   4. Types of pressures      1. Gauge pressure      2. Absolute pressure      3. Atmospheric pressure   5. Magnitude and position of pressures      1. Hydrostatic pressure      2. Pressure head      3. Pressure energy   6. Pascal’s law      1. Statement of Pascal's law      2. Applications of Pascal's law   7. Law of floatation and buoyancy      1. Archimedes' principle      2. Conditions for floating, sinking, and neutral buoyancy      3. Applications of buoyancy | 1. Practical tests 2. Project 3. Portfolio of evidence 4. Third party report 5. Written tests |
| 1. Apply hydrodynamics concepts | * 1. Types of fluid flow      1. Laminar flow      2. Turbulent flow      3. Steady flow      4. Unsteady flow      5. Compressible flow      6. Incompressible flow   2. Momentum equation      1. Newton's second law of motion applied to fluids      2. Control volume analysis      3. Linear momentum equation      4. Angular momentum equation      5. Applications of the momentum equation   3. Bernoulli’s principle      1. Derivation of Bernoulli's equation      2. Assumptions and limitations of Bernoulli's equation      3. Applications of Bernoulli's equation | 1. Practical tests 2. Project 3. Portfolio of evidence 4. Third party report 5. Written tests |
| 1. hydrology concept | * 1. Hydrological cycle      1. Components of the hydrological cycle (e.g., precipitation, evaporation, infiltration, runoff)      2. Energy balance in the hydrological cycle      3. Human impact on the hydrological cycle   2. Precipitation      1. Types of precipitation (e.g., rain, snow, hail)      2. Measurement of precipitation (e.g., rain gauges, radar)   3. Evaporation      1. Types of evaporation (e.g., open water evaporation, soil evaporation, transpiration)      2. Factors affecting evaporation (e.g., temperature, humidity, wind speed, solar radiation)      3. Measurement of evaporation   4. Stream flow   5. Safety in hydrometric      1. Hazards associated with hydrometric (e.g., flooding, drowning, electrical hazards)      2. Safety precautions for hydrometric (e.g., personal protective equipment, emergency procedures) | 1. Practical tests 2. Project 3. Portfolio of evidence 4. Third party report 5. Written tests |
| 1. Determine discharge | * 1. Discharge velocity      1. Definition of discharge velocity      2. Relationship between discharge, velocity, and cross-sectional area      3. Measurement of discharge velocity (e.g., current meters, weirs)      4. Factors affecting discharge velocity’s   2. Reynold’s equation      1. Derivation of Reynolds equation      2. Components of Reynolds equation (e.g., convective acceleration, local acceleration, pressure gradient, viscous forces)      3. Applications of Reynolds equation (e.g., pipe flow, open channel flow)      4. Reynolds number and its significance in fluid flow   3. Head loss      1. Definition of head loss      2. Types of head loss (e.g., major loss, minor loss)      3. Factors affecting head loss (e.g., pipe length, diameter, roughness, flow rate)      4. Calculation of head loss (e.g., Darcy-Welsbach equation, Hazen-Williams equation)      5. Non- uniform flow equation   4. Channel design      1. Channel design criteria (e.g., conveyance capacity, stability, aesthetics)      2. Channel cross-sectional shapes (e.g., trapezoidal, rectangular, circular)      3. Channel lining materials (e.g., concrete, riprap, vegetation)      4. Channel slope and velocity | 1. Practical tests 2. Project 3. Portfolio of evidence 4. Third party report 5. Written tests |
| 1. Apply hydraulic machine concept | * 1. Types of pumps      1. Centrifugal pumps      2. Positive displacement pumps      3. Special purpose pumps   2. Pump working principles      1. Energy conversion      2. Head development      3. Discharge characteristics      4. Pump efficiency   3. Types of turbines      1. Hydraulic turbines      2. Gas turbines      3. Steam turbines   4. Turbine working principles | 1. Practical tests 2. Project 3. Portfolio of evidence 4. Third party report 5. Written tests |

**Suggested Methods of Instruction**

1. Practical
2. Project
3. Démonstrations
4. Group discussions
5. Direct instructions
6. Field trips

**Recommended Resources for 25 Trainees**

| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Reference materials | For trainee’s use | 25 | 1:1 |
|  | Scale Rulers | For trainee’s use | 25 | 1:1 |
|  | Graph papers | For trainer’s use | Sufficient |  |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Classroom | 9m by 8m | 1 | 1:25 |
|  | Water/hydraulic workshop | 9m by 8m | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Assorted colour of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
|  | stationery | For trainee’s use | 25 pcs per stationery | 1:1 |
|  | Oils | For trainee’s use | Sufficient |  |
|  | gaskets | For trainee’s use | Sufficient |  |
|  | sealant | For trainee’s use | Sufficient |  |
| **D** | **Tools and Equipment** | | | |
|  | Scientific calculator | For trainee’s use | 25 pcs | 1:1 |
|  | Caliper, scale rule | For trainee’s use | 25 pcs | 1:1 |
|  | Flow meter, pressure gauge, manometer, piezometer, oscilloscope, temperature sensor, pitot tube, | For trainee’s use | 1 pc | 1:25 |
|  | Weir, pumps, valves, taps, pipes, calibration kits, sluice gates, valves, tanks, | For trainee’s use | 1 pc | 1:25 |
|  | Bernoulli’s apparatus, Leak detectors, sluice gates | For trainee’s use | 1 pc | 1:25 |

## CIVIL ENGINEERING DRAWINGS I

**UNIT CODE:** 0732 551 17A

**UNIT DURATION: 80 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Produce Civil Engineering Drawings I

**Unit Description**

This unit describes the competencies required to produce building drawings. It involves producing and interpreting architectural drawings, interpreting electrical drawings, and mechanical drawings.

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| Learning Outcomes | DURATION (HOURS) |
| * + - 1. Produce and Interpret architectural drawings | 30 |
| * + - 1. Interpret electrical drawings | 30 |
| * + - 1. Interpret mechanical drawings | 20 |
| **TOTAL** | 80HOURS |

**Learning Outcomes, Content and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Produce interpret architectural drawings | * 1. Construction Dimensions.      1. Measurement units      2. Common dimensioning conventions      3. Conversion between measurement systems   2. Drawing Specifications      1. Key elements in specifications      2. Cross-referencing drawings with specifications      3. Implications of design changes   3. Drawing Layouts      1. Types of layouts (floor plans, elevations, cross section)      2. Zoning and building codes | * Practical tests * Project * Portfolio of evidence * Third party report * Written tests |
| 1. Interpret electrical drawings | * 1. Electrical Circuit Symbols      1. Standard electrical symbols      2. Significance of each symbol   2. Electrical Circuit Sketching      1. Techniques for accurate circuit sketching      2. Integration of electrical layouts with architectural designs      3. Sketches based on specifications   3. Connection Layouts      1. Importance of connection layouts      2. Drawing effective connection diagrams      3. Evaluation of existing layouts for improvements | * Practical tests * Project * Portfolio of evidence * Third party report * Written tests |
| 1. Interpret mechanical drawings | * 1. Mechanical Components Identification      1. Common mechanical components in drawings         1. Gas supply         2. Cold and hot water supply systems         3. Plumbing layout         4. Sewer system         5. Fire fighting         6. Ventilation system         7. Water treatment system         8. Refrigeration         9. Building automation system      2. Functions of various components      3. Component interactions in systems   2. Mechanical Dimensions Interpretation      1. Importance of accurately reading dimensions      2. Techniques for verifying component sizes      3. Dimension extraction from drawings   3. Components Layout Interpretation      1. Correspondence of layouts with functional requirements      2. Spatial arrangements in mechanical systems      3. Case studies of successful mechanical layouts | * Practical tests * Project * Portfolio of evidence * Third party report * Written tests |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstration
4. Group discussion
5. Direct instructions
6. Site visits

**Recommended Resources for 25 Trainees**

| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Technical drawing reference books | For trainee’s use | 14 | 1:2 |
|  | Building Standards Codes, 2024 or equivalent | For trainee’s use | 25 pcs | 1:1 |
|  | Electrical Codes of Practice, (e.g., NEC or IEC standards) | For trainee’s use | 25 pcs | 1:1 |
|  | Bar Bending Schedules | For trainee’s use | 25 pcs | 1:1 |
|  | Building Drawings samples | For both trainer’s and trainee’ use | 25 pcs | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Computer designing room | 9m by 8m | 1 | 1:25 |
|  | Computers with AutoCAD Software, AutoCAD Civil 3D, Revit, AutoCAD Mechanical, Revit MEP) | For trainers and trainees use | 25 pcs | 1:1 |
|  | Plotter/Printer | For trainers and trainees use | 1 pc | 1:25 |
|  | Training Room | 9m by 8m | 1 | 1:25 |
|  | Projector | For trainer’s use | 1 pc | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Assorted colour of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
|  | Pens , pencils, erasers | For trainee’s use | 25 pcs | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Architectural Drawing Sets | For trainee’s use | 25 pcs | 1:1 |
|  | Drawing Board | For trainee’s use | 25 pcs | 1:1 |

## RESEARCH PROJECT I

**UNIT CODE: 0732 551 32A**

**UNIT DURATION:** 20 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Conduct Research Project I

**Unit Description**

This unit specifies the competencies required to Conduct Research Project**.** It involves 1. Developing research proposal.

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| Learning Outcomes | DURATION (HOURS) |
| Develop research proposal | 20 |
|  | 20 HOURS |

**Learning Outcomes, Content and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Develop research proposal | * 1. **Project Title Identification**      1. Research topic selection      2. Relevance to field of study      3. Scope and limitations   2. **Proposal Preparation**      1. Writing problem statement      2. Defining objectives      3. Developing methodology      4. Project budget and timeline   3. **Proposal Submission**      1. Formatting as per institutional guidelines      2. Submission process and deadlines      3. Feedback and revisions | * Practical tests * Project * Portfolio of evidence * Third party report * Written tests |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstration
4. Group discussion
5. Direct instructions

**Recommended Resources for 25 Trainees**

| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Reference books: citation guides | For trainee’s use | 25 | 1:1 |
|  | Blue prints and sample plans | For trainee’s use | 25 | 1:1 |
|  | Scale Rulers, protractors and compasses, set-squares | For trainer’s use | 2 pcs each | 2:1 |
|  | Graph papers | For trainee’s use | 25 pcs | 1:1 |
|  | Drawings samples | For both trainer’s and trainee’ use | 25 pcs | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Classroom | 9m by 8m | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Assorted colour of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
|  | Stationery | For trainee’s use | 25 pcs | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Scientific calculator | For trainee’s use | 25 pcs | 1:1 |
|  | Projector | For trainee’s use | 1 pcs | 1:25 |
|  | Computers/laptop  installed with software’s | For trainee’s use | 13 pcs | 1:2 |
|  | Printer | For trainee’s use | 1 | 1:25 |

## VECTORS, MATRICES AND DATA ANALYSIS

**UNIT CODE: 0732 541 33A**

**Duration: 50 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply Vectors, Matrices and Data Analysis

**Unit Description**

This unit describes the competencies required by a technician in order to apply a wide range of mathematical skills in their work; it involves applying Apply Vectors, Matrices and Perform Statistical and probability calculations

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| **Learning Outcomes** | **DURATION (HOURS)** |
| 1. Apply Vector theory | 20 |
| 1. Carry out Matrix calculations | 10 |
| 1. Perform Statistical and probability calculations | 20 |
| **TOTALS** | **50** |

**Learning Outcomes, Content, and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcomes** | Content | **Suggested Assessment Methods** |
| 1. Apply Vector theory | * 1. Vector and Scalar Quantities      1. Definition and properties of vectors and scalars   2. Operations on Vectors      1. Vector addition, subtraction, scalar multiplication   3. Dot and Cross Products      1. Application of dot and cross products in mathematics   4. Position of Vectors      1. Representation of vectors in 2D and 3D   5. Equations of Lines and Planes      1. Vector equations for lines and planes in space | * Practical tests * Project * Portfolio of evidence * Third party report * Written tests |
| 1. Carry out Matrix calculations | * 1. Determinants and Inverses   2. 1Determinants for 2x2 and 3x3 matrices   3. Inverse of matrices   4. Simultaneous Equations      1. Solving linear systems using matrix methods (Cramer’s rule)   5. Eigenvalues and Eigenvectors      1. Eigenvalues and eigenvectors of matrices   6. Matrix Transformations      1. Applications in 2D and 3D geometry transformations | 1. Practical tests 2. Project 3. Portfolio of evidence 4. Third party report 5. Written tests |
| 1. Perform Statistical and probability calculations | * 1. Data identification, Collection and Organization      1. Methods of identifying, collecting and organizing data   2. Data presentation      1. Tables, Bar Charts, Histograms, Pie Charts, Line Graphs   3. Measures of Central Tendency      1. Mean, median, mode, and range calculations   4. Measures of dispersion      1. Range, Variance, Standard Deviation   5. Probability Laws      1. Rules of probability, including conditional probability   6. Probability Distributions      1. Normal distribution, binomial distribution, Poisson distribution   7. Sampling Distribution      1. Methods of sampling and sampling distributions   8. Confidence Intervals      1. Determining confidence intervals for population parameters   9. Hypothesis Testing   10. Testing hypotheses using large and small sample sizes   11. Correlation and Regression       1. Determining correlation coefficients       2. Simple linear regression analysis | 1. Practical tests 2. Project 3. Portfolio of evidence 4. Third party report 5. Written tests |

# MODULE VII

## MEASUREMENTS, ESTIMATION AND COSTING PRINCIPLES III

**UNIT CODE: 0732 551 36A**

**UNIT DURATION:** 60 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Perform measurements and cost estimation

**Unit Description**

This unit describes competencies required to Perform measurements and cost estimation. It involves; working up dimensions, taking off quantities, abstracting measured quantities and preparing tender documents

**Summary of Learning Outcomes**

| LEARNING OUTCOME | HOURS |
| --- | --- |
| 1.To Apply construction external work taking off principles | 20 |
| 2.To Abstract measured quantities | 20 |
| 3.To Prepare bill of quantities | 20 |
| TOTAL | 60 HOURS |

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply construction external work taking off principles | * 1. Documentation of External Works Elements      1. Identifying external works like paving, drainage, and landscaping      2. Walkways      3. Drainage systems      4. Landscaping features      5. Documenting external elements as per requirement      6. Recording structural landscaping elements   2. Quantification of External Works Elements      1. Measuring external works quantities      2. Applying standard units of measurement      3. Calculating material volumes      4. Considering environmental factors in quantity estimations   3. Booking External Works Quantities      1. Recording external elements accurately      2. Using standard booking sheets      3. Ensuring proper documentation      4. Cross-verifying with site conditions | 1. Written 2. Observation 3. Report 4. Practical |
| 1. Abstract measured quantities | |  | | --- | | * 1. Preparation of Abstracting Sheet      1. Abstracting formats      2. Organizing measurements for clarity      3. Applying SMM/CESMM standards      4. Reviewing abstracting accuracy   2. Transferring Descriptions to Abstracting Sheet      1. Copying booked item descriptions      2. Maintaining accuracy and consistency      3. Following SMM/CESMM guidelines      4. Ensuring compliance with project requirements   3. Transferring Squared Quantities to Abstracting Sheet      1. Calculating squared quantities      2. Ensuring accurate documentation      3. Using standard formats      4. Double-checking calculations for accuracy   4. Calculation of Net Quantities      1. Techniques for calculating net quantities      2. Applying SMM/CESMM methods      3. Ensuring accuracy      4. Adjusting quantities based on project variations   5. Running Through Dimensions      1. Reviewing all dimensions      2. Correcting any errors      3. Ensuring measurements are accurate      4. Confirming dimensions align with drawings | | 1. Written 2. Observation 3. Report 4. Practical |
| 1. Prepare bill of quantities | |  | | --- | | * 1. Preparation of Specifications      1. Specifications preparations         1. Material         2. Workmanship      2. Following SMM/CESMM standards      3. Cross-referencing with drawings and designs   2. Preparation of Schedule of Rates      1. Calculating rates based on abstracted quantities      2. Applying standard costing guidelines      3. Ensuring accuracy in costing      4. Adjusting rates based on project constraints   3. Preparation of Bill of Quantities      1. Compiling BOQ based on working drawings      2. Ensuring BOQ is comprehensive and accurate      3. Following standard BOQ formats      4. Reviewing BOQ for consistency with specifications | | * Written * Observation * Report * Practical |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstration
4. Group discussion
5. Direct instructions
6. Site visits

**Recommended resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks |  | 25 pcs | 1:1 |
|  | White board | For trainer’s use | 1 | - |
|  | Standard Method of Measurement (SMM) | Latest edition | 25 | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | 72 Square Meter | 1 | 1:25 |
|  | Computer Lab | 96 Square Meter | 1 | 1:25 |
|  |  |  |  |  |
| **C** | **Consumable materials** |  |  |  |
|  | Ink | Assorted Colours for trainer’s use | 500ml per term. | - |
|  | White board Marker | Refillable type | 10 pcs per term | - |
|  | Dimension papers | A4 size | 25 | 1:1 |
|  | Billing papers | A4 size | 25 | 1:1 |
| **D** | **Tools and Equipment** |  |  |  |
|  | 1 Projector | appropriate | 1 | 1:25 |
|  | calculator | scientific | 25 | 1:1 |
|  | Laptop | Intel corei5 | 1 | 1:25 |
|  | PPEs | Trainer Use (dust coat) | 1 pc | - |
|  | Pen | Trainee | 1 pc | 1:1 |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstration
4. Group discussion
5. Direct instructions
6. Site visits

**Recommended resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks |  | 25 pcs | 1:1 |
|  | White board | For trainer’s use | 1 | - |
|  | Standard Method of Measurement (SMM) | Latest edition | 25 | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | 72 Square Meter | 1 | 1:25 |
|  | Computer Lab | 96 Square Meter | 1 | 1:25 |
|  |  |  |  |  |
| **C** | **Consumable materials** |  |  |  |
|  | Ink | Assorted Colours for trainer’s use | 500ml per term. | - |
|  | White board Marker | Refillable type | 10 pcs per term | - |
|  | Dimension papers | A4 size | 25 | 1:1 |
|  | Billing papers | A4 size | 25 | 1:1 |
| **D** | **Tools and Equipment** |  |  |  |
|  | 1 Projector | appropriate | 1 | 1:25 |
|  | calculator | scientific | 25 | 1:1 |
|  | Laptop | Intel corei5 | 1 | 1:25 |
|  | PPEs | Trainer Use (dust coat) | 1 pc | - |
|  | Pen | Trainee | 1 pc | 1:1 |

## HIGHWAY ENGINEERING STRUCTURES DESIGN II

**UNIT CODE: 0732 551 34A**

**UNIT DURATION:** 150Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Design highway Engineering Structures II

**Unit Description**

This unit specifies the competencies required to design civil engineering structures. It involves

Designing timber structures and steel structures

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| Learning Outcomes | **DURATION (HOURS)** |
| 1. Design timber structures | **75** |
| 1. Design steel structures | **75** |
| **TOTAL** | 150 **HOURS** |

1. **Learning Outcomes, Content and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Design timber structures | * 1. Use of BS 5268   2. Stress grading, grade stress and strength class, permissible stress.   3. Design of structural timber elements:   1.3.1 Timber beams  1.3.2 Timber joists  1.3.3 Timber columns   * 1. Determination of appropriate timber sections | * Written * Observation * Report * Practical |
| 1. Design steel structures | * 1. Use of BS 5950   2. Gathering steel sections   3. Calculation of load for roof trusses   4. Design of structural members      1. Beam,      2. Column   5. Detailing of structural steel work connections | 1. Written 2. Observation 3. Report 4. Practical |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstration
4. Group discussion
5. Direct instructions
6. Site visits

**Recommended Resources for 25 Trainees**

| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Textbooks on Structural Design | For trainee’s use | 14 | 1:2 |
|  | Rulers | For trainer’s use | 2 pcs each | 2:1 |
|  | Excel design sheets | For trainee’s use | 25 pcs | 1:1 |
|  | Building Drawings samples | For both trainer’s and trainee’ use | 25 pcs | 1:1 |
|  | Design manuals (BS 6399 – Loads, BS 5268 Timber design, BS 5950 steel design) | For both trainer’s and trainee’ use | 25 pcs | 1:1 |
|  | Material Specification Samples | For both trainer’s and trainee’ use | 25 pcs | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Training room | 9m by 8m | 1 | 1:25 |
|  | Computer lab | 9m by 8m | 1 | 1:25 |
|  | Computers with design software (AutoCAD Civil 3D, REVIT, StaadPro, Etabs or equivalent) | For trainer and trainee use | 25 | 1:1 |
|  | Projector | For trainers use | 1 pc | 1:25 |
|  | Plotters | For trainers and trainees use | 1 pc | 1:25 |
|  | Printers | For trainers and trainees use | 1 pc | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Assorted colour of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
|  | Pens, pencils, erasers | For trainee’s use | 1pc | 25:1 |
|  | A3 printing papers |  |  |  |
| **D** | **Tools and Equipment** | | | |
|  | Bar bending schedules | For trainee’s use | 25 pcs | 1:1 |
|  | Steel Bending Equipment | For trainee’s use | 25 pcs | 1:1 |

## HIGHWAY ENGINEERING PROJECTS SUPERVISION

**UNIT CODE: 0732 551 35A**

**UNIT DURATION: 120 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Supervise highway engineering projects

**Unit Description**

This unit describes the competencies required to supervise highway engineering projects.

It involves Implementing project timelines, executing construction project quality control, coordinating project site activities and human resources, managing project cost, coordinating project labour, managing project labour, implementing project contract and Managing construction materials, plant, tools and equipment

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| Learning Outcomes | DURATION (HOURS) |
| 1. Implement project timelines | 20 |
| 1. Execute construction project quality control | 20 |
| 1. Coordinate project site activities and human resources | 20 |
| 1. Manage project cost | 10 |
| 1. Coordinate project labour | 20 |
| 1. Implement project contract | 10 |
| 1. Manage construction materials, plant, tools and equipment | 20 |
| TOTAL | 120 |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Implement project timelines | * 1. Meaning of statutory bodies   2. Types of statutory bodies and their legal requirements      1. Government agencies, regulatory bodies, and licensing authorities (e.g., NEMA, OSHA, local planning authorities)   3. Types of project approvals      1. Environmental Approvals: Permits and assessments related to environmental impact (e.g., EIA approval)      2. Planning and Zoning Approvals: Permissions for land use, building construction, and zoning changes      3. Health and Safety Approvals: Compliance with workplace safety regulations and construction site standards      4. Building and Construction Permits: Approvals for the design, construction, and renovation of buildings      5. Utility Approvals: Permissions for connecting to or modifying utility services (e.g., water, electricity, drainage)   4. Project approvals procedures   5. Functions of statutory approval documents   6. Project work schedule   7. Classification of project activities      1. Primary Activities: Core tasks essential to completing the project (e.g., construction, design work)      2. Supporting Activities: Tasks that support the primary activities (e.g., procurement, logistics)      3. Administrative Activities: Organizational and management tasks (e.g., documentation, approvals)      4. Critical Activities: Tasks that must be completed on time to avoid delays in the project timeline   8. Inter-relationship of project activities   9. Definition of project time programme   10. Project work programming tools   11. Process of allocating activity timelines       1. Critical path method       2. PERT chart       3. Gantt charts   12. Importance of reviewing previous similar jobs   13. Sources of information       1. Historical Data: Data from similar projects, including timeframes, resource usage, and outcomes       2. Expert Advice: Consultations with industry professionals and project managers       3. Government and Regulatory Sources: Guidelines, regulations, and requirements from statutory bodies       4. Project Stakeholders: Input from team members, clients, and contractors involved in past projects   14. Project planning management phases | * Observation * Oral questioning * Projects * Written tests * Third party * Portfolio |
| 1. Execute construction project quality control | * 1. Definition of quality   2. Code of professional conduct and ethics   3. Importance of quality in a project   4. Contract documents      1. Agreement      2. General Conditions of Contract      3. Special Conditions of Contract      4. Bill of Quantities (BoQ)      5. Drawings and Specifications      6. Tender Documents      7. Contractor’s Proposal or Bid      8. Schedule of Works or Program      9. Performance Bond or Guarantee      10. Insurance Certificates      11. Change Orders or Variations      12. Completion Certificate   5. Project activities   6. Site dynamics   7. Development of quality checklists   8. Project quality plan   9. Project quality control plan   10. Work quality inspection   11. Principles of work quality control   12. Site information documentation methods   13. Features of a project quality report       1. Project Overview       2. Quality Objectives       3. Quality Assurance and Control Processes       4. Inspection and Testing Procedures       5. Non-Conformance Reports       6. Corrective Actions       7. Quality Audits       8. Compliance with Standards and Regulations       9. Materials and Equipment Quality       10. Personnel Qualifications and Training       11. Project Performance Metrics       12. Recommendations for Improvement   14. Report writing | * Observation * Oral questioning * Projects * Written tests * Third party * Portfolio |
| 1. Coordinate project site activities and human resources | * 1. Legal frameworks (County authority regulations, NEMA, WARMA, NCA)   2. Environmental Management Policies   3. Communication channels   4. Safety and security inspections   5. Project site security   6. Project risk analysis and management   7. Report writing | * Observation * Oral questioning * Projects * Written tests * Third party * Portfolio |
| 1. Manage project cost | * 1. Project budgeting   2. Analysis of contract documents   3. Cost risk analysis   4. Project activities   5. Resource schedules   6. Procurement laws and regulation   7. Material handling and wastage management   8. Warehousing and storage   9. Resource utilization monitoring tools   10. Resource utilization analysis   11. Project resource utilization report   12. Project cost variation   13. Variation and price fluctuations analysis   14. Features of a project financial report   15. Preparation of a project financial report | * Observation * Oral questioning * Projects * Written tests * Third party * Portfolio |
| 1. Coordinate project labor | * 1. Code of professional conduct and ethics   2. Definition of project human resources   3. Identification of legislations affecting the management of human resources (labour laws)   4. Communication channels   5. Project human resource requirements   6. Human resource planning process   7. Review of the human resource plan   8. Staff welfare   9. Human resource record keeping   10. Confidentiality of information   11. Retention policy | * Observation * Oral questioning * Projects * Written tests * Third party * Portfolio |
| 1. Implement project contract | * 1. Identification of contract documents and their functions   2. Types of contracts      1. Lump Sum Contract      2. Unit Price Contract      3. Cost-Plus Contract      4. Time and Materials Contract      5. Design and Build Contract      6. Management Contract      7. Target Cost Contract      8. J.V (Joint Venture) Contract      9. Subcontract      10. Negotiated Contract   3. Law of contract and tort   4. Conflict management   5. Regulatory bodies      1. National Construction Authority (NCA)      2. Building and Construction Authority (BCA)      3. Institute of Engineers (IEK)      4. Kenya Bureau of Standards (KEBS)      5. Environmental Management and Coordination Authority (EMCA)      6. Public Procurement Regulatory Authority (PPRA)      7. Occupational Safety and Health Administration (OSHA)      8. National Environmental Management Authority (NEMA)      9. Energy Regulatory Commission (ERC)      10. Local Government Authorities (Municipal/County)   6. Process of approval      1. Project Proposal Submission      2. Review of Application      3. Compliance Check      4. Site Inspection      5. Preparation of Approval Report      6. Approval of Plans and Documents      7. Issuance of Approval Certificate      8. Public Notification (if required)      9. Permit Issuance      10. Project Commencement   7. Development of a project documentation register   8. Updating project register   9. Confidentiality of the information in the register   10. Security of the register   11. Project stakeholders       1. Identification and classification of stakeholders       2. Roles of each stakeholder during the life of the project       3. Types of stakeholders’ contracts       4. Stakeholders’ engagement plan development and review   12. Project work plan   13. Project works inspection plan   14. Projects work inspection report writing   15. Communicating channels   16. Project implementation report | * Observation * Oral questioning * Projects * Written tests * Third party * Portfolio |
| 1. Manage construction materials, plant, tools and equipment | * 1. Building Plant, Tools, and Equipment      1. Building Plant: Machinery used for construction, such as cranes, excavators, and bulldozers, which are essential for large-scale operations.      2. Tools: Hand tools and power tools, including hammers, drills, saws, and measuring instruments, used for smaller tasks and finishing work.      3. Equipment: Larger machinery such as mixers, generators, scaffolding, and compactors, which aid in both construction and material handling.      4. Purpose: Effective utilization and management of these resources ensure project efficiency, safety, and timely completion.   2. Types of Building Materials      1. Natural Materials: Wood, stone, clay, and sand, which are sourced directly from nature and used in their raw form.      2. Manufactured Materials: Concrete, steel, glass, and synthetic materials that undergo processing for specific construction purposes.      3. Composite Materials: Materials like reinforced concrete, which are created by combining two or more different materials to enhance performance.      4. Finishing Materials: Paints, tiles, plaster, and flooring materials used to complete the appearance of the building.      5. Sustainable Materials: Eco-friendly materials such as recycled steel, bamboo, or low-carbon concrete, used to minimize environmental impact.   3. Standard Material Schedule      1. Definition: A detailed document that outlines the materials required for the construction project, specifying quantities, types, and quality standards.      2. Purpose: To help project managers and procurement teams order the right materials in advance, ensuring there are no delays or shortages during construction.      3. Key Components: Material types, quantities, delivery schedules, and cost estimates.   4. Standard Material Rates      1. Definition: Pre-determined cost rates for various building materials, which are used for budgeting and cost estimation purposes.      2. Purpose: To ensure consistent pricing across the project and to help with cost control and financial planning.      3. Sources: Material rates can be derived from market surveys, suppliers' quotes, and historical data from previous projects.   5. Types of Equipment      1. Heavy Equipment: Includes bulldozers, cranes, excavators, backhoes, and loaders, used for large-scale tasks such as excavation and material handling.      2. Construction Equipment: Smaller machinery such as cement mixers, compactors, and generators used for day-to-day construction operations.      3. Specialized Equipment: Includes scaffolding, formwork, and concrete pumps, tailored to specific needs of the project.      4. Transportation Equipment: Trucks, wheelbarrows, and conveyor belts used for moving materials within the site.      5. Maintenance Equipment: Tools and machines used for maintaining and repairing construction plant and equipment.   6. Standard Equipment Schedule      1. Definition: A document listing all the equipment needed for a project, including specifications, quantity, expected usage, and maintenance schedule.      2. Purpose: To ensure that all required equipment is available and operational for the duration of the project, minimizing downtime.      3. Components: Equipment types, usage duration, maintenance timelines, and handling procedures.   7. Verification of Materials      1. Definition: The process of checking materials upon delivery to ensure they conform to the specified standards and quality.      2. Methods: Visual inspection, material testing, and comparison with project specifications or supplier documentation.      3. Purpose: To ensure that only acceptable materials are used in construction, preventing future defects or safety issues.   8. Recording      1. Definition: Keeping detailed records of all materials, tools, and equipment used on the project, including receipts, usage logs, and inventory lists.      2. Purpose: Accurate recording ensures traceability of materials, helps with stock management, and aids in project audits and cost control.      3. Types of Records: Material delivery logs, equipment usage records, maintenance logs, and inventory tracking systems.   9. Issuing of Materials      1. Process: The procedure of distributing materials to various construction teams as required for their tasks.      2. Procedure: Materials should be issued based on project schedules and needs, ensuring the right quantities are allocated at the correct time.      3. Records: Issuing logs should document the material type, quantity, recipient, and purpose of usage.   10. Plant, Tools, and Equipment Maintenance       1. Importance: Regular maintenance ensures the proper functioning of equipment, reduces the risk of breakdowns, and extends the lifespan of plant and tools.       2. Routine Maintenance: Includes daily checks, cleaning, lubrication, and safety inspections.       3. Preventative Maintenance: Scheduled inspections and repairs to avoid equipment failures.       4. Repairs and Replacements: Any worn-out or damaged tools and equipment must be repaired or replaced to maintain operational efficiency.       5. Documentation: Maintenance records and logs must be maintained to track repairs, service dates, and the condition of equipment. | * Observation * Oral questioning * Projects * Written tests * Third party * Portfolio |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussions
5. Direct instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Project management Textbooks | For trainee’s use | 14 | 1:2 |
|  | Rulers | For trainer’s use | 2 pcs each | 2:1 |
|  | Project Management Guides | For trainee’s use | 25 pcs | 1:1 |
|  | Building Drawings samples | For both trainer’s and trainee’ use | 25 pcs | 1:1 |
|  | Technical Drawing and CAD Manuals | For both trainer’s and trainee’ use | 25 pcs | 1:1 |
|  | Notebooks and Project Files |  |  |  |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Technical Drawing room | 9m by 8m | 1 | 1:25 |
|  | Computer with CAD Software Licenses | For trainer and trainee use | 25 | 1:1 |
|  | Projectors |  |  |  |
| **C** | **Consumable materials** | | | |
|  | Assorted colour of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
| **D** | **Tools and Equipment** | | | |
|  | Safety Gear (helmets, gloves, vests) | For trainee’s use | 25 pcs | 1:1 |

## RESEARCH PROJECT II

**UNIT CODE: 0732 551 38A**

**UNIT DURATION:** 60 HOURS

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Conduct Research Project II

**Unit Description**

This unit specifies the competencies required to Conduct Research Project**.** It involves collecting project data, analyzing project data, presenting project report, developing proposed project models.

**Summary of Learning Outcomes**

|  |  |
| --- | --- |
| Learning Outcomes | **DURATION (HOURS)** |
| 1.Collect project data | **10** |
| 3. Analyse project data | **10** |
| 4. Present project report | **10** |
| 5. Develop proposed project model | **10** |
| **TOTAL** | 40 **HOURS** |

**Learning Outcomes, Content and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Collect project data | * 1. Data Collection Tools      1. Survey/questionnaire design      2. Interview guidelines      3. Data logging systems   2. Identification of Performance Indicators      1. Key performance metrics      2. Selection of measurable outputs      3. Baseline and benchmark data   3. Conducting Project Performance Tests      1. Testing procedures      2. Equipment and tools for data collection      3. Recording test results   4. Data Collection Based on Performance Indicators      1. Data gathering methods      2. Ensuring data reliability      3. Collecting both qualitative and quantitative data   5. Data Analysis and Presentation      1. Organizing data sets      2. Selection of statistical software/tools      3. Graphical representation of data | * Practical tests * Project * Portfolio of evidence * Third party report * Written tests |
| 2. Analyze project data | * 1. Selection of Analysis Methods      1. Choosing between qualitative and quantitative methods      2. Statistical techniques      3. Software/tools for analysis   2. Verification of Data Accuracy and Consistency      1. Cross-checking with initial tests      2. Identifying outliers and anomalies      3. Ensuring data integrity   3. Comparison of Results with Performance Indicators      1. Measuring results against benchmarks      2. Identifying deviations      3. Analyzing causes for performance variations   4. Determination of Statistical Significance      1. Applying statistical significance tests      2. Interpreting p-values and confidence intervals      3. Evaluating hypothesis results | * Practical tests * Project * Portfolio of evidence * Third party report * Written tests |
| 3. Present project report | * 1. Compilation of Project Report      1. Structuring the report (Introduction, Methodology, Results)      2. Including references and citations      3. Summarizing findings and conclusions   2. Presentation of Project Report      1. Preparing presentation slides      2. Oral presentation techniques      3. Responding to audience questions   3. Ethical Standards in Reporting      1. Adhering to ethical guidelines      2. Avoiding plagiarism      3. Ensuring transparency and honesty in reporting | * Practical tests * Project * Portfolio of evidence * Third party report * Written tests |
| 4.Develop proposed project model | |  | | --- | | * 1. Preparation of Project Design      1. Creating project sketches or blueprints      2. Defining design specifications      3. Aligning with engineering standards   2. Work Plan Schedule      1. Creating a timeline for execution      2. Assigning tasks and milestones      3. Tracking progress   3. Preparation of Tools and Materials      1. Listing required materials      2. Sourcing tools and equipment      3. Managing project resources   4. Development of Project Model      1. Building the physical or conceptual model      2. Testing and validating model performance      3. Documenting model development process | | * Practical tests * Project * Portfolio of evidence * Third party report * Written tests |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstration
4. Group discussion
5. Direct instructions

| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| --- | --- | --- | --- | --- |
| **A** | **Learning Materials** | | | |
|  | Rolls Flip Charts | For both trainer’s and trainee’ use | 5 pcs | 1:5 |
|  | Reference books: citation guides | For trainee’s use | 25 | 1:1 |
|  | Blue prints and sample plans | For trainee’s use | 25 | 1:1 |
|  | Scale Rulers, protractors and compasses, set-squares | For trainer’s use | 2 pcs each | 2:1 |
|  | Graph papers | For trainee’s use | 25 pcs | 1:1 |
|  | Drawings samples | For both trainer’s and trainee’ use | 25 pcs | 1:1 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Whiteboards | For trainer’s use | 1 pc | 1:25 |
|  | Chalkboard | For trainer’s use | 1 pc | 1:25 |
|  | Classroom | 9m by 8m | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Assorted colour of whiteboard markers | For trainee’s use | 10 pcs | 10:1 |
|  | Stationery | For trainee’s use | 25 pcs | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Scientific calculator | For trainee’s use | 25 pcs | 1:1 |
|  | Projector | For trainee’s use | 1 pcs | 1:25 |
|  | Computers/laptop  installed with software’s | For trainee’s use | 13 pcs | 1:2 |
|  | Printer | For trainee’s use | 1 | 1:25 |