

**REPUBLIC OF KENYA**

**COMPETENCY-BASED MODULAR CURRICULUM**

**FOR**

**CONSTRUCTION PLANT TECHNOLOGY**

**KNQF LEVEL 6**

**ISCED PROGRAMME CODE: 0716 554A**

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# FOREWORD

The provision of quality education and training is fundamental to the Government’s overall strategy for social and economic development. Quality education and training contribute to the achievement of Kenya’s development blueprint and sustainable development goals.

Reforms in the education sector are necessary to achieve Kenya Vision 2030 and meet the provisions of the Constitution of Kenya 2010. The education sector had to be aligned to the Constitution, and this resulted in the formulation of the Policy Framework for Reforming Education and Training in Kenya (Sessional Paper No. 14 of 2012). A key feature of this policy is the radical 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 the mode of delivery allow for multiple entry and exit in TVET programmes.

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 in developing competent human resources for the Mechanical Engineering Sector’s growth and 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.

# ACKNOWLEDGMENT

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 Engineering and Manufacturing 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 Plant Engineering 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 Plant Engineering Sector acquire competencies to perform their work more efficiently and effectively.

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# ABBREVIATIONS AND ACRONYMS

CBET Competency Based Education and Training

TVET Technical and Vocational Education and Training

RAM Random Access Memory

DVD Digital Versatile Disk

HDMI High-Definition Multimedia Interface

DVI Digital Visual Interface

VGA Video graphics Array

USB Universal Serial Bar

ISCED International Standard Classification of Education

IEEE Institute of Electrical and Electronics Engineers

PPE Personal Protective Equipment

PLC Programmable Logic Controller

PCB Printed Circuit Board

LCD Liquid Crystal Display

LED Light Emitting Diode

ADC Analog-to-Digital Converter

DAC Digital-to-Analog Converter

IC Integrated Circuit

TRIAC Triode for Alternating Current

MOSFET Metal-Oxide-Semiconductor Field-Effect Transistor

BJT Bipolar Junction Transistor

RC Resistor Capacitor

RL Resistor Inductor

DC Direct Current

EMF Electromotive Force

MMF Magnetomotive Force

EV Electric Vehicle

SOC State of Charge

AC Alternating Current

KVL Kirchhoff's Voltage Law

KCL Kirchoff's Current Law

CV Curriculum Vitae

# KEY TO ISCED UNIT CODE



# COURSE OVERVIEW

This curriculum is designed to equip Construction Plant Technology Level 6 with the competencies required to: maintain construction plant hydraulic system, maintain construction plant engine, maintain construction plant brake system, maintain construction plant transmission system, maintain construction plant under carriage, maintain construction plant steering and suspension systems, maintain construction plant electronic control unit, and maintain construction plant attachments.

The course consists of basic, common and core units of learning as indicated hereafter:

The units of competency comprising Construction Plant Technology Certificate Level 6 qualifications include the following competencies:

**Units of Learning**

|  |  |  |  |
| --- | --- | --- | --- |
| **MODULE I** | | | |
| **Unit Code** | **Units Title** | **Unit Duration (Hours)** | **Credit Factor** |
| **MODULE I** | | | |
| **BASIC UNIT OF LEARNING** | | | |
| 0611451 01A | Digital Literacy | 40 | 4.0 |
| **COMMON UNITS OF LEARNING** | | | |
| 0715 451 02A | Workshop Technology | 80 | 8.0 |
| 0732 441 03A | Technical Drawing | 80 | 8.0 |
| **CORE UNIT OF LEARNING** | | | |
| 0716451 04A | Construction Plant Engines Maintenance | 160 | 16.0 |
| **MODULE II** | | | |
| **BASIC UNIT OF LEARNING** | | | |
| 0031441 05A | Communication Skills | 40 | 4.0 |
| **COMMON UNIT OF LEARNING** | | | |
| 0541 441 06A | Applied Mathematics | 80 | 8.0 |
| 0713441 07A | Electrical and Electronics Principles | 80 | 8.0 |
| **CORE UNIT OF LEARNING** | | | |
| 0716451 08A | Construction Plant Hydraulic System maintenance | 160 | 16.0 |
| **MODULE III** | | | |
| **BASIC UNIT OF LEARNING** | | | |
| 0413441 09A | Entrepreneurial Skills | 40 | 4.0 |
| **CORE UNITS OF LEARNING** | | | |
| 0716 451 10A | Construction Plant Transmission System maintenance | 160 | 16.0 |
| 0716 451 11A | Construction Plant Brake System maintenance | 150 | 15.0 |
| **MODULE IV** | | | |
| **BASIC UNIT OF LEARNING** | | | |
| 0417441 12A | Work Ethics and Practices | 40 | 4.0 |
| **COMMON UNIT OF LEARNING** | | | |
| 0715 441 13A | Mechanical science | 80 | 8.0 |
| **CORE UNIT OF LEARNING** | | | |
| 0716 451 14A | Construction Plant Steering and Suspension Systems maintenance | 150 | 15.0 |
| **MODULE V** | | | |
| **COMMON UNITS OF LEARNING** | | | |
| 0541 541 15A | Engineering Mathematics | 100 | 10.0 |
| 0715 541 16A | Engineering Mechanics | 80 | 8.0 |
| 0715 541 17A | Thermodynamics and fluid mechanics | 140 | 14.0 |
| **CORE UNIT OF LEARNING** | | | |
| 0716 551 18A | Construction plant attachments. | 160 | 16.0 |
| **MODULE VI** | | | |
| **COMMON UNIT OF LEARNING** | | | |
| 0732 551 19A | computer aided drawing | 140 | 14.0 |
| **CORE UNIT OF LEARNING** | | | |
| 0716 551 20 A | Construction Plant Undercarriage Maintenance | 180 | 18.0 |
| **MODULE VII** | | | |
| **COMMON UNIT OF LEARNING** | | | |
| 0713 541 21A | Electronics and Control Principles | 160 | 16.0 |
| **COMMON UNIT OF LEARNING** | | | |
| 0716 551 22A | Construction Plant Electrical Systems Maintenance | 180 | 18.0 |
|  | **INDUSTRIAL ATTATCHMENT** | **480** | **48.0** |
|  | **GRAND TOTAL** | **2960** | **29.6** |

**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) or KCE Division III

Or

1. Equivalent qualification as determined by TVETA.

**Trainer Qualification**

Qualifications of a trainer for this course include:

1. Possession of at least higher qualification than Construction Plant KNQF Level 6 or in a related trade area.
2. Licensed by TVETA
3. Registered by Engineer Board of Kenya (E.B.K) or Kenya Engineering Technology Registration Board (KETRB).

**Industry Training**

An individual enrolled in this course will be required to undergo Industry training for a minimum period of 480 hours in a Construction plant 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**

This course will be assessed in both formative and summative as follows;

1. During formative assessment, all performance criteria shall be assessed based on performance criteria weighting.
2. Summative assessment shall focus on critical aspects of the unit of competency.
3. Theory and practical weight shall be as follows:
   1. 10:90 for unit in module 1 and module 2 for each unit of learning.
   2. 30:70 for units in module 3 and module 4 for each unit of learning.
   3. 40:60 for units in module 5 and 6 for each unit of learning.
4. Formative and summative assessment weight shall constitute 60% and 40% of the overall score, respectively.
5. For a candidate to be declared competent in a unit of competency, a candidate shall meet the following conditions:
6. Obtained at least 40% in theory assessment in formative and summative assessments
7. Obtained at least 50% in practical assessment, in formative and summative assessment where applicable.
8. Obtained at least 50% in the weighted results between formative assessment and summative assessment, where the former constitutes 60% and the latter and the latter 40% of the overall score.
9. Assessment performance rating for each of the unit of competence shall be as follows:

|  |  |
| --- | --- |
| **MARKS** | **COMPETENCE RATING.** |
| 80-100 | Mastery |
| 65-79 | Proficiency |
| 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 KenyaNational Certificate in Construction Plant Technology Level 6 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 I

# DIGITAL LITERACY

**ISCED UNIT CODE: 0611 451 01A**

**Relationship with Occupational Standards**

This unit addresses the Unit of Competency: Apply Digital Literacy

**Duration of Unit: 40 Hours**

**Unit Description**

This unit covers the learning outcomes 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 and job entry techniques, and performing jobs online.

**Summary of Learning Outcomes**

By the end of this unit of learning, the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Operate computer devices | 6 |
|  | Solve tasks using office suite | 14 |
|  | Manage data and information | 6 |
|  | Perform online communication and collaborations | 4 |
|  | Apply cybersecurity skills | 4 |
|  | Perform online jobs | 4 |
|  | Apply job entry techniques. | 2 |
| **Total** | | **40** |

**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) | 1. Observation 2. Written assessment 3. Oral assessment 4. 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, SumIF, 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 presentations       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       1. Applying slide effects and transitions       2. Check and deliver          1. Spell check a presentation          2. Slide orientation          3. Slide shows, navigation   26. Print presentations (slides and handouts) | * Observation * Written * Practical assessment * Portfolio of Evidence * Project * 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. News Group      8. Ecommerce   4. Types of Internet Access Applications   5. Web browsing concepts      1. Key concepts      2. Security and safety   6. Web browsing      1. Using the web browser      2. Tools and settings      3. Clearing Cache and cookies      4. URIs      5. Bookmarks      6. Web outputs   7. Web based information      1. Search      2. Critical evaluation of information      3. Copyright, data protection   8. Downloads Management   9. Performing Digital Data Backup (Online and Offline)   10. Emerging issues in internet | * Observation * Portfolio of Evidence * Project * Written assessment * Practical 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      1. Common setup features      2. Setup   7. Mobile collaboration      1. Key concepts      2. Using mobile devices      3. Applications      4. Synchronization | * Observation * Written * Practical assessment * Portfolio of Evidence * Project * 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 * Written * Practical assessment * Portfolio of Evidence * Project * assessment |
| 1. Perform Online Jobs | * 1. Introduction to online working   2. Types of online Jobs   3. Online job platforms      1. Remotask      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 * Written * Practical assessment * Portfolio of Evidence * Project * assessment |
| 1. Apply job entry techniques | * 1. Types of job opportunities      1. Self-employment      2. Service provision      3. product development      4. salaried employment         1. Sources of job opportunities   2. Resume/ curriculum vitae      1. What is a CV      2. How long should a CV be      3. What to include in a CV      4. Format of CV      5. How to write a good CV      6. Don’ts of writing a CV   3. Job application letter      1. What to include      2. Addressing a cover letter      3. Signing off a cover letter   4. Portfolio of Evidence      1. Academic credentials      2. Letters of commendations      3. Certification of participations      4. Awards and decorations   5. Interview skills      1. Listening skills      2. Grooming      3. Language command      4. Articulation of issues      5. Body language      6. Time management      7. Honesty   6. Generally knowledgeable in current affairs and technical area | * + Observation   + Written   + Practical assessment   + Portfolio of Evidence   + Project   + assessment |

**Suggested Methods Instruction**

* + Instructor-led facilitation using active learning strategies
  + Demonstration
  + Practical
  + Viewing of related videos
  + Group discussions
  + Project
  + Role play
  + Case study

**Recommended Resources for 30 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | Comprehensive texts books on Digital Literacy | 30 pcs | 1:1 |
|  | Installation Manuals | Detailed guides for equipment and software installation and troubleshooting | 5 pcs | 1:6 |
|  | PowerPoint Presentations | For trainer’s use, covering course content and practical applications |  |  |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:30 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:30 |
|  | Printer | An ink-jet, laser-jet or toner-cartridge printer for printing notes, instructions and working drawings | 1 | 1:30 |
|  | Templates | Templates for creating various documents e.g. CV, Cover Letter, etc. | 30 | 1:1 |
| **B** | **Learning Facilities & Infrastructure** |  |  |  |
|  | Lecture/Theory Room  /Learning Resource  Area\* | Spacious, equipped with projectors and Seats for 30 trainees, approximately 45 sqm (5 m x 9 m) | 1 | 1:30 |
|  | Computer Laboratory | Equipped with at least 30 functional computers with internet connectivity and the following software:   * + - Windows/ Linux/ Macintosh Operating System     - Microsoft Office Software     - Google Workspace Account     - Antivirus Software | 30 | 1:1 |
|  |  |  |  |  |
| **C** | **Consumable Materials** |  |  |  |
|  | Printing Papers | A4 and A3 Printing papers suitable for the task | Enough |  |
|  | Whiteboard Marker Pens | Dry-erase markers for trainers use. Assorted colors | Enough |  |
|  | Storage devices | Any of the following storage devices:   * USB Flash Drive * USB Hard Drive * Compact Disks (CDs) * Digital Versatile Disks (DVDs) | Enough |  |

# WORKSHOP TECHNOLOGY

**UNIT CODE: 0715 441 02A**

**Relationship with Occupational Standards:**

This unit addresses the unit of competency: Apply workshop technology

**Duration of Unit:** 80 Hours

**Unit description**

This unit describes the competencies required by a technician in order to apply workshop practice in their work. It includes applying workshop safety, material science principles and workshop tools and equipment, carryout metal joining processes. It also includes performing material preservation and Applying workshop organisation techniques house keeping

**Summary of Learning Outcomes**

By the end of this unit of learning, the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Apply workshop safety | 5 |
|  | Apply material science principles | 10 |
|  | Apply workshop tools and equipment | 10 |
|  | Carry out metal joining processes | 20 |
|  | Perform material preservation | 20 |
|  | Apply workshop organization techniques | 15 |
| **Total** | | **80** |

**Learning Outcomes, Content and suggested assessment methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** | |
| --- | --- | --- | --- |
| 1. Apply workshop safety | * 1. Workshop safety      1. Workshop safety definition      2. Types and uses of PPE’s   2. Emergency responses steps      1. Common emergencies         1. Fire         2. Chemical spills         3. Injuries   3. Fire safety      1. Fire extinguishers types and uses      2. Flammable materials identification      3. Fire prevention   4. Safe handling and disposal of chemicals and materials      1. Chemical hazard identification      2. Safe handling procedure      3. Storage and labelling of chemicals      4. Chemical disposal procedures      5. Emergency response for chemical exposure   5. Identifying and marking hazardous zones      1. Common hazardous zones         1. Flammable zones         2. High traffic zones         3. Electrical hazard zones         4. Chemical storage areas   6. Work area organization and maintenance      1. Setting up      2. Proper storage and labelling of tools and equipment   7. Workplace hazards      1. Physical hazards         1. Noises         2. Vibration         3. Heat         4. Sharp object      2. Chemical hazards         1. Fuels         2. Oils         3. Cleaning agents      3. Electric hazards         1. Live wires         2. Batteries         3. Electrical systems   8. Workshop accidents, causes and prevention      1. Near Accident      2. Trivial Accident      3. Minor Accident      4. Serious Accident      5. Fatal Accident: | * Written tests. * Practical * Project * Portfolio of evidence * Third party report |
| 1. Apply material science principles | * 1. Material science principles      1. Definition      2. Importance of material science in engineering   2. Engineering materials Classification and characteristics      1. Metals      2. Polymers      3. Ceramics   3. Properties of engineering materials      1. Mechanical properties         1. Strength         2. Hardness         3. Toughness         4. Malleability         5. Ductility         6. Rigidity      2. Thermal properties         1. Specific heat         2. Thermal expansion      3. Chemical properties         1. Corrosion resistance      4. Electrical properties         1. Electrical conductivity         2. Insulation properties   4. Material selection for engineering materials      1. Factors to consider   5. Material handling safety      1. Handling metals and alloys      2. Chemical and fuels      3. Safety measures for plastics and composites      4. Electrical safety and conductive materials | * Practical * Project * Portfolio of evidence * Third party report * Written tests. |
| 1. Apply Workshop tools and equipment | * 1. Tools and equipment safety and maintenance practices      1. Inspection      2. Safe handling techniques   2. Technical drawing interpretation      1. Purpose of assembly drawing      2. Bill of quantity      3. Assembly instructions   3. Workshop tools and equipment uses and maintenance      1. Measuring tools         1. Tape measure         2. Steel rule         3. Callipers         4. Micrometer gauge         5. Protractor         6. Spirit level         7. Dial indicator         8. Torque wrench      2. Marking out tools         1. Scriber         2. Marking gauge         3. Combination square      3. Cutting tools         1. Hacksaw         2. Chisel         3. Files         4. Scissors      4. Fitting tools         1. Wrenches         2. Sockets         3. Pliers         4. Hammers         5. Punch         6. Tap and die      5. Forging tools         1. Anvil         2. Hammers         3. Tongs         4. Swage block      6. Sheet metal tools         1. Shears         2. Tin snips         3. Rivet gun         4. Vise      7. Workshop machine         1. Grinding machine         2. Arc welding machine         3. Gas welding machine         4. Drilling machine | * Written tests * Practical * Project * Portfolio of evidence * Third party report |
| 1. Carry out metal joining processes | * 1. Observation of safety      1. Safety gears      2. Machine operation manuals   2. Metal joining methods      1. Welding         1. Arc welding         2. Gas welding      2. Riveting      3. Fastening   3. Material preparation      1. Measuring      2. Marking out   4. Process of metal finishing      1. Grinding      2. Filing      3. Polishing | * Practical * Project * Portfolio of evidence * Third party report * Written tests. |
| 1. Perform engineering material preservation | * 1. Material preservation      1. Definition of material preservation      2. Importance of material preservation      3. Storage techniques      4. Material preservation safety measures   2. Common preservation methods      1. Protective coatings      2. Chemical treatments      3. Controlled storage conditions      4. Proper handling techniques      5. Cleaning and maintenance   3. Material preservation procedure      1. Work requirements assessment      2. Selection of appropriate preservation method | * Practical * Project * Portfolio of evidence * Third party report * Written tests. |
| 1. Apply workshop organisation techniques | * 1. Workshop layout      1. Types of workshop layout         1. Fixed layout         2. Process layout         3. Line layout         4. Operation layout         5. Combination/group layout      2. Safety signs      3. Emergency exits   2. Management inventory      1. Types of inventories      2. Record keeping      3. Job card preparation   3. Maintenance schedules      1. Goals of maintenance schedule         1. Reactive         2. Equipment failure         3. Maintenance backlog      2. Types of maintenance         1. Preventive maintenance         2. Corrective maintenance         3. Condition based maintenance         4. Predictive maintenance         5. Break down maintenance   4. Housekeeping      1. Definition      2. Importance of housekeeping   5. Housekeeping activities and their Importance      1. Tool and equipment organization      2. Work area cleanliness      3. Safe handling and disposal of hazardous materials      4. Inspection and maintenance of equipment      5. Personal protective equipment management      6. Air and ventilation maintenance      7. Incident prevention and reporting   6. Housekeeping tools and equipment      1. Uses and maintenance         1. Brooms and brushes         2. Dustpans and squeegees         3. Vacuum cleaners         4. Mops and mop buckets         5. Waste bins and recycling containers   7. Housekeeping materials      1. Cleaning cloths and rags      2. Cleaning agents and solvents      3. Lubricants      4. Gloves and PPE’s      5. Disposable bags and liners   8. Workshop waste sorting and disposal      1. Types of waste         1. General waste         2. Hazardous waste         3. Recyclable waste         4. Organic waste         5. e-waste      2. Waste sorting procedure         1. Designated bins for different types of waste         2. Sorting by material         3. Pre-sorting hazardous waste      3. Hazardous waste disposal         1. Chemical waste         2. Used oil and solvents         3. Paints and finishes | * Practical * Project * Portfolio of evidence * Third party report * Written tests. |

**Suggested Delivery Methods**

* Demonstration
* Discussions
* Practical
* Exercises
* Industrials visits
* Simulation

**List of Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Learning Materials** |
|  | Textbooks | Comprehensive textbooks on Manual Metal Arc Welding (MMAW) | 25 | 1:1 |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:25 |
|  | Computer | Functional desktop computer with online instructional content | 1 | 1:25 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:25 |
|  | Printer | An ink-jet, laser-jet or toner-cartridge printer for printing notes, instructions and working drawings | 1 | 1:25 |
| **B** | **Learning Facilities & Infrastructure** |
|  | Lecture/Theory Room | Spacious room with seats for 25 trainees, approximately 60 sqm | 1 | 1:25 |
|  | Workshop | Standard workshop with bench/fitting area and welding booths approximately 80 sqm | 1 | 1:25 |
| **C** | **Materials and Supplies** |
|  | Dust coat/ overall | Shields skin and regular clothes from sparks | 25 | 1: |
|  | Gloves | Shields hands from sharp edges, heat, and chemical exposure | 25 | 1:1 |
|  | Safety boots | Protects feet from heavy objects, sharp materials, and impact. | 25 | 1:1 |
|  | Welding helmets | Protecting the eyes while providing a clear view of the weld. | 25 | 1:1 |
|  | Ear muffs/ ear plugs | Shields against prolonged exposure to high noise levels from machinery | 25 | 1:1 |
|  | Safety goggles | Protects eyes from flying metal particles, sparks, and dust | 25 | 1:1 |
|  | Raw materials | Steel and aluminum  Plates   * 4mm thickness. * 6 mm thickness.   Pipes   * 4 mm thickness * 6 mm thickness |  |  |
|  | Arc welding electrodes | Electrodes used in Arc welding | 20 packets |  |
|  | First Aid kit | Fully equipped First Aid kit for use in case of accidents | 1 | 1:25 |
|  | Brooms and cleaning stuff | Hand brooms and mops for cleaning | 10 | 2:5 |
|  | Cotton waste | Absorbent cotton waste for cleaning of oils and other dirt on machines, tools and equipment | Enough |  |
|  | Cleaning detergents | General degreasers | 10 litres |  |
| Floor detergents | 10 litres |
| Hand detergents | 10 litres |
| **D** | **Tools and Equipment** |
| **Measuring tools** | | | | |
|  | Steel rules | Calibrated steel rules for linear measurements | 20 | 4:5 |
|  | Vernier calipers | Calibrated Vernier calipers for linear measurements | 20 | 4:5 |
|  | Tri squares | Properly aligned steel Tri-square for checking perpendicular edges | 5 | 1:5 |
|  | Vernier height gauge and surface plates | Calibrated Vernier height gauges and surface plates for measurement of heights | 5 | 1:5 |
|  | Measuring tapes | Calibrated measuring tapes for linear measurements | 20 | 4:5 |
|  | Angle gauges | Calibrated steel rules for linear measurements | 5 | 1:5 |
| **Marking out tools** | | | | |
|  | Scribers | steel pencil scribers for marking out lines on metal surfaces | 20 | 4:5 |
|  | Dot punches | steel dot punches for marking out centres | 20 | 4:5 |
|  | Callipers | Quality steel callipers for marking out arcs on metal surfaces | 5 | 1:5 |
| **Cutting Tools** | | | | |
|  | Assorted hand files | Flat and round hand files for material preparation and finishing | 20 | 4:5 |
|  | Hacksaws | Hack saws with functional frames and blades for cutting metal plates and pipes | 20 | 4:5 |
|  | Tinsnips |  | 10 | 2:5 |
|  | Angle grinders | Portable angle grinders with cutting and grinding disks for cutting and grinding metal plates and pipes | 5 | 1:5 |
| **Work holding tools** | | | | |
|  | Work benches | Stable work benches for carrying out bench work | 5 | 1:5 |
|  | Collet | Hold the tungsten electrode in place | 5 | 1:5 |
|  | Bench vices | Functional bench vices/clamps for holding work pieces during bench work | 20 | 4:5 |
|  | Tongs | Functional pairs of tongs for holding hot pieces of metal during welding | 10 | 2:5 |
| **Finishing tools** | | | | |
|  | Wire brushes | To clean metal surfaces | 20 | 4:5 |
|  | File cards | Cleaning tool used to maintain files | 5 | 1:5 |
|  | **Machines and Equipment** |
|  | Arc welding machine |  | 5 | 1:5 |
|  | Gas welding machine |  | 5 | 1:5 |
|  | Firefighting equipment | for ensuring safety in workshops where fire hazards are present, such as sparks | 3 |  |
|  | Welding gun | Feeds the filler wire into the weld pool | 5 | 1:5 |
|  | Drilling machine |  |  |  |
|  | **Reference Materials** |
| 1 | Working drawings |  |  |  |
| 2 | Operation sheets/ templates |  |  |  |
| 3 | Welding Procedure Specifications (WPS) |  | 25 pcs | 1:1 |
| 4 | Training Presentations/Slides | Digital format for shared access among trainees | 1 | 1:25 |
| 6 | Practical Assessment Guides | Worksheets for practical assessments | 25 pcs | 1:1 |

# TECHNICAL DRAWING

**UNIT CODE: 0732451/03A**

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply technical drawing

**Duration of Unit:** 80

**Unit Description**

This unit covers the competences required to apply technical drawings. It involves using technical drawing tools, equipment and materials, producing plane geometry drawings, orthographic drawings of components, solid geometry drawings, isometric drawings and assembly drawings.

**Summary of Learning Outcomes**

By the end of this unit of learning, the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Use technical drawing tools, equipment and materials | 10 |
|  | Produce plane geometry drawings | 10 |
|  | Produce orthographic drawings of components | 20 |
|  | Produce solid geometry drawings | 10 |
|  | Produce Isometric drawings | 20 |
|  | Produce assembly drawings | 10 |
| **Total** | | 80 |

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| * + - 1. Use and maintain drawing equipment and materials | * 1. Drawing equipment      1. T square      2. Set square      3. Protractor      4. Engineering drawing set   2. Drawing materials      1. Drawing papers      2. Maskin tape      3. Clips      4. Drawing board      5. Clutch pencils   3. Use and maintenance of drawing equipment | * Practical Tests * Written tests * Portfolio of evidence |
| * + - 1. Produce plane geometry drawings | * 1. Types of lines in drawings      1. Boarder lines      2. Faint continuous lines      3. Broken lines      4. Chain lines      5. Centre lines      6. Cutting lines   2. Construction of angles      1. Acute angles      2. Right angles      3. Reflex angles      4. Obtuse angles      5. Straight angles   3. Bisection of angles      1. Acute angles      2. Right angles      3. Reflex angles      4. Obtuse angles   4. Measurement of angles      1. Acute angles      2. Right angles      3. Reflex angles      4. Obtuse angles      5. Straight angles   5. Construction of plane geometric forms      1. Triangles      2. Quadrilaterals      3. Polygons      4. Circles and tangents   6. Construction of scales      1. Plane scales      2. Diagonal scale      3. Reducing and enlargement scales | * Practical Tests * Written tests * Portfolio of evidence |
| 1. Produce orthographic drawings of components | * 1. Orthographic drawings      1. First angle projection      2. Third angle projection   2. Dimensioning   3. Sectional views   4. Free hand sketches      1. Geometric forms      2. Tools      3. Equipment      4. Mechanical components | * Practical Tests * Written tests * Portfolio of evidence |
| 1. Produce solid geometry drawings | * 1. Sketches and drawings of patterns      1. Cylinders      2. Prisms      3. pyramids   2. solids drawings      1. Prisms      2. Cones      3. Cylinders   3. Development and interpenetrations of solids      1. cylinder to cylinder      2. cylinder to prisms      3. prism to prism   4. Different symbols and abbreviations   5. Auxiliary views and true shapes of truncated solids      1. Truncated cylinder      2. Truncated prism      3. Truncated pyramid | * Practical Tests * Written tests * Portfolio of evidence |
| 1. Produce isometric drawings | * 1. Isometric sketches and drawings of components   2. Isometric curves and circles   3. Oblique sketches of components | * Practical Tests * Written tests * Portfolio of evidence |
| 1. Produce assembly drawings | * 1. Orthographic views of assembly drawings      1. First angle projection      2. Third angle projection   2. Sectional views   3. Parts list | * Practical Tests * Written tests * Portfolio of evidence |

**Suggested Methods of Delivery**

* Projects
* Demonstration
* Practice
* Discussions

**Recommended Resources for 30 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | Comprehensive texts books on Technical Drawing | 30 pcs | 1:1 |
|  | PowerPoint Presentations | For trainer’s use, covering course content and practical applications | 1 | 1:30 |
|  | Working drawings | Working drawings giving a detailed overview of the task at hand |  |  |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:30 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:30 |
| **B** | **Learning Facilities & Infrastructure** |  |  |  |
|  | Drawing Room  /Learning Resource  Area\* | Spacious, equipped with a projector and drawing tables for 25 trainees, approximately 45 sqm (5 m x 9 m) | 1 | 1:30 |
| **C** | **Consumable Materials** |  |  |  |
|  | Drawing papers | A4, A3 and A2 size drawing papers for drafting of sketches and working drawings | 1 ream | 1:30 |
|  | Drawing Pencils | For drawing   * HB * 2H/3H * 2B | Enough |  |
|  | Eraser | Dustless eraser for pencil stains | 30 |  |
|  | Masking Tape | For attaching the drawing paper to the drawing board | Enough |  |
| **D** | **Tools and Equipment** |  |  |  |
|  | Drawing Instruments | The include:   * T-squares * 30-60 degree set squares * 45 degree set square * Protractor * Compass set | 30 sets | 1:1 |
|  | Pencil Sharpener | For creating sharp pencil tips | 30 pcs | 1:1 |
|  | Drawing Tables | For drawing | 30 pcs | 1:1 |
| **E** | **Reference Materials** |  |  |  |
|  | Welding /blueprint /drawing Standards | Reference on industry standards (e.g., BS, ANSI, AWS etc.) | 5 pcs | 1:6 |
|  | Multimedia Learning Modules | Videos and tutorials | 30 pcs | 1:1 |

# CONSTRUCTION PLANT ENGINES MAINTENANCE

**UNIT CODE:** 0716 451 04A

**UNIT DURATION:** 160Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Maintain Construction Plant Engines

**Unit Description**

This unit describes the competencies required to perform construction plant engine overhaul, service construction plant engine cooling system, service construction plant engine lubrication system, Service construction plant exhaust system and Service construction plant fuel system.

**Summary of Learning Outcomes**

By the end of this unit of learning, the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Perform construction plant engine overhaul | 80 |
|  | Service construction plant engine cooling system | 30 |
|  | Service construction plant engine lubrication system | 20 |
|  | Service construction plant exhaust system | 10 |
|  | Service construction plant fuel system. | 20 |
| **Total** | | **160** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| * 1. Perform construction plant engine overhaul | * 1. Personal protective equipment (PPE)      1. Apron      2. Safety boots      3. Gloves      4. Goggles      5. Cartridges/nose mask      6. Helmet      7. Ear muffs   2. Safety precautions      1. Training      2. Ventilation      3. Machine isolation      4. Hazard identification      5. Tool safety      6. Chemical handling      7. Communication      8. Securing the earth moving machine   3. Preparation of the work area   4. Identify tools and equipment      1. Fully equipped toolbox with assorted spanners      2. Engine lifting equipment         1. Engine hoist      3. Measuring and inspection tools         1. Vernier callipers         2. Optical gauge         3. Dial gauge         4. Micrometre screw gauge         5. Straight edge         6. Feeler gauge         7. Valve spring compressor         8. Spring tension gauge         9. Vernier height gauge         10. Try square         11. Engine compression test kit      4. Vee block      5. Lapping stick      6. Lapping paste   5. Engine removal      1. Draining engine oil      2. Draining the engine coolant      3. Removing of the engine peripherals         1. Intake manifolds         2. Exhaust manifold         3. Wire harness         4. Coolant piping      4. Setting up the engine lifting equipment      5. Removing engine mountings      6. Disconnecting engine from the gear box         1. Removing the engine   6. Engine dismantling   7. Cleaning engine major components      1. Cylinder head      2. Engine block      3. Pistons      4. Crankshafts      5. Camshafts      6. Valves      7. Connecting rods   8. Inspection of engine components      1. Cylinder head      2. Engine block      3. Pistons      4. Crankshafts      5. Camshafts      6. Valves      7. Connecting rods      8. Valve springs   9. Engine component measurements and tests      1. Crankshaft         1. Main journal bearing area ovality measurement         2. Con bearing area ovality measurement      2. Engine block         1. Warpage test         2. Cylinders ovality test         3. Cylinder taper test      3. Piston         1. Taper test         2. Ovality      4. Valves         1. Straightness         2. Sealing ability      5. Valve spring         1. Length         2. Squareness         3. Tension      6. Cylinder head         1. Warpage test   10. Cylinder head servicing       1. Valve lapping       2. Cylinder refacing       3. Leakage test   11. Replacement of worn-out engine components       1. Piston rings       2. Cylinder head gasket       3. Valves       4. Valve springs       5. Bearings       6. Valve guide bearing       7. Engine oil seals          1. Crankshaft main seal          2. Valve seals          3. Top cover oil seal   12. Assembly of engine components   13. Engine timing   14. Tappet adjustment   15. Engine compression test   16. Fitting engine back to the earthmoving machine.   17. Fitting back engine peripherals       1. Exhaust manifold       2. Intake manifold       3. Piping       4. Wire harness   18. Topping up engine oil   19. Topping up engine coolant   20. Fitting back the battery   21. Running the engine       1. Engine performance test       2. Engine tune up       3. Dynamometer test | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| * 1. Service construction plant engine cooling system | * 1. Gathering of tools and equipment      1. Cooling system service kit         1. Radiator cap pressure testing kit         2. thermometer      2. Fully equipped tool box with assorted spanners   2. Introduction to cooling system      1. Identification of cooling systems         1. Water cooling system   3. Inspection and servicing of the cooling system      1. Inspection of cooling fans      2. Inspection of fan belts      3. Inspection of the radiator         1. Radiator pressure test         2. Radiator cap pressure testing         3. Radiator leakage test         4. Radiator fins and tubing checks   4. Thermostat test   5. Water pump inspection      1. Visual inspection         1. Leakage checks         2. Corrosion checks         3. Coolant stains checks      2. Pulley and belt         1. Belt condition         2. Pulley movement      3. Unusual noises listening         1. Grinding or whining sounds      4. Coolant flow checking   6. Inspection of the coolant horses   7. Replacement of worn-out cooling system parts   8. Refilling of the coolant   9. Documentation of the service      1. Job cards      2. Checklists      3. Files      4. Logbooks   10. House keeping       1. Tool and equipment organization       2. Work area cleanliness       3. Safe handling and disposal of hazardous materials       4. Inspection and maintenance of equipment       5. Personal protective equipment management       6. Air and ventilation maintenance       7. Incident prevention and reporting | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| * 1. Service construction plant engine lubrication system | * 1. Preparing work area   2. Tools selection      1. Grease guns      2. Oil can      3. Assorted spanners      4. Oil filter wrench      5. Oil filter cap wrench      6. Oil filter pliers      7. Oil drain pan      8. Funnel      9. Oil extractor pump      10. Oil filter cutter      11. Lubricating flushing kit      12. Oil analysis kit      13. Torque wrench   3. Selecting of Service kits      1. Seal kits      2. Filter kits      3. Hose repair kits      4. Lubricants kits      5. Pump repair kits      6. Pressure gauge kits   4. Draining engine oil   5. Identifying engine lubrication components      1. Oil sump      2. Oil pump      3. Oil filters      4. Lubrication ducts   6. Identifying engine lubrication faults      1. Oil leaks      2. Clogged oil filters      3. Low oil level      4. Malfunctioning oil pumps   7. Rectifying engine lubrication faults   8. Flushing engine lubrication system   9. Replenishing the engine oil   10. Testing the engine lubrication system   11. Documenting the lubrication system service.   12. Performing house keeping | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| 1. Service construction plant exhaust system | * 1. Work area preparation   2. Selecting of tools and equipment      1. Exhaust gas analyser kit      2. Exhaust back pressure gauge      3. Catalytic converter test kit      4. Exhaust pipe cutters      5. Tool box with assorted spanners      6. multimeter      7. Exhaust system service kit         1. Exhaust hoses         2. Mufflers         3. Heat shield         4. Insulation materials         5. Gasket and seals   3. Checking for the exhaust system faults      1. Exhaust leaks      2. Faulty catalytic converter      3. Damaged muffler      4. Faulty oxygen sensor      5. Exhaust system vibration   4. Testing catalytic converter/ particulate filter      1. Emission test      2. Exhaust gas analysis      3. Visual inspection of the particulate filter   5. Dismantling exhaust system   6. Repairing exhaust system faults      1. Exhaust leaks      2. Faulty catalytic converter      3. Damaged muffler      4. Faulty oxygen sensor      5. Exhaust system vibration   7. Reassembling exhaust system   8. Testing and checking oxygen sensors   9. Testing exhaust system   10. Documenting exhaust system service   11. House keeping | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| * 1. Service construction plant fuel system | * 1. Safety observation   2. Work area preparation   3. Selection of tools and equipment      1. Assorted spanners      2. Injector nozzles tester   4. Service kit selection      1. Fuel filters      2. Fuel hoses      3. Fuel pumps      4. Seal and gaskets      5. Fuel additives      6. Cleaning tools      7. Diagnostic tools      8. Service manual   5. Fuel induction components identification      1. Fuel tank      2. Fuel pump      3. Priming pump (lift pump)      4. Fuel filter      5. Injector nozzles   6. Fuel system induction system induction system components testing and service      1. Fuel tank         1. Leakage tests         2. Cleaning      2. Injectors pump         1. Phasing         2. Pressure test         3. Calibration      3. Injector nozzle         1. Spray pattern test   7. Fuel system component’s fault inspection      1. Fuel tank      2. Fuel pump      3. Priming pump (lift pump)      4. Fuel filter      5. Injector nozzles   8. Repairing fuel components faults   9. Documenting fuel system service   10. Performing house keeping | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |

**Suggested Methods of delivery**

* Practicals
* Projects
* Demonstration
* Group discussion
* Direct instruction
* Industrial Visits

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S/No. | Category/Item | Description/ Specifications | Quantity | Recommended Ratio  (Item: Trainee) |
| A | **Learning Materials** |  |  |  |
|  | Textbooks |  | 5 pcs | 1:5 |
|  | Projector | For trainer’s use | 1 | 1:25 |
|  | Installation manuals |  |  |  |
|  | Charts |  |  |  |
|  | PowerPoint presentations | For trainer’s use | 1 |  |
|  | learning models | For trainer’s use | 1 | 1:25 |
|  | Earth moving machine engines |  | 5 | 1:5 |
| B | **Learning Facilities & Infrastructure** |  |  |  |
|  | Lecture/theory room |  | 1 | 1:25 |
|  | Workshop |  | 1 | 1:25 |
|  | Workbenches |  | 5 | 1:5 |
| C | **Consumable materials** |  |  |  |
|  | Assorted sealant | silicone | 400grams | 16:1 |
|  | Assorted gaskets |  |  |  |
|  | Assorted oil seals |  |  |  |
|  | Engine oil |  | 20 litres | 4:5 |
|  | First aid kit |  | 1 | 1:25 |
|  | Cleaning detergents | Enough | 1 litre | 1: 25 |
|  | Cotton wool waste | Enough | 2 kilograms | 2:25 |
|  | Kerosene |  | 20 litres | 4:5 |
|  | Assorted Emery papers |  | 1 roll | 1:25 |
| D | **Tools and Equipment** |  |  |  |
|  | Assorted spanners |  | 2 | 2:25 |
|  | Filter wrench |  | 4 | 4:25 |
|  | Torque wrench |  | 4 | 4:25 |
|  | jaw puller |  | 2 | 2:25 |
|  | Seal installer |  | 4 | 4:25 |
|  | Injector nozzle pressure tester |  | 5 | 1:5 |
|  | Micro meter screw gauge |  | 10 | 2:5 |
|  | Vernier callipers |  | 10 | 2:5 |
|  | Try Square |  | 10 | 2:5 |
|  | Vernier height gauge |  | 10 | 2:5 |
|  | Vee block |  | 10 | 2:5 |
|  | Dial gauge |  | 10 | 2:5 |
|  | Optical gauge |  | 10 | 2:5 |
|  | Straight edge |  | 10 | 2:5 |
|  | Lapping stick |  | 10 | 2:5 |
|  | Oil cans |  | 5 | 1:5 |
|  | Multimeter |  | 5 | 1:5 |
|  | Torque wrench |  | 5 | 1:5 |
|  | Feeler gauge |  | 5 | 1:5 |
|  | Hammer |  | 5 | 1:5 |
|  | Valve spring compressor |  | 3 | 3:25 |
|  | Spring tension gauge |  | 3 | 3:25 |
|  | Radiator pressure testing kit |  | 2 | 2:25 |
|  | Engine dynamometer tester |  | 1 | 1:25 |
|  | Thermometer |  | 5 | 1:5 |
|  | Exhaust gas analyzer kit |  | 2 | 2:25 |
|  | Exhaust back pressure gauge |  | 2 | 2:25 |
|  | Catalytic converter test kit |  | 1 | 1:25 |
|  | Exhaust pipe cutters |  | 2 | 2:25 |
| E. | **Earth Moving machines** |  |  |  |
|  | Bulldozer |  | 1 | 1:25 |
|  | Excavators |  | 1 | 1:25 |
|  | Backhoe loader |  | 1 | 1:25 |
|  | Grader |  | 1 | 1:25 |

# MODULE II

# BASIC UNIT OF LEARNING

# COMMUNICATION SKILLS

**ISCED UNIT CODE:** **0031 441 05A**

**Relationship with Occupational Standards**

This unit addresses the Unit of Competency: Apply Communication Skills

**Duration of Unit:** **40 Hours**

**Unit Description**

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

**Summary of Learning Outcomes**

By the end of this unit of learning, the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Apply communication channels. | 10 |
|  | Apply written communication skills. | 10 |
|  | Apply non-verbal communication skills. | 4 |
|  | Apply oral communication skills. | 4 |
|  | Apply group communication skills. | 10 |
| **Total** | | **40** |

**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 gestures   2. Apply body posture   3. 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      1. Facilitating resolution of issues      2. Developing action plans      3. Group organization techniques      4. Turn-taking techniques      5. Conflict resolution techniques      6. Team-work | * Oral assessment * Written assessment * Observation * Portfolio of Evidence * Practical assessment |

**Suggested Methods of Instruction**

* Discussion
* Roleplaying
* Simulation
* Direct instruction
* Demonstration
* Field trips

**Recommended Resources for 30 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | Comprehensive texts books on Communication Skills | 30 pcs | 1:1 |
|  | Mobile Phones | Smartphone for use by trainees | 30 pcs | 1:1 |
|  | Internet connection | Internet connection to aid communication between trainees |  |  |
|  | PowerPoint Presentations | For trainer’s use, covering course content and practical applications | 1 | 1:30 |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:30 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:30 |
|  | Printer | An ink-jet, laser-jet or toner-cartridge printer for printing notes, instructions and working drawings | 1 | 1:30 |
|  | Templates | Templates for creating various documents e.g. CV, Cover Letter, minutes, reports etc. | 30 | 1:1 |
| **B** | **Learning Facilities & Infrastructure** |  |  |  |
|  | Lecture/Theory Room  /Learning Resource  Area\* | Spacious, equipped with projectors and Seats for 30 trainees, approximately 45 sqm (5 m x 9 m) | 1 | 1:30 |
|  | Computer Laboratory | Equipped with at least 30 functional computers with internet connectivity and the following software:   * + - Windows/ Linux/ Macintosh Operating System     - Microsoft Office Software     - Google Workspace Account     - Antivirus Software | 30 | 1:1 |
| **C** | **Consumable Materials** |  |  |  |
|  | Printing Papers | A4 and A3 Printing papers suitable for the task | Enough |  |
|  | Flashcards | For carrying out various activities by trainees | Enough |  |
|  | Flipcharts | Sufficient for group work activities and displaying | Enough |  |
|  | Whiteboard Marker Pens | Dry-erase markers for trainers use. Assorted colors | Enough |  |

# COMMON UNITS OF LEARNING

# APPLIED MATHEMATICS

**Unit Code: 0541 441 06A**

**Relationship with Occupational Standards**

This unit addresses the Unit of Competency: Apply Mathematics

**Unit Duration: 80 Hours**

**Unit Description**

This unit describes the competences required in order to Apply trigonometric functions, carrying out mensuration, Apply statistics and probability

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcomes** | **Duration (Hours)** |
|  | Apply algebra | 20 |
|  | Apply trigonometric functions | 20 |
|  | Carry out mensuration | 20 |
|  | Apply statistics and probability | 20 |
| TOTAL | | 80 |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| * + - 1. Apply algebra | * 1. Indices      1. Power zero      2. Negative powers      3. Fractional powers      4. Laws of indices         1. Addition         2. Subtraction         3. Division         4. Multiplication   2. BODMAS   3. Roots      1. Square roots      2. Cube roots      3. nth roots   4. Logarithms      1. Laws of Logarithms         1. Product Law         2. Quotient Law         3. Power Law   5. Use of scientific calculator      1. Power ON/OFF      2. Mode         1. Degree         2. Radian         3. Gradient         4. SD      3. Clear      4. Save      5. Shift   6. Simultaneous equations   (up to 3 equations)   * + 1. Elimination     2. Substitution     3. Reduction     4. Graphical   1. Quadratic equations      1. Factorization      2. Quadratic formula      3. Completing the square      4. Graphical | * Written tests |
| * + - 1. Apply trigonometric functions | * 1. Angles      1. Acute      2. Obtuse      3. Reflex      4. Right angle   2. Triangles      1. Isosceles      2. Equilateral      3. Right angled      4. Scalene   3. Trigonometric Ratios      1. Sine      2. Cosine      3. Tangent      4. Cosecant      5. Secant      6. Cotangent   4. Trigonometric Identities      1. Proof of identities      2. Pythagorean identities   5. Solve trigonometric equations   6. Hyperbolic functions      1. Sinh x      2. Cosh x      3. Cosech x      4. Tanh x      5. Sech x | * Written tests |
| * + - 1. Carry out mensuration | * 1. Units and symbols of measurement      1. Mass      2. Distance      3. Speed      4. Temperature      5. Time   2. Imperial and metric units      1. Conversions   3. Perimeter      1. Regular shapes   4. Area      1. Regular shapes   5. Volume      1. Regular shapes | * Written tests |
| * + - 1. Apply statistics and probability | * 1. Data presentation      1. Continuous variables         1. Histogram         2. Line      2. Discrete variable         1. Bar graph         2. Pie graph      3. Grouped data         1. Histogram         2. Bar         3. Cumulative frequency         4. ogive      4. Ungrouped data         1. Line         2. Cumulative frequency   2. Measures of central tendency      1. Mean         1. Grouped data         2. Ungrouped data      2. Mode         1. Grouped data         2. Ungrouped data      3. Medium         1. Grouped data         2. Ungrouped data   3. Measures of dispersion      1. Standard deviation         1. Grouped data         2. Ungrouped data      2. Variance         1. Grouped data         2. Ungrouped data   4. Probability      1. With replacement      2. Without replacement   5. Probability distribution functions      1. Binomial distribution      2. Poisson distribution   6. Normal distribution | * Written tests |

**Suggested Delivery Methods**

* Demonstration
* Group discussions
* Exercises
* Online materials
* Direct instructions
* Simulation

**Recommended Resources for 30 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Learning Materials** | | | |
|  | Textbooks | Comprehensive textbooks on Engineering Mathematics | 30 | 1:1 |
|  | Graph books | For graphical representation of solutions | 30 | 1:1 |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:30 |
|  | Computer | Functional desktop computer with online instructional content | 1 | 1:30 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:30 |
|  | Printer | An ink-jet, laser-jet or toner-cartridge printer for printing notes, instructions and working drawings | 1 | 1:30 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room | Spacious room with seats for 25 trainees, approximately 60 sqm | 1 | 1:30 |
| **C** | **Materials and Supplies** | | | |
|  | First Aid kit | Fully equipped First Aid kit for use in case of accidents | 1 | 1:30 |
| **D** | **Tools and Equipment** | | | |
|  | Set of Mathematical instruments | For constructions and measurements | 30 | 1:1 |
|  | Scientific Calculator | For Calculations | 30 | 1:1 |
|  | Firefighting extinguishers | Water, carbon dioxide and chemical powder fire extinguishers for fire fighting | 1 | 1:30 |
| **E** | **Reference Materials** | | | |
|  | Training Presentations/Slides | Digital format for shared access among trainees | 1 | 1:30 |
|  | Standard Mathematical Tables | For reference on formulae, identities, laws and principles | 30 | 1:1 |

# ELECTRICAL AND ELECTRONICS PRINCIPLES

**UNIT CODE:** **0713 441 07A**

**Relationship with Occupational Standards**

This unit addresses the unit of competency: Apply Electrical and electronics principles.

**Unit Duration:** 80 Hours

**Unit Description**

This unit describes the competences required in order to apply electrical and electronics principles. It involves applying basic concepts of electrical quantities, cells and batteries, magnetism and electromagnetism, basic electrical machines and electronics principles.

**Summary of Learning Outcomes**

By the end of this unit of learning, the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Apply basic concepts of electrical quantities | 10 |
|  | Apply DC and AC circuits | 10 |
|  | Apply the concept of cells and batteries | 10 |
|  | Apply magnetism and electromagnetism | 10 |
|  | Apply basic electrical machines | 20 |
|  | Apply electronics components | 20 |
| **Total** | | 80 |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Use the concept of basic Electrical quantities | * 1. Basic SI Units      1. Overview of SI Units         1. Power (Watts, W)         2. Current (Amperes, A)         3. Resistance (Ohms, Ω)         4. Voltage (Volts, V)   2. Conductors and Insulators      1. Identification and Characteristics         1. Metals vs. non-metals         2. Applications in electrical circuits   3. Electrical Quantities      1. Charge, Force, Work, and Power      2. Definitions and units      3. Calculations involving Electrical quantities   4. Ohm’s Law      1. Understanding Ohm's Law      2. Practical applications and calculations   5. Basic Electrical and Electronic Measurements      1. Measurement Techniques      2. Use of Multimeters, oscilloscopes, and ammeters      3. Measurement accuracy and calibration | * Portfolio of evidence * Practical test * Third party report * Written tests * Project work |
| 1. Apply DC and AC circuits | * 1. Introduction to Electrical Circuits      1. Introduction to electricity:      2. Voltage, current, and power.      3. Overview of DC and AC circuits.      4. Basic circuit elements: Resistors, capacitors, and inductors.   2. DC Circuit Analysis      1. Series and parallel circuits.      2. Voltage and current division principles.      3. Kirchhoff's Voltage Law (KVL) and Kirchhoff's Current Law (KCL).      4. Analysis of complex circuits using KVL and KCL.      5. Hands-on lab: Building and testing DC circuits.   3. AC circuits analysis      1. Introduction to AC: Sinusoidal waveforms, frequency, and period.      2. RMS values, peak values, and average values.      3. AC voltage and current sources.      4. Phasor representation of AC quantities.      5. Impedance and admittance.      6. Series and parallel AC circuits.      7. Resonance in RLC circuits.      8. Practical analysis of AC circuits using phasors.      9. Power in AC Circuits         1. Power factor and power factor correction.         2. Real, reactive, and apparent power.         3. AC power calculations for single-phase and three-phase circuits.         4. Energy consumption and efficiency.         5. Applications of AC power in household and industrial settings.   4. Practical Activity:      1. Connection in series and Parallel Simulation | * Portfolio of evidence * Practical test * Third party report * Written tests * Project work |
| 1. Apply the concept of cells and batteries | * 1. Introduction to Cells and Batteries   2. Overview of energy storage and electrochemical cells.   3. Basic concepts: Voltage, current, capacity, and energy density.   4. e.m.f and internal resistance of cells   5. Electrochemical principles: Redox reactions and electrode potentials.   6. Components of a cell: Anode, cathode, electrolyte, and separator.   7. Types of cells: Primary vs. secondary cells (non-rechargeable vs. rechargeable).   8. Primary Cells (Non-Rechargeable)      1. Zinc-Carbon Cells: Construction, chemistry, and applications.      2. Alkaline Cells: Advantages over zinc-carbon, usage, and performance characteristics.      3. Comparison of common primary cells (e.g., lithium primary cells).      4. Performance limitations and efficiency of primary cells.      5. Environmental impact and disposal considerations for non-rechargeable batteries.      6. Hands-on lab: Testing the performance of different primary cells.   9. Secondary Cells (Rechargeable)      1. Lead-Acid Batteries: Chemistry, construction, and applications (e.g., automotive).      2. Nickel-Cadmium (NiCd) and Nickel-Metal Hydride (NiMH): Differences, pros, and cons.      3. Charging and discharging cycles of rechargeable cells.      4. Lithium-Ion Batteries: Working principles, construction, and applications.      5. Advantages of lithium-ion technology over older battery types.      6. Safety considerations: Overcharging, thermal runaway, and battery management systems.      7. Emerging Technologies: Solid-state batteries, lithium-sulphur, and other advancements.      8. Energy density and power density considerations in modern applications.      9. Batteries maintenance      10. Hands-on lab: Disassembling and examining a rechargeable battery.   10. Battery Performance and Characteristics       1. Battery capacity: Ampere-hour (Ah) ratings and energy content.       2. Factors affecting battery life: Temperature, charge/discharge rates, and cycling.       3. Internal resistance and its effect on performance.       4. Battery efficiency and energy losses.       5. State of charge (SOC) and depth of discharge (DOD).       6. Battery degradation and aging mechanisms.       7. Measuring battery parameters (voltage, current, capacity).       8. Testing techniques for battery health and performance.       9. Hands-on lab: Performance testing of different battery types.   11. Applications of Batteries       1. Batteries in consumer electronics (e.g., smartphones, laptops).       2. Automotive applications: Starting, lighting, and ignition (SLI) batteries.       3. Electric vehicles (EVs) and hybrid electric vehicles (HEVs): Battery requirements and challenges.       4. Industrial and grid storage applications.       5. Renewable energy integration: Solar and wind energy storage solutions.       6. Specialized applications: Medical devices, aerospace, and military.       7. Case studies on battery failure and safety incidents.       8. Discussion on regulations and standards for battery use.   12. Environmental Impact and Recycling       1. Environmental impact of battery production and disposal.       2. Strategies for reducing the ecological footprint of battery technologies.       3. Recycling processes for different types of batteries.       4. Government policies and regulations regarding battery disposal.       5. Advances in battery recycling technologies.   13. Hands-on lab: Exploring the recycling process and evaluating eco-friendly battery alternatives. | * Portfolio of evidence * Practical test * Third party report * Written tests * Project work |
| 1. Apply magnetism and electromagnetism | * 1. Magnetic Circuits and Devices      1. Introduction to magnetic circuits.      2. Magnetic flux, magnetic field density, magnetic field strength, Reluctance, magnetomotive force (MMF), and magnetic flux.      3. Calculations involving magnetic circuits      4. Analogies between electric and magnetic circuits.      5. Magnetic materials in electrical devices (soft and hard magnetic materials).   2. Electromagnetic Induction      1. Faraday’s Law of electromagnetic induction.      2. Lenz's Law: Direction of induced EMF.      3. Practical applications: Electric generators and transformers.      4. Induced EMF in different configurations (moving conductors, changing magnetic fields).      5. Self-induction and mutual induction.      6. Transformers: Working principles, construction, and applications.      7. Step up and step-down transformers      8. Power losses in transformers.      9. Calculations involving transformers      10. Energy stored in magnetic fields. | * Portfolio of evidence * Practical test * Third party report * Written tests * Project work |
| 1. Apply basic electrical machines | * 1. DC Machines      1. DC machine construction and types (motors and generators).      2. Working principle of DC generators and back EMF.      3. Types of DC generators: Series, shunt, and compound.      4. Working principle of DC motors.      5. Types of DC motors: Series, shunt, and compound.      6. Speed-torque characteristics of DC motors.      7. Performance analysis and efficiency of DC machines.      8. Starting methods for DC motors.      9. Hands-on lab: Testing and operating a DC motor/generator.   2. Induction Motors (AC Machines)      1. Introduction to induction motors: Construction and working principles.      2. Types of induction motors: Squirrel cage and wound rotor.      3. Rotating magnetic fields and slip in induction motors.      4. Equivalent circuit model of an induction motor.      5. Torque-speed characteristics.      6. Methods of starting and speed control.      7. Performance analysis of induction motors.      8. Losses and efficiency considerations.   3. Hands-on lab: Testing and operating an induction motor. | * Portfolio of evidence * Practical test * Third party report * Written tests * Project work |
| 1. Apply electronics components | * 1. Introduction to Electronic Components      1. Overview of electronics: What are electronic components?      2. Classification of components: Passive, active, and electromechanical.      3. Introduction to circuit symbols and schematic diagrams.      4. Basic electrical quantities and units (voltage, current, resistance).      5. Understanding datasheets and component specifications.      6. Overview of testing and measurement tools (multimeters, oscilloscopes).   2. Passive Components      1. Resistors: Types, color codes, power ratings, and applications.      2. Capacitors: Types (ceramic, electrolytic, film), capacitance value, and working voltage.      3. Charging and discharging of capacitors in DC circuits.      4. Applications of capacitors in filtering, timing, and energy storage.      5. Inductors: Types, inductance value, and applications.      6. Inductor behavior in DC and AC circuits.      7. Introduction to filters: RC, RL, and RLC circuits.   3. Semiconductor Devices      1. Diodes: Introduction to PN junctions, characteristics, and types (LEDs, Zener diodes, Schottky diodes).      2. Applications of diodes in rectification, voltage regulation, and signal clipping.      3. Transistors: Types (BJT and MOSFET), characteristics, and configurations.      4. Basic transistor circuits: Switches and amplifiers.      5. Hands-on lab: Building and testing simple diode and transistor circuits.      6. Special semiconductor devices: Thyristors, TRIACs, and optoelectronic devices.      7. Characteristics and applications in switching and control.   4. Integrated Circuits (ICs)      1. Overview of integrated circuits: Analog vs. digital ICs.      2. Operational amplifiers (Op-Amps): Characteristics and basic configurations.      3. Applications of Op-Amps in signal processing.      4. Timers and oscillators: 555 timer IC and its applications.      5. Voltage regulators: Linear and switching regulators.      6. Introduction to data converters (ADC and DAC).      7. Digital ICs: Logic gates and flip-flops.      8. Applications of digital ICs in basic logic circuits.      9. Hands-on lab: Building circuits using Op-Amps, timers, and logic gates.   5. Electromechanical and Specialized Components      1. Relays: Types, operation, and applications in switching.      2. Switches and connectors: Types and usage in electronic circuits.      3. Transformers: Basic operation, step-up/step-down functions, and isolation.      4. Displays: LED, LCD, and seven-segment displays.      5. Circuit Design and Practical Applications      6. Basic circuit design principles: Bread boarding, PCB layout, and soldering.      7. Introduction to circuit simulation tools (e.g., Multisim, LTSpice).      8. Testing and troubleshooting techniques.      9. Real-world applications of electronic components.      10. Building practical projects: Power supplies, audio amplifiers, and sensor-based circuits.      11. Hands-on lab: Final project assembly and testing. | * Portfolio of evidence * Practical test * Third party report * Written tests * Project work |

**Suggested Methods of Instruction**

* Demonstration
* Practice
* Field trips
* Discussions

**Recommended Resources for 30 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Learning Materials** |  |  |  |
| 1 | Textbooks | Comprehensive texts on electrical and control principle. | 5 pcs | 1:6 |
| 2 | Charts | Visual aids covering electrical theories and safety protocols | 10 pcs | 1:3 |
| 3 | PowerPoint Presentations | For trainer’s use, covering course content and practical applications | 1 | 1:30 |
| **B** | **Learning Facilities & Infrastructure** |  |  |  |
| 1 | Lecture/Theory Room | Equipped with projectors and seating for 25 trainees, ~60 sqm | 1 | 1:30 |
| 2 | Workshop | Hands-on training area with workbenches, tools, and safety equipment, ~80 sqm | 1 | 1:30 |
| 3 | Computer Laboratory | Equipped with testing setups for electrical experiments, ~50 sqm.  Equipped with computers installed with Circuit simulation software. | 30 | 1:1 |
|  |  |  |  |  |
| **C** | **Consumable Materials** |  |  |  |
| 1 | Electrical Wires | Assorted sizes and color-coded (e.g., 1.5mm², 2.5mm², 4mm²) | 6 rolls | 1:5 |
| 2 | Insulation Tapes | For securing connections and insulation, assorted colors | 30 pcs | 1:1 |
| 3 | Breadboard | For prototyping and testing circuits | 6 pcs | 1:5 |
| 4 | Sensors | Assorted types (temperature, pressure, proximity) | 10 pcs | 1:3 |
| 5 | Signal generators | For generating AC signals | 6pcs | 1:5 |
| 6 | Transducers | Assorted | 10 pcs | 1:3 |
| 7 | Electronic components | Resistors, transistors, capacitors, relays, transformers. Integrated IC, OPAM. | 100pcs | 4:3 |
|  |  |  |  |  |
| **D** | **Tools and Equipment** |  |  |  |
| 1 | Screwdrivers | Assorted sets for various applications | 2 sets | 1:15 |
| 2 | Side Cutters | For cutting wires and cables | 4 pcs | 1:7.5 |
| 3 | Pliers | For gripping and bending wires | 3 pcs | 1:10 |
| 4 | Stripping Knives | For stripping insulation from wires | 4 pcs | 1:7.5 |
| 5 | Computers | Equipped with electrical and electronics simulation software | 6 pcs | 1:5 |
| 6 | Multimeters | For measuring voltage, current, and resistance | 6 pcs | 1:5 |
| 7 | Clamp Meters | For measuring current flow in circuits | 6 pcs | 1:5 |
| 8 | Oscilloscope | For observing waveforms and signals | 1 | 1:30 |
| 9 | Voltmeter | For measuring voltage | 1 | 1:30 |
| 10 | Ammeter | For measuring current | 1 | 1:30 |
| 11 | Signal Generator | For generating electrical signals for testing | 1 | 1:30 |
| 12 | Soldering gun | For soldering | 10 | 1:3 |
| 13 | Soldering wire | For making joints in electrical circuits | 10 | 1:3 |
| 14 | PLC | For program practice | 6 | 1:5 |
| 15 | Cells and batteries | For learning | 6 | 1:5 |
|  |  |  |  |  |
| **E** | **PPE (Personal Protective Equipment)** |  |  |  |
| 1 | PPE Sets | Includes helmets, gloves, safety goggles, shoes, and harnesses | 30 sets | 1:1 |
| 2 | Safety Signs and Barriers | For simulating safety zones and hazards | 10 sets | 1:3 |
| 3 | Earthing Test Kits | For ground testing and demonstrating earthing procedures | 6 pcs | 1:5 |
| 4 | Electrical Test Benches | For hands-on testing of functionality and circuit design | 6 pcs | 1:5 |
|  |  |  |  |  |
| **F** | **Reference Materials** |  |  |  |
| 1 | Industrial Automation Manuals | Covering principles and practices in automation | 30 pcs | 1:1 |
| 2 | Electrical Standards | Reference on industry standards (e.g., IEEE Guidelines) | 6 pcs | 1:5 |
| 3 | Technical Handbooks | On motors, drives, and wiring systems | 30 pcs | 1:1 |
| 4 | Training Presentations/Slides | Digital format for shared access among trainees | 1 | 1:30 |
| 5 | Multimedia Learning Modules | Digital licenses for videos and tutorials | 30 pcs | 1:1 |
| 6 | Practical Assessment Guides | Worksheets for practical assessments | 30 pcs | 1:1 |

# CORE UNIT OF LEARNING

# CONSTRUCTION PLANT HYDRAULIC SYSTEM MAINTENANCE

**UNIT CODE**: 0716 451 08A

**UNIT DURATION:** 160Hours

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Maintain construction plant hydraulic system

**UNIT DESCRIPTION**

This unit describes the competencies required to service construction plant hydraulic valves, replace construction plant hydraulic filter, service construction plant fuel tank, service construction plant pump, service construction plant hydraulic cylinder.

**Summary of Learning Outcomes**

By the end of this unit of learning, the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Service construction plant hydraulic valves | 45 |
|  | Replace construction plant hydraulic filter | 15 |
|  | Service construction plant fuel tank | 15 |
|  | Service construction plant hydraulic pump | 55 |
|  | Service construction plant hydraulic cylinder. | 30 |
| **Total** | | **160** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Service construction plant hydraulic valves | * 1. Safety observation      1. Personal protective equipment (PPE)      2. Apron      3. Safety boots      4. Gloves      5. Goggles      6. Cartridges/ nose mask      7. Helmet      8. Ear muffs   2. Safety precautions      1. Training      2. Ventilation      3. Machine isolation      4. Machine stabilization      5. Hazard identification      6. Tool safety      7. Chemical handling      8. Communication   3. Identification of hydraulic valves components      1. valve body      2. Spool      3. Solenoid      4. Springs      5. Seals      6. Ports      7. Actuators      8. Mounting brackets   4. Selection of tools      1. Hydraulic valves faults diagnosis      2. Application of Diagnostic kits      3. Hydraulic diagnostic kits      4. Electrical diagnostics kits      5. Engine diagnostics kits   5. Hydraulic valves service kit selection      1. Seal kits      2. Filter kits      3. Hose repair kits      4. Valve repair kits      5. Pump repair kits      6. Cylinder repair kits      7. Pressure gauge kits      8. Hydraulic fluid kits      9. Hydraulic tool kits   6. Hydraulic system dismantling   7. Cleaning and inspection of hydraulic system components      1. valve body      2. Spool      3. Solenoid      4. Springs      5. Seals      6. Ports      7. Actuators      8. Mounting brackets   8. Replacement of Damaged hydraulic valve components      1. Worn out parts      2. Broken parts      3. Rusted parts      4. Weak springs   9. Testing hydraulic valves      1. Leakage test      2. Pressure drop test      3. Operation or functional test      4. Crack pressure test      5. Response time test      6. Contamination test      7. Temperature test   10. Service documentation       1. Job cards       2. Checklists       3. Files       4. Logbooks   11. Housekeeping       1. Tool and equipment organization       2. Work area cleanliness       3. Safe handling and disposal of hazardous materials       4. Inspection and maintenance of equipment       5. Personal protective equipment management       6. Air and ventilation maintenance       7. Incident prevention and reporting |  |
| * Practical * Written test * Project * Third party report * Portfolio of evidence |
| 1. Replace construction plant hydraulic filter | * 1. Identification of hydraulic filters      1. Suction filter      2. Pressure filter      3. Return filter      4. Inline filter      5. Duplex filter      6. Magnetic filter      7. Hydraulic oil filter      8. Spin-on filter      9. Cartridge filter   2. Selection of hydraulic filters Service kits      1. O-rings      2. Seals      3. Fuel      4. Compressed air   3. Removal of the hydraulic filters      1. Suction filter      2. Pressure filter      3. Return filter      4. Inline filter      5. Duplex filter      6. Magnetic filter      7. Hydraulic oil filter      8. Spin-on filter      9. Cartridge filter   4. Cleaning and inspection of the hydraulic filters   5. Replacement of faulty hydraulic filters components      1. Clogged hydraulic filters      2. Worn out seals and O-rings   6. Installation of hydraulic filters   7. Service documentation      1. Job cards      2. Checklists      3. Files      4. Logbooks   8. Housekeeping      1. Tool and equipment organization      2. Work area cleanliness      3. Safe handling and disposal of hazardous materials      4. Inspection and maintenance of equipment      5. Personal protective equipment management      6. Air and ventilation maintenance      7. Incident prevention and reporting | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| 1. Service construction plant fuel tank. | * 1. Work area preparation   2. Locating fuel tank   3. Types of hydraulic fuel tank      1. Steel tanks      2. Aluminum tanks      3. Polyethylene tanks      4. Integrated fuel tanks      5. Customized      6. Pressurized hydraulic tanks      7. Auxiliary or external fuel tanks   4. Functions of hydraulic fuel tanks      1. Fuel storage      2. Fuel supply to engine      3. Ventilation and pressure management      4. Contaminant separation      5. Heat dissipation      6. Support for fuel gauging      7. Safety and spill and prevention      8. Fuel sedimentation collection   5. Tools selection      1. Fuel transfer pump      2. Fuel transfer hoses      3. Drip trays      4. Fuel storage container      5. Degreasers and cleaning solvents      6. Scrub brushes or wire brushes      7. Fuel quality tester      8. Borescope flashing or inspection light   6. Selecting service kits      1. Tank filter      2. Seals      3. Gaskets   7. Inspecting fuel tank      1. Leakages test      2. Cracks identification      3. Sediments check   8. Performing housekeeping      1. Tool and equipment organization      2. Work area cleanliness      3. Safe handling and disposal of hazardous materials      4. Inspection and maintenance of equipment      5. Personal protective equipment management      6. Air and ventilation maintenance      7. Incident prevention and reporting | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| 1. Service construction plant hydraulic pump | * 1. Preparing work area   2. Selecting service kits      1. Seals      2. O-ring      3. Bearings      4. Bushings      5. Valves      6. Springs      7. Hydraulic shafts and couplings      8. Hydraulic pump piston      9. Hydraulic pump rotors and vanes      10. Gaskets      11. Seal carrier      12. Adjustment kit.   3. Detaching of Hydraulic pump drive belt   4. Inspecting hydraulic pump drive belt   5. Identification of hydraulic fuel pumps.      1. Gear pump      2. Vane pump      3. Piston pump      4. Screw pump      5. Axial piston pump      6. Radial piston pump      7. Hand pump      8. Electric hydraulic pump      9. Hydraulic gear motor      10. Pressure compensator Gear pump      11. Vane pump      12. Piston pump      13. Screw pump      14. Axial piston pump      15. Radial piston pump      16. Hand pump      17. Electric hydraulic pump   6. Dismantling of hydraulic pump components.   7. Inspecting hydraulic pump components.      1. Pump housing      2. Pump drive shaft      3. Rotor and vanes      4. Pistons      5. Swash plate      6. Gears      7. Valves      8. Seals and gaskets      9. Inlet and outlet ports      10. Bearings      11. Wear plates      12. Coupling      13. Hydraulic gear motor      14. Pressure compensator   8. Replacing of Hydraulic pump components   9. Testing of Hydraulic pump components   10. Replacing of hydraulic pump drive belt   11. Service documentation       1. Job cards       2. Checklists       3. Files       4. Logbooks   12. Performing housekeeping       1. Tool and equipment organization       2. Work area cleanliness       3. Safe handling and disposal of hazardous materials       4. Inspection and maintenance of equipment       5. Personal protective equipment management       6. Air and ventilation maintenance       7. Incident prevention and reporting | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| 1. Service construction plant hydraulic cylinder. | * 1. Preparing work area   2. Selecting service kits      1. Hydraulic diagnostic      2. Seal      3. Wear ring      4. Rod end      5. Piston      6. Glad      7. Backup ring      8. O-ring      9. Rod wiper      10. Fastener      11. Lubrication and anti-corrosion      12. Bleed valve   3. Tools identification      1. Cylinder disassembly and assembly tools      2. Seal installation and removal      3. Hydraulic pressure gauge      4. Torque wrench      5. Cleaning and inspection tools      6. Bench vice      7. Cylinder hone   4. Draining of hydraulic oil   5. Disassembling of hydraulic cylinder components      1. Double-acting cylinder      2. Single-acting cylinder      3. Telescopic cylinder      4. Rodless cylinder      5. Pneumatic cylinder      6. Miniature cylinder      7. High-pressure cylinder      8. Hydraulic lift cylinder      9. Welded cylinder      10. Tie-rod cylinder   6. Inspecting of hydraulic cylinder   7. Disassembling of hydraulic cylinder   8. Reassembling of hydraulic cylinder   9. Testing of the hydraulic cylinder      1. Leak test      2. Pressure test      3. Drift test      4. Rod straightness test      5. Speed test      6. Load test      7. Endurance test | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |

**Suggested Methods of Delivery**

* Practical
* Project
* Demonstration
* Group discussion
* Direct instruction

The delivery may also be supplimented and enhanced by the following , if the opportunity allows;

* + Costruction plant industrial visits

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks |  | 5 pcs | 1:5 |
|  | Projector | For trainer’s use | 1 | 1:25 |
|  | Installation manuals |  |  |  |
|  | Charts |  |  |  |
|  | PowerPoint presentations | For trainer’s use | 1 |  |
|  | Learning models | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room |  | 1 | 1:25 |
|  | Workshop |  | 1 | 1:25 |
|  | Work benches |  | 5 | 1:5 |
| **C** | **Consumable materials** |  |  |  |
|  | Assorted Sealants |  | 5 rolls | 1:5 |
|  | Assorted gaskets |  | Enough  Enough |  |
|  | Assorted oil seals |  |  |  |
|  | hydraulic oil |  | 20 litres | 4:5 |
|  | First aid kit |  | 1 | 1:25 |
|  | Cleaning detergents |  | 1 litre | 1: 25 |
|  | Cotton wool waste |  | 2 kilograms | 2:25 |
|  | Kerosene |  | 20 litres | 4:5 |
|  | Grease |  | 5 kilograms | 5:25 |
|  | Lubricating oil |  | 20 litres | 4:5 |
|  | Assorted Emery papers |  | 1 roll | 1:25 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Assorted fully equipped tool box |  | 2 | 2:25 |
|  | Filter wrench |  | 5 | 1:5 |
|  | Hydraulic pressure gauge |  | 1 | 1:25 |
|  | Oil analysis kit |  | 2 | 2:25 |
|  | Torque wrench |  | 5 | 1:5 |
|  | Hydraulic puller |  | 2 | 2:25 |
|  | Fluid transfer pump |  | 1 | 1:25 |
|  | Hydraulic cylinder repair kit |  | 4 | 4:25 |
|  | Seal installer |  | 4 | 4:25 |
| **E.** | **Earth Moving machines** |  |  |  |
|  | Bulldozer |  | 1 | 1:25 |
|  | Excavators |  | 1 | 1:25 |
|  | Backhoe loader |  | 1 | 1:25 |
|  | Cranes |  | 1 | 1:25 |
|  | Loader |  | 1 | 1:25 |
|  | Grader |  | 1 | 1:25 |
|  | Concrete mixer |  | 1 | 1:25 |
|  | Trencher |  | 1 | 1:25 |
|  | Paver |  | 1 | 1:25 |
|  | Hydraulic breaker |  | 1 | 1:25 |
|  | Backhoe loader |  | 1 | 1:25 |

# MODULE III

# BASIC UNIT OF LEARNING

# ENTREPRENEURIAL SKILLS

**ISCED UNIT CODE: 0413 441 09A**

**Relationship with occupational standards**

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

**Duration of unit: 40 Hours**

**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**

By the end of this unit of learning, the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Apply financial literacy | 6 |
|  | Apply the entrepreneurial concept | 4 |
|  | Identify entrepreneurship opportunities | 6 |
|  | Apply business legal aspects | 6 |
|  | Innovate Business Strategies | 6 |
|  | Develop business plan | 12 |
| **Total** | | **40** |

**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 | * Observation * Project * Written assessment * Third party report * Interviews |
| 1. 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 | * Observation * Project * Written assessment * Third party report |
| 1. Identify entrepreneurship opportunities | * 1. Sources of business ideas   2. Factors to consider when evaluating business opportunity   3. Business life cycle | * Observation * Project * Written assessment * Third party report |
| 1. 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 | * Observation * Project * Written assessment * Third party report |
| 1. Innovate business Strategies | * 1. Creativity in business   2. Innovative business strategies   3. Entrepreneurial Linkages   4. ICT in business growth and development | * Observation * Project * Written assessment * Third party report |
| 1. 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 | * Observation * Written assessment * Project * Third party report |

**Suggested Methods of Instruction**

* Direct instruction with active learning strategies
* Project (Business plan)
* Case studies
* Field trips
* Group Discussions
* Demonstration
* Question and answer
* Problem solving
* Experiential
* Team training
* Guest speakers

**Recommended Resources for 30 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | Comprehensive texts books on Entrepreneurial Skills | 30 pcs | 1:1 |
|  | PowerPoint Presentations | For trainer’s use, covering course content and practical applications |  |  |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:30 |
|  | Media Resources | These include but are not limited to:   * Video Clips * Audio Clips * TV Sets * Radio Sets * Newspapers * Business Journals * Case studies |  |  |
|  | Templates | Templates for creating various documents e.g. business plan, invoices etc. | 30 | 1:1 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:30 |
| **B** | **Learning Facilities & Infrastructure** |  |  |  |
|  | Lecture/Theory Room  /Learning Resource  Area\* | Spacious, equipped with projectors and Seats for 30 trainees, approximately 45 sqm (5 m x 9 m) | 1 | 1:30 |
|  | Computer Laboratory | Equipped with at least 15 functional computers with internet connectivity and the following software:   * + - Windows/ Linux/ Macintosh Operating System     - Microsoft Office Software     - Google Workspace Account     - Antivirus Software | 1 | 1:1 |
|  |  |  |  |  |
| **C** | **Consumable Materials** |  |  |  |
|  | Writing Materials | Writing materials for note taking | Enough |  |
|  | Flashcards | For carrying out various activities by trainees | Enough |  |
|  | Charts | Sufficient for group work activities and displaying | Enough |  |
|  | Whiteboard Marker Pens | Dry-erase markers for trainers use. Assorted colours | Enough |  |

# CORE UNITS OF LEARNING

# CONSTRUCTION PLANT TRANSMISSION SYSTEM MAINTENANCE

**UNIT CODE:** 0716 451 10 A

**UNIT DURATION: 160 Hours**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Maintain construction plant transmission system

**Unit Description**

This unit describes the competencies required to troubleshoot construction plant transmission system, sservice construction plant clutch assembly, and service construction plant hydrostatic transmission system, construct on plant hydrokinetic transmission system, Service construction plant final drive and service construction plant hydraulic motor

**Summary of Learning Outcomes**

By the end of this unit of learning, the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Troubleshoot construction plant transmission systems | 50 |
|  | Service construction plant clutch assembly | 20 |
|  | Service construction plant hydrostatic transmission system | 30 |
|  | Service construction plant final drive | 30 |
|  | Service construction plant hydraulic motor | 30 |
| **Total** | | **160** |

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

|  |  |  |
| --- | --- | --- |
| Learning Outcome | Content | Suggested Assessment Methods |
| * + 1. Troubleshoot construction plant transmission system | * 1. Personal protective equipment (PPE)      1. Apron      2. Safety boots      3. Gloves      4. Goggles      5. Cartridges/ nose mask      6. Helmet      7. Ear muffs   2. Safety precautions      1. Training      2. Ventilation      3. Machine isolation      4. Machine stabilization      5. Hazard identification      6. Tool safety      7. Chemical handling      8. Communication   3. Selecting Service Kits      1. Hydraulic Filters      2. Seals and O-Rings      3. Gaskets:      4. Hydraulic Fluid      5. Check and Relief Valves      6. Pump Rebuild Kits   4. Selecting tools and equipment      1. Pressure Gauges      2. Flow Meters      3. Leak Detection Tools      4. Torque Wrenches      5. Cleaning Kits      6. Dial Indicators      7. Service Laptop with Diagnostic Software      8. Cleaning Kits   5. Dismasting transmission components      1. Gearbox      2. Clutch assembly      3. Drive shafts      4. Torque converter      5. Differential      6. Transmission fluid      7. Synchronizers      8. Shift linkage      9. Transmission housing      10. Bearings   6. Inspecting transmission system components      1. Check for Leaks      2. Inspect Hoses and Fittings      3. Examine Seals and O-Rings      4. Reservoir Inspection   7. Diagnosing transmission system faults      1. Leakages      2. Cracks      3. Worn parts      4. Hard shifting   8. Testing hydraulic transmission system      1. Pressure test      2. Flow testing      3. Temperature testing      4. Leak detection      5. Component testing      6. Hydraulic and control system testing      7. System runs down test   9. Service documentation      1. Job cards      2. Checklists      3. Files      4. Logbooks   10. Housekeeping       1. Tool and equipment organization       2. Work area cleanliness       3. Safe handling and disposal of hazardous materials       4. Inspection and maintenance of equipment       5. Personal protective equipment management       6. Air and ventilation maintenance       7. Incident prevention and reporting |  |
| * Practical assessment * Project * Third party report * Written test   Portfolio of evidence |
| * + 1. Service construction plant clutch assembly | * 1. Preparing work area      1. Safety Precautions      2. Organize Tools and Equipment      3. Prepare for Cleanliness      4. Organize Parts and Components      5. Prepare the Vehicle      6. Review Service Manual and Instructions      7. Lighting and Visibility   2. Identify clutch assembly components      1. Clutch disc      2. Pressure plate      3. Flywheel      4. Clutch release bearing      5. Clutch fork      6. Clutch master cylinder      7. Clutch slave cylinder      8. Clutch cable      9. Diaphragm spring      10. Pilot bearing   3. Selecting tools and equipment      1. Bleeder Kit      2. Brake and Clutch Fluid      3. Fluid Catch Bottle      4. Socket and Wrench Set      5. Brake Cleaner      6. Clutch Pedal Depressor Tool      7. Pliers and Screwdrivers      8. Hydraulic Jack and Jack Stands      9. Replacement Seals and Gaskets   4. Disassembling of construction plant clutch assembly   5. Inspecting of clutch components      1. Friction Material      2. Disc Thickness      3. Hub Splines      4. Surface Condition      5. Excessive Play      6. Alignment and Fit      7. Cracks or Bends      8. Hydraulic Lines      9. Fluid Quality:   6. Service clutch components assembly      1. Fluid Inspection and Replacement      2. Clutch Master Cylinder Service      3. Slave Cylinder Service      4. Clutch Line Inspection and Replacement      5. Adjustment of Clutch Pedal      6. Release (Throw-Out) Bearing Service      7. Pilot Bearing or Bushing Replacement      8. Bleeding the Clutch Hydraulic System      9. Flywheel Inspection and Resurfacing   7. Testing of the clutch components      1. Checks for leaks      2. Inspect clutch pedal      3. Master cylinder pressure test      4. Slave cylinder pressure test      5. Clutch pedal force test      6. Cutch pedal travel test      7. Engagement test      8. Disengagement test      9. Flow meter testing   8. Service documentation      1. Job cards      2. Checklists      3. Files      4. Logbooks   9. Housekeeping      1. Tool and equipment organization      2. Work area cleanliness      3. Safe handling and disposal of hazardous materials      4. Inspection and maintenance of equipment      5. Personal protective equipment management      6. Air and ventilation maintenance      7. Incident prevention and reporting | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| * + 1. Service construction plant hydrostatic transmission system | * 1. Preparing work area      1. Safety Precautions      2. Organize Tools and Equipment      3. Prepare for Cleanliness      4. Organize Parts and Components      5. Prepare the Vehicle      6. Review Service Manual and Instructions      7. Lighting and Visibility   2. Identify hydrostatic transmission components      1. Hydraulic Pump      2. Hydraulic Motor      3. Reservoir      4. Control Valve      5. Charge Pump      6. Relief Valve      7. Filter      8. Heat Exchanger      9. Hoses and Tubing   3. Selecting of tools and equipment      1. Pressure Gauge Kit      2. Flow Meter      3. Hydraulic Test Ports and Fittings      4. Dial Indicator      5. Torque Wrench      6. Hydraulic Fluid Filter Wrench      7. Oil Sample Kit   4. Dismantling hydrostatic transmission system   5. Inspecting of hydrostatic transmission fittings      1. Checking the hydraulic pressure system      2. Inspecting of hydraulic drive motors      3. Replacing of hydraulic fluid      4. Performing adjustment and calibrations of hydrostatic clutch system to specifications   6. Testing of hydrostatic transmission system   7. Inspecting of clutch components      1. Friction Material      2. Disc Thickness      3. Hub Splines      4. Surface Condition      5. Excessive Play      6. Alignment and Fit      7. Cracks or Bends      8. Hydraulic Lines      9. Fluid Quality:   8. Service clutch components assembly      1. Fluid Inspection and Replacement      2. Clutch Master Cylinder Service      3. Slave Cylinder Service      4. Clutch Line Inspection and Replacement      5. Adjustment of Clutch Pedal      6. Release (Throw-Out) Bearing Service      7. Pilot Bearing or Bushing Replacement      8. Bleeding the Clutch Hydraulic System      9. Flywheel Inspection and Resurfacing   9. Service documentation      1. Job cards      2. Checklists      3. Files      4. Logbooks   10. Housekeeping       1. Tool and equipment organization       2. Work area cleanliness       3. Safe handling and disposal of hazardous materials       4. Inspection and maintenance of equipment       5. Personal protective equipment management       6. Air and ventilation maintenance       7. Incident prevention and reporting | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| * + 1. Service construction plant final drive | * 1. Preparing work area      1. Safety Precautions      2. Organize Tools and Equipment      3. Prepare for Cleanliness      4. Organize Parts and Components      5. Prepare the Vehicle      6. Review Service Manual and Instructions      7. Lighting and Visibility  1. Identify construction plant final drive components    * 1. Hydraulic Motor      2. Planetary Gearbox (or Gear Reduction Assembly)      3. Brake Assembly      4. Final Drive Housing (or Casing)      5. Output Shaft 2. Selection of tools and equipment 3. Hydraulic jack lifts 4. Torque wrenches 5. Cranes 6. Sealant and gasket removal tools 7. Pressure testing equipment 8. Bearing pullers 9. Alignment tools 10. Diagnostic tools 11. Dismantling of hydrostatic final drive 12. Identifying drive configuration of transmission     * 1. Input stage       2. Planetary gears       3. Output stage 13. Inspecting final drive for faults     * 1. Excessive vibration or noise       2. NLeaks of hydraulic fluids       3. Loos of power or reduced speed       4. Overheating of the final drive       5. Final drive lockup 14. Servicing/repairing of damage final drive components 15. Inspecting of clutch components     * 1. Friction Material       2. Disc Thickness       3. Hub Splines       4. Surface Condition       5. Excessive Play       6. Alignment and Fit       7. Cracks or Bends       8. Hydraulic Lines       9. Fluid Quality: 16. Service clutch components assembly     * 1. Fluid Inspection and Replacement       2. Clutch Master Cylinder Service       3. Slave Cylinder Service       4. Clutch Line Inspection and Replacement       5. Adjustment of Clutch Pedal       6. Release (Throw-Out) Bearing Service       7. Pilot Bearing or Bushing Replacement       8. Bleeding the Clutch Hydraulic System       9. Flywheel Inspection and Resurfacing     1. Service documentation        1. Job cards        2. Checklists        3. Files        4. Logbooks     2. Housekeeping        1. Tool and equipment organization        2. Work area cleanliness        3. Safe handling and disposal of hazardous materials        4. Inspection and maintenance of equipment        5. Personal protective equipment management        6. Air and ventilation maintenance        7. Incident prevention and reporting | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| * + 1. Service construction plant hydraulic motor | * 1. Preparing work area      1. Safety Precautions      2. Organize Tools and Equipment      3. Prepare for Cleanliness      4. Organize Parts and Components      5. Prepare the Vehicle      6. Review Service Manual and Instructions      7. Lighting and Visibility   2. Identification of hydraulic motor components      1. Rotor      2. Stator      3. Drive shaft      4. Valve plate      5. Bearings      6. Housing      7. Pistons      8. Swashplate      9. Port plate      10. Seals   3. Selecting tools and equipment      1. Hydraulic pressure gauge      2. Torque range      3. Hydraulic oil filtration equipment      4. Seal puller/seal installation tool      5. Micrometres and callipers      6. Hydraulic motor pulley puller      7. Bearing puller      8. Vibration analysis equipment   4. Dismantling of hydraulic motor   5. Cleaning of hydraulic motor components   6. Inspecting of hydraulic motor components for faults      1. Visual inspection      2. Operational checks      3. Pressure and flow testing      4. Hydraulic fluid inspection      5. Seal and gasket inspection      6. Shaft and bearing inspection      7. Alignment check      8. Torque testing   7. Servicing/Replacing faulty hydraulic motor components   8. Seal and bearing replacement   9. Cleaning and filtration   10. Reconditioning and rebuilding   11. Performance calibrations   12. Testing of hydraulic motor components       1. Test for run out       2. Test for shaft wear       3. Check for end play in bearing       4. Pressure testing on seals and gaskets       5. Hydraulic test       6. Pressure relief valve test       7. Fluid quality test   13. Service documentation       1. Job cards       2. Checklists       3. Files       4. Logbooks   14. Housekeeping       1. Tool and equipment organization       2. Work area cleanliness       3. Safe handling and disposal of hazardous materials       4. Inspection and maintenance of equipment       5. Personal protective equipment management       6. Air and ventilation maintenance       7. Incident prevention and reporting | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |

Suggested Methods of Instruction

* Practical
* Projects
* Demonstration
* Group discussion
* Direct instruction
* Industrial Visits

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S/No. | Category/Item | Description/ Specifications | Quantity | Recommended Ratio  (Item: Trainee) |
| A | Learning Materials |  |  |  |
|  | Textbooks |  | 5 pcs | 1:5 |
|  | Installation manuals |  |  |  |
|  | Projectors | For trainer’s use | 1 | 1:25 |
|  | Laptops | For trainer’s use | 1 | 1:25 |
|  | Charts |  |  |  |
|  | PowerPoint presentations | For trainer’s use |  |  |
| B | Learning Facilities & infrastructure |  |  |  |
|  | Lecture/theory room |  | 1 | 1:25 |
|  | Workshop |  | 1 | 1:25 |
|  | Work benches |  | 5 | 1:5 |
|  | Transmission Models | For trainer’s use | 1 | 1:25 |
| C | Consumable materials |  |  |  |
|  | Transmission fluids/oil | 20 litters |  | 4:5 |
|  | Transmission filters | 1 | 5 | 1:5 |
|  | Gaskets and seals | 5 pieces | 5 | 1:5 |
|  | Grease | 2kilograms | 5 | 2:5 |
|  | Transmission belts | 5 pieces | 5 | 1:5 |
|  | Clutches and friction materials | 1 piece | 5 | 1:5 |
|  | Transmission Coolant | 5 litters | 5 | 1:5 |
| D | Tools and Equipment |  |  |  |
|  | Earth moving machines |  | 1 | 1:25 |
|  | Transmission fluid pumps |  | 5 | 1:5 |
|  | Fluid exchange machine |  | 5 | 1:5 |
|  | Fluid extractor |  | 5 | 1:5 |
|  | Scan tools/diagnostic computers |  | 5 | 1:5 |
|  | Pressure testers |  | 5 pcs | 1:5 |
|  | Torque wrenches |  | 5 pcs | 1:5 |
|  | Pneumatic tools |  | 5 pcs | 1:5 |
|  | Hydraulic jacks | For machines | 5pcs | 1:5 |
|  | Transmission jacks |  | 2 | 2:25 |
|  | Cleaning equipment |  |  |  |
|  | Specialized repair tools |  | 5 | 1:5 |
|  | Assorted Measuring and calibration tools |  | 5 | 1:5 |
|  | Transmission flush and cooling system equipment |  | 1 | 1:25 |
|  | Safety equipment |  | 25 | 1:1 |

# CONSTRUCTION PLANT BRAKE SYSTEM MAINTENANCE

**UNIT CODE:** 0716 451 11A

**UNIT DURATION: 150** Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Maintain Construction Plant Brake System

**Unit Description**

This unit describes the competencies required to inspect construction plant braking system, service construction plant band brakes, service construction plant disk and drum brake system, service construction plant anchor type brake system and service construction plant toggle brakes.

**Summary of Learning Outcomes**

By the end of this unit of learning, the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Inspect construction plant braking system | 30 |
|  | Service construction plant band brakes | 30 |
|  | Service construction plant disk and drum brake system | 30 |
|  | service construction plant anchor type brake system | 30 |
|  | Service construction plant toggle brakes. | 30 |
| **Total** | | **150** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Inspect construction plant braking system | * 1. Personal protective equipment (PPE)      1. Apron      2. Safety boots      3. Gloves      4. Goggles      5. Cartridges/ nose mask      6. Helmet      7. Ear muffs   2. Observing safety precautions      1. Training      2. Ventilation      3. Personal protective gear      4. Machine isolation      5. Machine stabilization      6. Hazard identification      7. Tool safety      8. Chemical handling   3. Introduction to construction plant braking system      1. Types of construction plant brakes         1. Hydraulic Wet Disc Brakes         2. Drum Brakes         3. Hydraulic Dry Disc Brakes         4. Air Brakes         5. Parking Brakes         6. Anti-Lock Braking Systems (ABS)   4. Checking construction plant brake components      1. Brake Pads and Shoes      2. Brake Discs and Drums      3. Master Cylinder      4. Brake Calipers      5. Brake Lines and Hoses      6. Parking Brake Mechanism      7. Brake Actuators      8. Brake Booster (Power Brake Unit)      9. ABS (Anti-Lock Braking System) Sensors      10. Brake Fluids and Lubricants | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| 1. Service construction plant band brakes | * 1. Identify construction plant band brakes      1. Winch Brakes on Cranes      2. Drum Winches on Excavators      3. Crawler Dozers      4. Mining and Quarry Equipment   2. Preparing work area      1. Safety Precautions      2. Organize Tools and Equipment      3. Prepare for Cleanliness      4. Organize Parts and Components      5. Prepare the Vehicle      6. Review Service Manual and Instructions      7. Lighting and Visibility   3. Selecting correct tools and materials      1. Basic Hand Tools      2. Brake Band Lining Tools      3. Calipers and Measuring Tools      4. Brake Band Adjustment Tools      5. Lifting and Support Equipment      6. Cleaning and Lubrication Supplies      7. Inspection and Testing Equipment   4. Dismantling construction brake band component   5. Cleaning internal components for brake bands   6. Inspecting brake band component for faults      1. **Check for Cracks or Fractures**      2. Examine for Deformation      3. Inspect for Corrosion      4. Inspect Brake Lining      5. Look for Signs of Glazing      6. Examine Rivets or Adhesive Bonding      7. Evaluate Drum Condition      8. Inspect Adjustment Mechanisms   7. Servicing and repair of damages in brake bands      1. Install New Lining      2. Remove Rust and Corrosion      3. Reshape or Adjust the Band if Needed      4. Replace Worn Springs and Tensioners      5. Lubricate Moving Part      6. Smooth Drum Surface      7. Reinstall the Brake Band      8. Reconnect Tensioners and Adjusters      9. Adjust Band Tension      10. Check Band Alignment   8. Testing of construction plant brake band      1. Functional Test      2. Load Test      3. Check for Uneven Contact   9. Service documentation      1. Job cards      2. Checklists      3. Files      4. Logbooks   10. Housekeeping       1. Tool and equipment organization       2. Work area cleanliness       3. Safe handling and disposal of hazardous materials       4. Inspection and maintenance of equipment       5. Personal protective equipment management       6. Air and ventilation maintenance       7. Incident prevention and reporting | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| 1. Service construction plant drum and disk brake system | * 1. Identify construction drum brake and disk brake system      1. Drum Brake Components         1. Brake Drum         2. Brake Shoes         3. Brake Lining         4. Wheel Cylinder         5. Return Springs         6. Adjuster Mechanism         7. Backing Plate      2. Disc Brake Components         1. Brake Rotor (Disc         2. Brake Caliper         3. Brake Pads         4. Brake Piston (s         5. Caliper Bracket         6. Brake Fluid Lines         7. Anti-Rattle Clips         8. ABS Sensor (if equipped)         9. Dust Boots and Seals   2. Dismantling of brake drum and disk brake system   3. Clean the drum and disk brake components   4. Inspecting of brake drum and disk for faults      1. Check for Grooves, Scoring, or Cracks      2. Measure Drum Diameter      3. Check Lining Thickness      4. Look for Glazing or Contamination      5. Check for Weak or Damaged Springs      6. Inspect Mounting Hardware      7. Check for Leaks      8. Check Piston Operation      9. Look for Wear Marks or Grooves      10. Check for Rust or Corrosion      11. Check for Free Movement   5. Serving/Replacing faulty disk and drum components      1. Remove Worn Brake Shoes      2. Install New Brake Shoes      3. Replace Brake Lining if Needed      4. Rebuild the Cylinder      5. Replace Return Spring      6. Resurface the Drum      7. Replace Seals and Dust Boots      8. Resurface the Rotor   6. Reassemble drum and disk components   7. Carry out brake bleeding   8. Testing disk and drum brake components   9. Service documentation      1. Job cards      2. Checklists      3. Files      4. Logbooks   10. Housekeeping       1. Tool and equipment organization       2. Work area cleanliness       3. Safe handling and disposal of hazardous materials       4. Inspection and maintenance of equipment       5. Personal protective equipment management       6. Air and ventilation maintenance       7. Incident prevention and reporting | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| 1. Service construction plant anchor type brake system | * 1. Identify construction plant anchor brake system components      1. Anchor plate      2. Brake shoe      3. Brake drum      4. Actuating lever      5. Springs      6. Pivot pin      7. Adjustment screw      8. Brake lining      9. Mounting bracket   2. Dismantle construction plant anchor brake system   3. Clean the internal anchor brake system components   4. Inspecting anchor type brakes components for faults      1. Check for Damage or Excessive Wear      2. Inspect for Cracks      3. Examine Brake Shoe Lining Thickness      4. Check for Uneven Wear      5. Check for Secure Mounting      6. Inspect Pin and Bushing Wear      7. Corrosion      8. Check for Wear and Surface Condition   5. Servicing anchor type brake components      1. Replace or Rebuild Brake Shoes      2. Adjust Shoe Position      3. Install New Anchor Pin and Bushing      4. Align and Secure the Anchor Pin      5. Install New Springs      6. Lubricate and Reinstall      7. Flush and Replace Brake Fluid      8. Adjust Brake Shoe Clearance   6. Reassemble anchor brake system components   7. Testing anchor type brake components   8. Service documentation      1. Job cards      2. Checklists      3. Files      4. Logbooks   9. Housekeeping      1. Tool and equipment organization      2. Work area cleanliness      3. Safe handling and disposal of hazardous materials      4. Inspection and maintenance of equipment      5. Personal protective equipment management      6. Air and ventilation maintenance      7. Incident prevention and reporting | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| 1. Service construction plant toggle brakes | * 1. Identify construction plant toggle brakes      1. Brake lever      2. Toggle mechanism      3. Brake shoes      4. Brake drum      5. Spring      6. Actuating rod      7. Pivot pin      8. Mounting bracket      9. Adjustment nut      10. Cable assembly   2. Select the require tools      1. Wrenches and Socket Sets      2. **Brake Spring Pliers**      3. Brake Shoe Adjustment Tools      4. **Hydraulic Jack**      5. Hydraulic Fluid Dispenser      6. Brake Pressure Tester      7. Torque Wrench   3. Dismantle construction plant toggle brake   4. Inspect the toggle brakes for faulty      1. **Toggle Link Wear**      2. Brake Pads and Shoes      3. Drums and Rotors      4. **Springs and Retainers**      5. Check Fluid Levels      6. Inspect Brake Lines and Hoses      7. Inspect Brake Lines and Hoses   5. Servicing faulty toggle brake components   6. Testing toggle brake component      1. Brake Pedal Feel      2. Brake Engagement      3. Parking Brake Check   7. Service documentation      1. Job cards      2. Checklists      3. Files      4. Logbooks   8. Housekeeping      1. Tool and equipment organization      2. Work area cleanliness      3. Safe handling and disposal of hazardous materials      4. Inspection and maintenance of equipment      5. Personal protective equipment management      6. Air and ventilation maintenance      7. Incident prevention and reporting | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |

**Suggested Methods of Delivery**

* Practical
* Projects
* Demonstration
* Group discussion
* Direct instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks |  | 5 pcs | 1:5 |
|  | Installation manuals |  |  |  |
|  | Projectors | For trainer’s use | 1 | 1:25 |
|  | Laptops | For trainer’s use | 1 | 1:25 |
|  | Charts |  |  |  |
|  | PowerPoint presentations | For trainer’s use |  |  |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room |  | 1 | 1:25 |
|  | Workshop |  | 1 | 1:25 |
|  | Work benches |  | 5 | 1:5 |
|  | Undercarriage model | For trainer’s use | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
|  | Brake Pads and Linings | For machine use | 1 | 1:25 |
|  | **Brake Fluid** | For machine use | 2 | 2:25 |
|  | Lubricants and Grease | For machine use | 1 | 1:25 |
|  | **Brake Cleaner** | For machine use | 1 | 1:25 |
|  | Brake Hardware Kits | For machine use | 1 | 1:25 |
|  | Brake Dust Shields and Boots | For machine use | 1 | 1:25 |
|  | Sealing Washers and Gaskets | For machine use | 1 | 1:25 |
|  | Rotors and Brake Drums | For machine use | 1 | 1:25 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Earth Moving machines |  | 1 | 1:25 |
|  | Assorted/Specialized tools |  | 5 | 1:5 |
|  | Welding equipment |  | 2 | 2:25 |
|  | Measuring tools |  | 5 | 1:5 |
|  | Lifting chains equipment |  | 2 | 2:25 |
|  | Service manual |  | 2 | 2:25 |
|  | Track press cylinder seal kits |  | 5 | 1:5 |

# MODULE IV

# BASIC UNIT OF LEARNING

# WORK ETHICS AND PRACTICES

**ISCED UNIT CODE:** **0417 441 12A**

**Relationship with Occupational Standards**

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

**Duration of Unit: 40 Hours**

**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**

By the end of this unit of learning, the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Apply self-management skills | 10 |
|  | Promote ethical practices and values | 4 |
|  | Promote Teamwork | 10 |
|  | Maintain professional and personal development | 10 |
|  | Apply Problem-solving skills | 4 |
|  | Promote Customer care. | 2 |
| **Total** | | **40** |

**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      1. Developing and maintaining high self-esteem      2. Developing and maintaining positive self-image      3. Time management      4. Setting performance targets      5. Monitoring and evaluating performance targets | * Observation * Written 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 * Third party reports * Portfolio of evidence * Project * Practical |
| 1. Promote Teamwork | * 1. Types of teams   2. Team building      1. Individual responsibilities in a team      2. Determination of team roles and objectives      3. Team parameters and relationships      4. Benefits of teamwork      5. Qualities of a team player      6. Leading a team      7. Team performance and evaluation   3. Conflicts and conflict resolution   4. Gender and diversity mainstreaming   5. Developing Healthy workplace relationships   6. Adaptability and flexibility   7. Coaching and mentoring skills | * Observation * Written assessment * Third party reports * Portfolio of evidence * 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      1. Assessing training needs      2. Mobilizing training resources   5. Licenses and certifications for professional growth and development   6. Pursuing personal and organizational goals   7. Managing work priorities and commitments   8. Dynamism and on-the-job learning | * Observation * Written 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 * 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 * Third party reports * Portfolio of evidence * Project * Practical |

**Suggested Methods of Instruction**

* Instructor lead facilitation of theory using active learning strategies.
* Demonstrations
* Simulation/Role play
* Group Discussion
* Presentations
* Projects
* Case studies
* Assignments

**Recommended Resources for 30 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | Comprehensive texts books on Work Ethics and Practices | 30 pcs | 1:1 |
|  | PowerPoint Presentations | For trainer’s use, covering course content and practical applications |  |  |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:30 |
|  | Media Resources | This include but are not limited to:   * Video Clips * Audio Clips * TV Sets * Radio Sets |  |  |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:30 |
| **B** | **Learning Facilities & Infrastructure** |  |  |  |
|  | Lecture/Theory Room  /Learning Resource  Area\* | Spacious, equipped with projectors and Seats for 30 trainees, approximately 45 sqm (5 m x 9 m) | 1 | 1:30 |
|  | Computer Laboratory | Equipped with at least 30 functional computers with internet connectivity and the following software:   * + - Windows/ Linux/ Macintosh Operating System     - Microsoft Office Software     - Google Workspace Account     - Antivirus Software | 30 | 1:1 |
|  |  |  |  |  |
| **C** | **Consumable Materials** |  |  |  |
|  | Printing Papers | A4 and A3 Printing papers suitable for the task | Enough |  |
|  | Flashcards | For carrying out various activities by trainees | Enough |  |
|  | Charts | Sufficient for group work activities and displaying | Enough |  |
|  | Whiteboard Marker Pens | Dry-erase markers for trainers use. Assorted colors | Enough |  |

# COMMON UNIT OF LEARNING

# MECHANICAL SCIENCE

**UNIT CODE: 0715 441 13**

**Relationship with Occupational Standards**: Apply Mechanical Science

**Duration of Unit**: **80 Hours**

**Unit Description**

This unit describes the competences required in order to apply mechanical science. It includes resolving forces, determining effects of loads in mechanical systems, analysing properties of materials, determining the nature of friction in mechanical systems and solving problems related to motion.

**Summary of Learning Outcomes**

By the end of this unit of learning, the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Resolve forces | 10 |
|  | Determine effects of loads in mechanical systems. | 20 |
|  | Analyze properties of materials. | 10 |
|  | Determine the nature of friction in mechanical systems | 20 |
|  | Solve problems related to motion. | 20 |
| **Total** | | **80** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Resolve forces | * 1. Definition of force   2. Types of force systems      1. Colinear      2. Coplanar      3. Concurrent   3. Theorems of forces      1. Triangle      2. Parallelogram      3. Polygon   4. Resolution of forces      1. Analysis      2. Graphical Method | * Written Tests * Portfolio of Evidence |
| 1. Determine effects of loads in mechanical systems. | * 1. Types of Forces      1. Friction      2. Centrifugal      3. Centripetal      4. Gravitational      5. Inertia   2. Moments      1. Definition      2. Calculations of moment of force about an axis   3. Principles of Moments      1. Clockwise and anticlockwise moments   4. Application of Moments of Forces in Engineering      1. Simply supported beams having point loads   5. Determination of moment couples      1. Simply supported beams with couples | * Written Tests * Portfolio of Evidence |
| 1. Analyze properties of materials | * 1. Mechanical Properties of Materials:      1. Strength (Compressive, Shear. And Tensile)      2. Brittleness      3. Hardness      4. Malleability      5. Plasticity      6. Elasticity      7. Toughness   2. Mechanical Materials Properties Tests      1. Tensile Test      2. Hardness Test   3. Direct Stresses      1. Define Stress      2. Types of Stress:         1. Tensile stress         2. Compressive stress      3. Calculate Stress   4. Selection of Materials      1. Factors to Consider in Materials Selection | * Written Tests * Portfolio of Evidence |
| 1. Determine the nature of friction in mechanical systems | * 1. Friction      1. Definition      2. Advantages and disadvantages of friction   2. Laws of Friction:      1. Laws of static friction      2. Laws of dynamic friction   3. Effects of Friction   4. Applications of Friction      1. Lubrication      2. Tyre Traction      3. Braking Systems      4. Bearing and Bushings      5. Grinding of Tools      6. Transmission Systems | * Written Tests * Portfolio of Evidence |
| 1. Solve problems related to motion. | * 1. Definition of terms      1. Distance      2. Displacement      3. Time      4. Speed      5. Velocity      6. Acceleration   2. Laws of Motion      1. Newton’s First Law of Motion      2. Newton’s Second Law of Motion      3. Newton’s Third Law of Motion   3. Calculating Parameters of Motion      1. Equations of linear and angular motion      2. Calculations         1. Displacement         2. Speed         3. Velocity         4. Acceleration   4. Linear and Angular Motion      1. Converting         1. Angular to Linear Motion         2. Linear to angular motion   5. Motion Graphs      1. Displacement/Time Graphs      2. Velocity/Time Graphs | * Written Tests * Portfolio of Evidence |

**Suggested Delivery Methods**

* Group discussions
* Demonstration by the trainer
* Online video clips
* Power point presentation

**Recommended Resources for 30 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Learning Materials** | | | |
|  | Textbooks | Comprehensive textbooks on Engineering Mathematics | 30 | 1:1 |
|  | Graph books | For graphical representation of solutions | 30 | 1:1 |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:30 |
|  | Computer | Functional desktop computer with online instructional content | 1 | 1:30 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:30 |
|  | Printer | An ink-jet, laser-jet or toner-cartridge printer for printing notes, instructions and working drawings | 1 | 1:30 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room | Spacious room with seats for 25 trainees, approximately 60 sqm | 1 | 1:30 |
| **C** | **Materials and Supplies** | | | |
|  | First Aid kit | Fully equipped First Aid kit for use in case of accidents | 1 | 1:30 |
| **D** | **Tools and Equipment** | | | |
|  | Scientific Calculator | For Calculations | 30 | 1:1 |
| **E** | **Reference Materials** | | | |
|  | Training Presentations/Slides | Digital format for shared access among trainees | 1 | 1:30 |
|  | Standard Mathematical Tables | For reference on formulae, identities, laws and principles | 30 | 1:1 |

# CORE UNIT OF LEARNING

# CONSTRUCTION PLANT STEERING AND SUSPENSION SYSTEMS MAINTENANCE

**UNIT CODE: 0716 451 14A**

**UNIT DURATION: 150** Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Maintain construction plant steering and suspension systems.

**Unit Description**

This unit describes the competencies required to service construction plant hydraulic valves, replace construction plant hydraulic filter, service construction plant fuel tank, service construction plant pump, service construction plant hydraulic cylinder.

**Summary of Learning Outcomes**

By the end of this unit of learning, the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Inspect construction plant steering and suspension systems. | 50 |
|  | Service construction plant steering system | 50 |
|  | Service construction plant suspension system | 50 |
| **Total** | | **150** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Inspect construction plant steering and suspension systems. | * 1. Personal protective equipment (PPE)      1. Apron      2. Safety boots      3. Gloves      4. Goggles      5. Cartridges/ nose mask      6. Helmet      7. Ear muffs   2. Safety precautions      1. Training      2. Ventilation      3. Machine isolation      4. Machine stabilization      5. Hazard identification      6. Tool safety      7. Chemical handling      8. Communication   3. Selecting tools and equipment      1. Wrenches and ratchet      2. Impact wrench      3. Hammers      4. Pin punch sets      5. Bearing press      6. Service manual      7. Grease gun      8. Screw drivers      9. Pliers      10. Torque wrenches      11. Hydraulic pullers      12. Spring compressors   4. Inspecting steering system      1. Steering wheels      2. Steering column      3. Steering gearboxes      4. Tie rods      5. Pitman arm      6. Centre link/drag link      7. Steering pump      8. Steering fluid reservoirs      9. Steering shaft      10. Steeling coupler   5. Activity documenting      1. Job cards      2. Checklists      3. Files      4. Logbooks   6. Performing housekeeping      1. Waste disposal method      2. Recycling methods      3. Resource management      4. Pollution control      5. Cleaning | * Project * Third party report * Written test * Portfolio of evidence Practical assessment |
| Service construction plant steering system | * 1. Selecting tools and equipment      1. Wrenches and ratchet      2. Impact wrench      3. Hammers      4. Pin punch sets      5. Bearing press      6. Service manual      7. Grease gun      8. Screw drivers      9. Pliers      10. Torque wrenches      11. Hydraulic pullers      12. Spring compressors   2. Draining lubricant      1. Hydraulic fluid      2. Grease      3. Power steering fluid      4. Penetrating oil      5. Silicone based lubricant   3. Disassembling Steering components      1. Steering wheels      2. Steering column      3. Steering gearboxes      4. Tie rods      5. Pitman arm      6. Centre link/drag link      7. Steering pump      8. Steering fluid reservoirs      9. Steering shaft      10. Steering coupler   4. Inspecting Steering components      1. leaks      2. Breakages      3. Cracks      4. Rust      5. Play or looseness      6. Bends      7. dents   5. Testing steering components      1. Straightness      2. Wheel play      3. Hydraulic pressure      4. Steering gear and linkage      5. Tie rod ends      6. Steering assists      7. Powe steering test      8. Alignment test      9. Load test      10. Steering stop function   6. Servicing Steering components      1. Steering wheels      2. Steering column      3. Steering gearboxes      4. Tie rods      5. Pitman arm      6. Centre link/drag link      7. Steering pump      8. Steering fluid reservoirs      9. Steering shaft      10. Steeling coupler   7. Applying technical information      1. Service manual reference   8. Assembling steering system      1. Assembly of steering component   9. Application lubricant      1. Steering linkage joints      2. Steering box and gears      3. Kingpin and bushing      4. Swivel joint and pivot joints      5. Hydraulic connections      6. Steering system testing   10. Road test | * Project * Third party report * Written test * Portfolio of evidence Practical assessment |
| 1. Service construction plant suspension system | * 1. Selection tools and equipment      1. Spring compressor      2. Hydraulic jack and lift      3. Torque wrenches      4. Suspension alignment tools      5. Component puller      6. Shock absorber tester      7. Grease gun      8. Measuring tools         1. Micrometre         2. Callipers screw gauge      9. Bushing removal tool      10. Hydraulic press equipment      11. Assorted spanners   2. Inspection of suspension system      1. Steering linkages         1. Checking for any damage         2. Wear, cracks and ben ding         3. Misalignment      2. Steering cylinder         1. Leakage inspection         2. Damage inspection      3. Steering pump and fluid         1. Leakage checks      4. Steering wheel or control mechanism         1. Test for smooth operation      5. Tie rods and ball joints         1. Wear and damage checks      6. Operation test         1. Turning steering checks   3. Steering suspension system dismantling      1. Disconnect the Power Sources         1. Hydraulic Systems            1. Depressurizing the system            2. Disconnection of hydraulic hoses            3. Capping off any open hydraulic lines to prevent contamination.         2. Pneumatic Systems            1. Releasing air pressure from the system.            2. Disconnecting air lines         3. Electrical Systems            1. Disconnection of any electrical connections      2. Removal of Suspension Components         1. Removal of external attachments         2. Loosening and removal of fasteners         3. Disconnection of the Suspension Arms and Linkages         4. Removal of springs, shock absorbers, or dampers   4. suspension system components cleaning   5. Inspection of suspension system components      1. Visual inspection         1. Coil springs            1. Checking for deformation            2. Inspect for Surface damage   Spring Tension   * + - 1. Shock absorbers/dampers:          1. Looking for leaks          2. Checking for damage          3. Compression test       2. Suspension Arms          1. Inspection for cracks and deformation          2. Checking of for rust or corrosion       3. Linkages and mounting points          1. Checking of bolts and fasteners          2. Inspection of bearings and bushings   1. Replacement of faulty suspension system components   2. Assembling suspension system      1. Installation of suspension frame      2. Installation of suspension springs:      3. installation of shock absorbers      4. Installation of suspension arms and linkages      5. Installation of hydraulic/pneumatic components:      6. Installation of cables/chains/rods      7. Reconnection of systems      8. Alignment and clearance      9. Testing      10. Final inspection   3. Adjustment of steering system      1. Adjusting steering linkages      2. Aligning and tightening linkages.      3. Checking steering play      4. Adjusting steering gear for play      5. Hydraulic steering adjustment      6. Adjusting steering stops      7. Testing steering system   4. Performing road-tests      1. Initial visual inspection      2. Checking for fluid levels      3. Testing steering operation      4. Checking suspension functionality      5. low-speed test      6. High-speed test      7. Check for unusual noises      8. Testing turning and maneuvering      9. Load test (if applicable)      10. Final checks | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |

**Suggested Methods of Instruction**

* Practicals
* Projects
* Demonstration
* Group discussion
* Direct instruction
* Industrial Visits

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S/No. | Category/Item | Description/ Specifications | Quantity | Recommended Ratio  (Item: Trainee) |
| A | **Learning Materials** |  |  |  |
|  | Textbooks |  | 5 pcs | 1:5 |
|  | Projector | For trainer’s use | 1 | 1:25 |
|  | Installation manuals |  | 5 copies | 1:5 |
|  | Charts | For trainer’s use | 10 | 2:5 |
|  | PowerPoint presentations | For trainer’s use | 1 |  |
|  | learning models | For trainer’s use | 1 | 1:25 |
|  | Earth moving steering and suspension system | For trainer’s use | 2 | 2:25 |
| B | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room |  | 1 | 1:25 |
|  | Workshop |  | 1 | 1:25 |
|  | Work benches |  | 5 | 1:5 |
| C | **Consumable materials** |  |  |  |
|  | Assorted sealant | silicone | 400 grams | 16:1 |
|  | Assorted gaskets |  | 5 | 1:5 |
|  | Assorted oil seals |  | 5 | 1:5 |
|  | First aid kit |  | 1 | 1:25 |
|  | Kerosene |  | 20 litres | 4:5 |
|  | Assorted Emery papers |  | 1 roll | 1:25 |
|  | Hydraulic fluid |  | 30 litres | 6:5 |
|  | Power steering fluid |  | 20 litres | 4:5 |
|  | Grease |  | 10 kilograms | 2:5 |
|  | Assorted steering fluid filters |  | 5 litres | 1:5 |
|  | Assorted belt |  | 5 | 1:5 |
|  | Brake fluid |  | 10 litres | 2:5 |
|  | Assorted dust cover boots |  | 5 | 1:5 |
|  | Assorted bushings and bearings |  | 5 | 1:5 |
|  | Assorted replacement bolts and nuts |  | 5 | 1:5 |
|  | Shock absorber fluid |  | 20 litres | 4:5 |
|  | Suspension fluid |  | 20 litres | 4:5 |
|  | Assorted suspension bushings |  | 5 | 1:5 |
|  | Assorted O-rings |  | 5 | 1:5 |
|  | Assorted air suspension filters |  | 5 | 1:5 |
|  | Assorted Suspension fluid filters |  | 5 | 1:5 |
| D | **Tools and Equipment** |  |  |  |
|  | Hydraulic Pump Tester |  | 2 | 2:25 |
|  | Torque Wrench |  | 4 | 4:25 |
|  | Steering Alignment Tools |  | 4 | 4:25 |
|  | Power Steering Pump Puller |  | 2 | 2:25 |
|  | Electronic Diagnostic Scan Tool |  | 3 | 3:25 |
|  | Wheel Alignment Machine |  | 1 | 1:25 |
|  | Steering and Suspension Tester |  | 3 | 3:25 |
|  | Hydraulic Pressure Tester |  | 3 | 3:25 |
|  | Suspension Load Tester |  | 3 | 3:25 |
|  | Ball Joint Press |  | 1 | 1:25 |
|  | Tie Rod End Puller |  | 5 | 1:5 |
|  | Pitman Arm Puller |  | 3 | 3:25 |
|  | Steering Box Puller |  | 3 | 3:25 |
|  | Steering Gearbox Tester |  | 2 | 2:25 |
|  | Tie Rod Remover Tool |  | 3 | 3:25 |
|  | Suspension Spring Compressor |  | 5 | 1:5 |
|  | Shock Absorber Testing Equipment |  | 1 | 1:25 |
|  | Strut Spring Compressor |  | 3 | 3:25 |
|  | Ball Joint Separator |  | 3 | 3:25 |
|  | Suspension Bushings Tool |  | 2 | 2:25 |
|  | Suspension Alignment Tool |  | 1 | 1:25 |
|  | Hydraulic Jack |  | 5 | 5:25 |
|  | Hydraulic Press |  | 1 | 1:25 |
|  | Hydraulic Lifting Equipment |  | 1 | 1:25 |
|  | Impact Wrench |  | 1 | 1:25 |
|  | Torque Wrench |  | 2 | 2:25 |
|  | Pry Bars |  | 2 | 2:25 |
|  | Screwdrivers and Pliers |  | 2 sets | 2:25 |
|  | Suspension Vibration Analyzer |  | 1 | 1:25 |
|  | Suspension Bushings |  | 5 | 1:5 |
|  | Workbenches with Vices |  | 5 | 5:25 |
|  | Wheel and Tire Balancer |  | 2 | 2:25 |
| E. | **Earth Moving machines** |  |  |  |
|  | Bulldozer |  | 1 | 1:25 |
|  | Excavators |  | 1 | 1:25 |
|  | Backhoe loader |  | 1 | 1:25 |
|  | Grader |  | 1 | 1:25 |

# MODULE V

# COMMON UNITS OF LEARNING

# ENGINEERING MATHEMATICS

**Unit Code:** 0541 541 15A

**Unit Duration:** 100 Hours

**Relationship to Occupational Standards**

**This unit addresses the Unit of Competency:** Apply Engineering Mathematics

**Unit Description**

This unit describes the competences required in order to apply engineering mathematics. It enables the learner to; Apply complex numbers, perform coordinate geometry, carry out binomial expansion, apply calculus, apply vector theorem and Apply matrices

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcomes** | **Duration (Hours)** |
|  | Apply complex numbers | 10 |
|  | Perform coordinate geometry | 10 |
|  | Carry out binomial expansion | 20 |
|  | Apply calculus | 40 |
|  | Apply vector theorem | 10 |
|  | Apply matrices | 10 |
| TOTAL | | 100 |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply complex numbers | * 1. Complex geometry      1. Real part      2. Imaginary part      3. Argand diagram      4. Modulus/Magnitude      5. Argument /Angle      6. Conjugate   2. Operations      1. Addition      2. Subtraction      3. Multiplication      4. Division      5. Conversions         1. Polar form to rectangular form         2. Rectangular form to polar form   3. De Moivre’s theorem      1. Expansion of complex numbers      2. Roots of complex numbers      3. Trigonometric identities using complex numbers | * Written tests |
| 1. Perform coordinate geometry | * 1. Cartesian geometry      1. Cartesian plane         1. x and y axes         2. Positive and negative coordinates      2. Gradient         1. Positive         2. Negative         3. Zero         4. Infinite         5. Gradients of parallel line         6. Gradients of perpendicular lines      3. y-intercept   2. Linear equations      1. Straight line      2. Parallel lines      3. Perpendicular lines   3. Graphs of linear equations      1. Straight lines   4. Polar geometry      1. Magnitude      2. Direction      3. Graphs   5. Conversions      1. Linear to polar      2. Polar to linear   6. Solving polar equations | * Written tests |
| 1. Carry out binomial expansion | * 1. Binomial series      1. Powers      2. Coefficients      3. Pascals triangle      4. Expansion   2. Binomial theorem      1. Positive powers of n      2. Negative powers of n      3. Fractional powers of n (roots)      4. Estimation of errors of small changes | * Written tests |
| 1. Apply calculus | * 1. Differentiation up to third order      1. Functions         1. Linear         2. Trigonometric         3. Logarithmic         4. Exponential      2. Rules         1. Power         2. Product         3. Chain         4. Quotient      3. Applications         1. Stationary points         2. Rates of change   2. Integration      1. Standard integral      2. Definite integral      3. Techniques         1. By parts         2. Substitution         3. Partial fractions      4. Applications         1. Area between and under curves         2. Volume      5. DIifferential equation      6. Double and triple integral      7. Laplace transform      8. Fourier series | * Written tests |
| 1. Apply vector theorem | * 1. Differentiate between vector and scalar quantities      1. Magnitude      2. Direction         1. Positive         2. Negative   2. Operation on vectors      1. Addition      2. Subtraction      3. Dot product      4. Cross product   3. Resolution of vectors      1. Analysis      2. Graphical Methods         1. Triangle theorem         2. Parallel theorem         3. Polygon theorem | * Written tests |
| 1. Apply matrices | * 1. Matrices      1. Types         1. Row         2. Column         3. Square         4. Zero         5. Identity         6. Diagonal   2. Matrices operations (up to 3 x 3)      1. Addition      2. Subtraction      3. Multiplication   3. Inverse of matrices (up to 3 x 3)      1. Determinant      2. Transpose      3. Adjoint      4. Inverse   4. Simultaneous equations   (up to 3 equations)   * + 1. Inverse method     2. Crammers Rule     3. Row reduction | * Written tests |

**Suggested Delivery Methods**

* Demonstration
* Group discussions
* Online materials
* Direct instructions
* Simulation

**Recommended Resources for 30 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Learning Materials** | | | |
|  | Textbooks | Comprehensive textbooks on Engineering Mathematics | 30 | 1:1 |
|  | Graph books | For graphical representation of solutions | 30 | 1:1 |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:30 |
|  | Computer | Functional desktop computer with online instructional content | 1 | 1:30 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:30 |
|  | Printer | An ink-jet, laser-jet or toner-cartridge printer for printing notes, instructions and working drawings | 1 | 1:30 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room | Spacious room with seats for 25 trainees, approximately 60 sqm | 1 | 1:30 |
| **C** | **Materials and Supplies** | | | |
|  | First Aid kit | Fully equipped First Aid kit for use in case of accidents | 1 | 1:30 |
|  | Brooms and cleaning stuff | Hand brooms and mops for cleaning | 10 | 2:5 |
| **D** | **Tools and Equipment** | | | |
|  | Set of Mathematical instruments | For constructions and measurements | 30 | 1:1 |
|  | Firefighting extinguishers | Water, carbon dioxide and chemical powder fire extinguishers for fire fighting | 1 | 1:30 |
| **F** | **Reference Materials** | | | |
|  | Training Presentations/Slides | Digital format for shared access among trainees | 1 | 1:30 |
|  | Standard Mathematical Tables | For reference on formulae, identities, laws and principles | 30 | 1:1 |

# ENGINEERING MECHANICS

**UNIT CODE: 0715 541 16A**

**Relationship to Occupational Standards**: Apply Engineering Mechanics

**Duration of Unit**: 80 Hours

**Unit Description**

This unit of competency describes the competences required in order to apply engineering mechanics principles. This includes, applying simple mechanisms, designing belts, ropes and chain drives, designing toothed gears and gear trains, designing mechanical rotor dynamic machines, applying stress and strain concepts, determining loading conditions, applying simple bending theory and applying torsion theory in mechanical systems.

**Summary of Learning Outcomes**

By the end of this unit, trainees should be able to;

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration (Hours)** |
|  | Simple Mechanisms | 10 |
|  | Belts, Ropes and Chain Drives | 10 |
|  | Toothed Gears and Gear Trains | 10 |
|  | Mechanical Rotor Dynamic Machines | 10 |
|  | Stress And Strain Concepts in Mechanical Systems | 10 |
|  | Loading Conditions in Mechanical Systems | 10 |
|  | Simple Bending Theory in Mechanical Systems | 10 |
|  | Torsion Theory in Mechanical Systems | 10 |
| **Total** | | **80** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. simple mechanisms | * 1. Define simple mechanism   2. Components of simple mechanism      1. Link      2. Element   3. Types of mechanisms      1. Single slider mechanism      2. Double slider mechanism | * Written Tests |
| 1. belts, ropes and chain drives | * 1. Definition      1. Belt      2. Rope      3. Chain   2. Belts      1. Material used for belt         + 1. Rubber           2. Cotton           3. Leather      2. Types of belts   2.2.2.1 Flat  2.2.2.2 V belt  2.2.2.3 Circular   * + 1. Configuration of belt drive   2.2.3.1Open   * + - 1. Crossed     1. Design Analysis of Flat and V-Belts   2.2.4.1Velocity ratio   * + - 1. Length of belt       2. Angle of contact       3. Power transmitted   1. Rope Drives      1. Types of rope drives   2. Chain Drives      1. Types of chain drives | * Written Tests |
| 1. toothed gears and gear trains | * 1. Types of Gears      1. Spur      2. Helical      3. Double helical   2. Types of Gear Trains      1. Simple gear train         1. Design calculations      2. Compound gear train         1. Design calculations      3. Reverted gear train         1. Design calculations      4. Epicyclic gear train   3. Lubrication of gears | * Written Tests |
| 1. Design mechanical rotor dynamic machines | * 1. Types of pumps and operation principle      1. Reciprocating pump      2. Centrifugal pump   2. Derivation of equations for      1. Reciprocating pumps      2. Centrifugal pumps   3. Analysis of pumps      1. Discharge      2. Efficiency      3. Power      4. Head      5. Weight per unit   4.4 Types and operation principle of rotary compressors   * + 1. Rotary screw compressors     2. Rotary vane compressors     3. Scroll compressor     4. Rotary lobe   1. Analysis of compressors      1. Inlet and outlet flow      2. Work done      3. Mass flow rate      4. Power requirement      5. Efficiency   2. Compressor Fans and Vanes      1. Structure and functions of compressor fans and vanes      2. Operation principles of fans and vanes in rotary compressors      3. Maintenance of fans and vanes   3. Design Analysis      1. Vane efficiency      2. Fan efficiency      3. Power consumption | * Written Tests |
| 1. Apply stress and strain concepts in mechanical systems | * 1. Define stress and strain   2. Types of simple stresses      1. Direct      2. Shear      3. Ultimate tensile stress      4. Yield stress      5. Breaking stress      6. True stress   3. Analysing stress on      1. Beams      2. Thin cylinders      3. Thin shells   4. Applications of stress and strain concepts      1. Bolts and nuts      2. Shafts | * Written Tests |
| 1. Determine loading conditions in mechanical systems | * 1. Define structure   2. Types of loading      1. Point load      2. Uniformly distributed load      3. Varying load   3. Types of beams      1. Simply supported beams      2. Cantilever beam   4. Overhanging beam |  |
| 1. Apply simple bending theory in mechanical systems | * 1. Engineers Bending Equation   2. Types of Beams      1. Simply supported beams      2. Cantilever beam      3. Overhanging beam   3. Analysis of Beams      1. T-section      2. L-section      3. I-section   4. Types of Shafts      1. Solid      2. Tubular      3. stepped   5. Analysis of shafts      1. Solid      2. Tubular      3. Stepped | * Written Tests |
| 1. Apply torsion theory in mechanical systems | * 1. Define Torsion   2. Torque Analysis   3. Analysis of Shafts      1. Series arranged shafts      2. Parallel arranged shafts   4. Determine angle of twist      1. Engineers’ torsion equation | * Written tests |

**Suggested Delivery Methods**

* Group discussions
* Demonstration by the trainer
* Online video clips
* Power point presentation
* Exercises by trainee

**Recommended resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Learning Materials** | | | |
|  | Textbooks | Comprehensive textbooks on Engineering Mathematics | 30 | 1:1 |
|  | Graph books | For graphical representation of solutions | 30 | 1:1 |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:30 |
|  | Computer | Functional desktop computer with online instructional content | 1 | 1:30 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:30 |
|  | Printer | An ink-jet, laser-jet or toner-cartridge printer for printing notes, instructions and working drawings | 1 | 1:30 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room | Spacious room with seats for 25 trainees, approximately 60 sqm | 1 | 1:30 |
| **C** | **Materials and Supplies** | | | |
|  | First Aid kit | Fully equipped First Aid kit for use in case of accidents | 1 | 1:30 |
|  | Brooms and cleaning stuff | Hand brooms and mops for cleaning | 10 | 2:5 |
| **D** | **Tools and Equipment** | | | |
|  | Calculators | For calculations | 30 | 1:1 |
|  | Firefighting extinguishers | Water, carbon dioxide and chemical powder fire extinguishers for fire fighting | 1 | 1:30 |
| **F** | **Reference Materials** | | | |
|  | Training Presentations/Slides | Digital format for shared access among trainees | 1 | 1:30 |

# THERMODYNAMICS AND FLUID MECHANICS

**UNIT CODE:** 0715 541 17A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: apply mechanical technology principles

Duration of Unit: 140 hours

**Unit Description**

This unit describes the competences required in order to apply thermodynamics and fluid mechanics in their work. It includes applying steady flow processes, perfect gas, steam cycles, fuel and combustion. It also includes applying heat transfers and exchangers, fluid mechanics concepts and operating of air compressors and fluid pumps.

**Summary of Learning Outcomes**

By the end of this unit, trainees should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | To Apply Thermodynamic Processes | 10 |
|  | To Apply knowledge of perfect gases | 10 |
|  | To Apply knowledge of steam cycle | 10 |
|  | To Apply knowledge of fuel combustion | 20 |
|  | To Apply heat transfer and heat exchangers in fluid | 20 |
|  | To Operate air compressors | 20 |
|  | To Apply the knowledge of the flow of fluids | 20 |
|  | To Apply the knowledge of viscous flow of fluids | 20 |
|  | To Apply dimensional and models analysis fluids | 30 |
|  | To Operate fluid pumps | 20 |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply Thermodynamic Processes | * 1. Basic thermodynamics terms definition      1. work,      2. Power      3. Internal Energy      4. Heat      5. Temperature   2. Laws of Thermodynamics      1. First law of thermodynamics      2. Second law of thermodynamics      3. Zeroth law of thermodynamics   3. Thermodynamic Processes      1. Non-flow Process.      2. Constant Volume Process      3. Constant Pressure Process      4. Hyperbolic Process.      5. Constant Temperature Process      6. Adiabatic Process      7. Polytropic Process.   4. Thermodynamics systems      1. Boundary and surrounding      2. Closed systems      3. Open systems      4. Isolated systems      5. Adiabatic system      6. Homogeneous systems      7. Heterogeneous systems   5. Heating and expansions of gases      1. Determine work done      2. Application of First Law of Thermodynamics      3. Reversible non-flow processes.      4. Irreversible non-flow processes   6. General Laws for Expansion and Compression      1. Define the terms:         1. Expansion         2. compression      2. Apply PVn = Constant for various values of n      3. Curves of pressure against volume for various values of n (index)   7. Application of Steady Flow Energy Equation to:      1. boilers      2. condensers      3. nozzles      4. diffusers      5. compressors      6. turbines | * Written tests |
| 1. Apply knowledge of perfect gases | * 1. Laws of Perfect Gases      1. Boyle's Law      2. Charles' Law      3. Gay-Lussac Law      4. Joule's Law      5. Avogadro's Law   2. General Gas Equation      1. Derive and apply general gas equation PV=nRT   3. Characteristic Equation of Gas      1. Application in engineering calculations   4. Universal Gas Constant      1. Define universal gas constant      2. Apply universal gas constant equation in engineering calculation   5. Specific Heat      1. Constant Volume      2. Constant Pressure | * Written tests |
| 1. Apply knowledge of steam cycle | * 1. Steam cycles      1. Rankine         1. Schematic diagram of a steam engine or turbine plant.         2. Determine Rankine efficiency         3. T-S and h-s graphs         4. Modified Rankine Cycle         5. Work-done using Rankine equations         6. Efficiency of Modified Rankine Cycle         7. Theoretical loss of work per kg of steam due to incomplete expansion         8. Loss in Rankine efficiency due to restricted expansion of steam         9. Enthalpy- entropy chart      2. Carnot         1. Draw schematic diagrams of Carnot engine         2. Carnot Cycle with Steam as Working Substance         3. Performance Criteria for Carnot Cycle      3. Reheat         1. T-S diagram of reheat steam cycle         2. Determine work-done using reheat equations         3. Determine efficiency of reheat cycles      4. Regenerative         1. Ideal regenerative cycle diagram         2. Regenerative Cycle with Single Feed Water Heater         3. Regenerative cycle with single feed water heater diagram         4. Determine work-done by Regenerative cycle         5. Determine Regenerative cycle efficiency         6. Regenerative Cycle with Two Feed Water Heaters and its efficiency   2. Thermodynamics steam turbines      1. Characteristics of steam turbines      2. classification of Steam Turbines      3. Pressure and Velocity of Steam in an Impulse Turbine      4. Velocity Triangles for Moving Blade of an Impulse Turbine      5. Combined Velocity Triangle for Moving Blades      6. Power Produced by an Impulse Turbine | * Written tests |
| 1. Apply knowledge of fuel combustion | * 1. Elements and Compounds of fuel      1. Define of terms         1. Element         2. Compound         3. Atoms         4. Molecules         5. Atomic Mass         6. Molecular Mass      2. Element and symbols table sketches   2. Combustion Equations of Fuels and calculations      1. Balanced Combustion Equations of Solid Fuels      2. Write a balanced Combustion Equations of Gaseous Fuels   3. Conversion analysis of fuels      1. Theoretical or Minimum Volume of Air Required for Complete Combustion      2. Conversion of Volumetric Analysis into Mass Analysis or Gravimetric Analysis      3. Conversion of Mass Analysis into Volumetric Analysis   4. Mass of Carbon in Flue Gases      1. Calculation of mass of carbon, contained in 1 kg of flue or exhaust gases   5. Mass of Flue Gases per kg of Fuel Burnt      1. Calculate the mass of dry flue gases by comparing the mass of carbon present in the flue gases with the mass of carbon in the fuel.   6. Excess Air Supplied calculations      1. Mass of excess air supplied by the mass of unused oxygen, found in the flue gases.      2. Total mass of air supplied   7. Flue Gas Analysis by Ors at Apparatus      1. Components      2. Use of the apparatus      3. Operation      4. Diagram sketches | * Written tests |
| 1. Apply heat transfer and heat exchangers in fluid | * 1. Heat transfer media      1. Heat Transfer methods:         1. Conduction         2. Convection         3. Radiation      2. Newton's Law of Cooling      3. Derivation and application of Fourier's\* Law of Heat Conduction equation   2. Heat Transfer by Conduction   through   * + 1. Slab        1. Thermal Conductivity        2. Temperature Gradient     2. Composite Wall     3. Thick Cylinder     4. Thick Sphere   1. Overall Coefficient of Heat Transfer      1. Heat exchangers | * Written tests |
| 1. Operate air compressors | * 1. Classification of air compressors      1. According to working      2. According to action      3. According to number of stages   2. Single Stage Reciprocating Air Compressor      1. Work done by a Single Stage Reciprocating Air Compressor without Clearance Volume   3. Work done during      1. isothermal compression      2. polytropic compression (pv" = Constant)      3. isentropic compression   4. Power Required to Drive a Single-stage Reciprocating Air Compressor      1. Calculations   5. Work-done by Reciprocating Air Compressor with Clearance Volume      1. Calculations      2. Determine Multistage Compression   6. Power Required to Drive a Two-stage Reciprocating Air Compressor   7. Minimum Work Required for a Two-stage Reciprocating Air Compressor | * Written tests |
| 1. Apply knowledge of flow of fluids | * 1. Types of Fluid Flow      1. Steady and unsteady flows      2. Uniform and non-uniform flows      3. Rotational and irrotational flows      4. Laminar and turbulent flows      5. Compressible and incompressible flows   2. Loss of Energy (or Head) in Pipes      1. Darcy-Weissbach formula      2. Chazy’s formula for loss of head due to friction      3. Loss of head due to sudden enlargement      4. Loss of head due to sudden contraction      5. Loss of head due to obstruction in pipe      6. Loss of head at the entrance to pipe      7. Loss of head at the exit of a pipe      8. Loss of head due to bend in the pipe   3. Hydraulic Gradient and Total Energy Lines      1. Pipes in Series or Compound Pipes      2. Pipes in Parallel      3. Power Transmission through Pipes | * Written tests |
| 1. Apply knowledge of viscous flow of fluids | * 1. Flow of viscous flow      1. Flow of Viscous Fluid in Circular Pipes      2. Flow of Viscous Fluid through an Annulus      3. Flow of Viscous Fluid Between Two Parallel Plates         1. One plate moving and other at rest         2. Both plates at rest         3. Both plates moving in opposite directions      4. Kinetic energy correction and momentum      5. Power Absorbed in Viscous Flow      6. Viscous Resistance of Journal Bearings      7. Viscous Resistance of Foot-step      8. Viscous Resistance of Collar Bearing | * Written tests |
| 1. Apply dimensional and models analysis fluids | * 1. Definition of terms      1. Dimensional homogeneity      2. Methods of solving dimensional analysis         1. Rayleigh’s theorem         2. Buckingham π theorem   2. Dimensional analysis similitude      1. Geometric      2. Kinematic      3. Dynamic   3. Dimensionless Numbers      1. Reynold’s Number (Re )      2. Froude’s Number (Fe )      3. Euler’s Number (Eu )      4. Weber’s Number (We )      5. Mach’s Number ( M )   4. Model test analysis and calculations      1. Classification of Models         1. Undistorted Models         2. Distorted Models         3. Scale Ratios for Distorted Models | * Written tests |
| 1. Operate fluid pumps | * 1. Principles of operation of:      1. Reciprocating pumps      2. Centrifugal pumps   2. Derivation of equations for a reciprocating pump      1. Coefficient of discharge      2. percentage slip      3. Work done      4. Acceleration head      5. Friction head      6. Pressure head in the cylinder   3. Application of reciprocating pumps equations to solve problems   4. Derivation of equations for a centrifugal pump      1. Effective head      2. Manometric head      3. efficiency      4. Mechanical efficiency      5. Discharge      6. Torque      7. Work done unit weight      8. Specific speed   5. Application of centrifugal pumps equations to solve problems | * Written tests |

**Suggested Delivery Methods**

* Group discussions
* Demonstration
* Online videos
* Power point presentation
* Exercise

**Recommended Resources for 30 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Learning Materials** | | | |
|  | Textbooks | * + - 1. Applied Thermodynamics For Engineering Technology (fifth edition) by T.D. Eastop and A. McConkey       2. Engineering Thermodynamics by R.K.Rajput       3. A Textbook Of Fluid Mechanics And Hydraulic Machines by R.K.Rajput       4. A Textbook Of Fluid Mechanics And Hydraulic Machines by R.K Bansal | 30 |  |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:30 |
|  | Computer | Functional desktop computer with online instructional content | 1 | 1:30 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:30 |
|  | Printer | An ink-jet, laser-jet or toner-cartridge printer for printing notes, instructions and working drawings | 1 | 1:30 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room | Spacious room with seats for 25 trainees, approximately 60 sqm | 1 | 1:30 |
| **C** | **Materials and Supplies** | | | |
|  | Dust coat/ overall | Shields skin and regular clothes from sparks | 30 | 1:1 |
|  | Fire extinguishers | Protect against fire | 30 | 1:1 |
|  | First Aid kit | Fully equipped First Aid kit for use in case of accidents | 1 | 1:30 |

# CORE UNIT OF LEARNING

# CONSTRUCTION PLANT ATTACHMENTS MAINTENANCE

**UNIT CODE:** 0716 551 20A

**UNIT DURATION: 160** Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Maintain construction plant attachments

**Unit Description**

This unit describes knowledge, skills and attitudes required by a construction plant technician to service construction plant grapple buckets, construction plant graders, construction plant tillers, rakes and forks, construction plant backhoes and construction plant augers and construction plant compactors.

**Summary of Learning Outcomes**

By the end of this unit, trainees should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Service construction plant grapple buckets | **30** |
|  | Service construction plant graders | **30** |
|  | Service construction plant tillers, rakes and forks | **20** |
|  | Service construction plant backhoes | **30** |
|  | Service construction plant augers | **30** |
|  | Service construction plant compactors. | **20** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| * + 1. Service construction plant grapple buckets | * 1. Personal protective equipment (PPE)      1. Apron      2. Safety boots      3. Gloves      4. Goggles      5. Cartridges/ nose mask      6. Helmet      7. Ear muffs   2. Observing safety precautions      1. Personal protective gear      2. Training      3. Ventilation      4. Machine isolation      5. Machine stabilization      6. Hazard identification      7. Tool safety      8. Chemical handling   3. Introduction to construction plant grapple buckets      1. Components of grabble buckets         1. Bucket shell         2. Grapple arms         3. Hydraulic cylinders         4. Rotating mechanism         5. Pins and bushings         6. Buckets teeth         7. Mooting bracket         8. Back frame         9. Control valve         10. Seals and hoses         11. Guarding’s and reinforcement         12. Wear plates   4. Selecting the correct tools      1. Wrenches and sockets      2. Hydraulic jacks      3. Lifting equipment      4. Torque wrenches      5. Grease guns and lubricants      6. Hydraulic pressure testers      7. Welding equipment      8. Pneumatic tools      9. Hydraulic fluid and hoses      10. Measuring tools      11. Angle grinders and cutters      12. Heat treatment tools      13. Inspection tools   5. Detaching grapple buckets   6. Cleaning grapple buckets   7. Inspecting the grapple buckets components buckets      1. Inspect pin and bushing      2. Buckets integrity      3. Rope cable   8. Service/repair grapple buckets faulty component      1. Lubrication      2. Hydraulic System Maintenance      3. Arm Alignment      4. Hydraulic Adjustment:      5. Debris Removal      6. Bucket Washing      7. Attaching new plant tillers, rakes and forks   9. Service documentation      1. Job cards      2. Checklists      3. Files      4. Logbooks   10. Housekeeping       1. Tool and equipment organization       2. Work area cleanliness       3. Safe handling and disposal of hazardous materials       4. Inspection and maintenance of equipment       5. Personal protective equipment management       6. Air and ventilation maintenance       7. Incident prevention and reporting | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| * + 1. Service construction plant graders | * 1. Identify construction plant graders component      1. Mouldboard (Blade)      2. Circle      3. Drawbar      4. Scarifier      5. Operator Cabin      6. Hydraulic System      7. Front and Rear Axles      8. Articulation Joint      9. Wheels and Tires:      10. Engine and Transmission:      11. Ripper   2. Selecting the correct tools and equipment      1. Specialized Grader Tools      2. Socket and Wrench Sets      3. Pliers and Adjustable Wrenches      4. Hammers and Mallets      5. Hydraulic Jack and Lifting Equipment      6. Hydraulic Test Kit      7. Hydraulic Line Wrenches      8. Diagnostic and Testing Equipment      9. Lubrication Tools      10. Heavy-Duty Tools      11. Measuring Tools   3. Detaching damaged construction plant graders   4. Securing construction plant graders component   5. Cleaning construction plant graders   6. Inspecting attachment points for damages      1. Check for Cracks or Wear      2. Examine the Bolts and Fasteners      3. Check Circle Drive Motor and Bearings      4. Examine for Structural Integrity      5. Inspect Pins and Bushings      6. Inspect Hydraulic Hoses and Fittings      7. Check for Excessive Play      8. Inspect Seals and Grease Points      9. Inspect Teeth for Wear or Damage      10. Examine Mounting Bolts and Pins   7. Services/Repair damage construction plant graders      1. Attaching new construction plant graders      2. Welding and Reinforcing      3. Hose and Fitting Replacement      4. Hydraulic Fluid Flush and Refill      5. Blade Edge Replacement      6. Circle and Bearing Repair      7. Drawbar Repair or Realignment      8. Joint Realignment and Bushing Replacement      9. Greasing and Sealing      10. Lubricating moving parts   8. Testing construction plant graders | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| * + 1. Service construction plant tillers, rakes and fork | * 1. Introduction to construction plant tillers, rakes and forks      1. Definition      2. Functions   2. Selecting tools and equipment      1. Socket and Wrench Sets:      2. Pliers and Adjustable Wrenches      3. Hammer and Mallet      4. Hydraulic Line Wrenches      5. Lubrication Tools      6. Diagnostic and Testing Tools      7. Measuring Tools      8. Impact Wrench   3. detaching damaged construction plant tillers, rakes and forks   4. cleaning construction plant tillers, rakes and forks   5. Inspecting construction plant tillers, rakes and fork      1. Inspection for tillers         1. Wear and tear         2. Sharpness         3. Attachments points      2. Inspection for forks         1. Wear and deformation         2. Welding and cracks         3. Sharpness and surface condition      3. Inspection for rakes         1. Condition and wear         2. Attachment point   6. Service and repair of damage construction plant tillers, forks and rakes      1. Welding Repairs      2. Fastener and Bolt Replacement      3. Hydraulic Cylinder Repair      4. Hose and Fitting Replacement      5. Hydraulic Fluid Replacement      6. Greasing of Pivot Points and Moving Parts      7. Cleaning and Debris Removal      8. Fork Prong Inspection and Alignment      9. Rake Tooth Replacement and Adjustment      10. Attaching new construction plant tillers, rakes and forks   7. Testing the construction plant tillers, rake and forks      1. Operational Test for Movement      2. Hydraulic Function Test      3. Attachment Quick Coupler Test      4. Load-Bearing Test      5. Alignment and Calibration Tests      6. Hydraulic Leak and Pressure Test      7. Wear Testing and Tolerance Checks      8. Noise and Vibration Test | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| * + 1. Service construction plant backhoes | * 1. Identification of construction plant backhoes components and functions      1. Boom      2. Stick (or Dipper Arm)      3. Bucket      4. Hydraulic Cylinders      5. Loader Arm      6. Loader Bucket      7. Hydraulic Pump and System      8. Swing Frame (Kingpost)      9. Stabilizers (Outriggers)      10. Operator’s Cabin      11. Chassis and Frame   2. Selecting of correct tools and equipment      1. Socket and Wrench Sets      2. Screwdrivers (Flathead and Phillips      3. Hydraulic Line Wrenches      4. Seal Installation Tools      5. Lubrication Equipment      6. Diagnostic and Testing Equipment      7. Lifting and Support Equipment      8. Specialized Tools for Component Servicing      9. Measuring and Calibration Tools      10. Electrical Repair Tools   3. Detaching damaged construction plant backhoes   4. Cleaning construction plant backhoes   5. Inspecting construction plant backhoes      1. Cracks or Dents      2. Structural Damage      3. Rust or Corrosion      4. Bucket and Attachment Inspection      5. Loader Arm Inspection   6. Service and repairing damage construction plant backhoes      1. Hydraulic Hose Replacement      2. Hydraulic Cylinder Repair      3. Hydraulic Fluid Change      4. Loader Arm Repair      5. Hydraulic Ram Repairs   7. Attaching of construction plant backhoes   8. Testing of construction plant backhoes      1. Hydraulic Pressure Test      2. Operability of Hydraulic Functions      3. Leak Detection      4. Boom and Stick Operation      5. Loader Arm Test      6. Pin and Bushing Check      7. Track Functionality      8. Load Handling Test | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| * + 1. Service construction plant augers | * 1. Identification of construction plant augers components      1. Drill Bit / Auger Head      2. Flighting (Helical Blade)      3. Auger Shaft      4. Auger Drive Motor/ Gearbox      5. Bearings      6. Adaptor or Quick Coupler      7. Shank      8. Auger Extension      9. Shroud or Dust Shield   2. Selection of tools and equipment      1. Wrenches and Socket Sets      2. Hydraulic Wrenches      3. Grease Guns and Lubrication Tools      4. Hydraulic Fluid Pumps and Oil Change Equipment      5. Impact Drivers      6. Pullers and Extractors      7. Torque Wrenches      8. Metal Cutting Tools      9. Hydraulic Test Equipment   3. Detaching of construction plant augers   4. Cleaning of construction plant augers   5. Inspection and servicing attachment points      1. Check for Wear and Tear      2. Inspect Pins and Bushings      3. Check for Loose Components   6. Service /Repair damage construction plant augers      1. Flighting and repair      2. Pilot replacement      3. Straightening bent shafts      4. Lubrication of moving parts   7. Attaching of construction plant augers   8. Construction plant augers testing | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| * + 1. Service construction plant compactors | * 1. Construction plant compactors components      1. Vibratory drum      2. Exciter system      3. Drive system      4. Hydraulic system      5. Frame and chassis   2. Securing construction plant   3. Inspection of construction plant compactors      1. Plate compactor      2. Jumping jack compactor      3. Rollers      4. Vibratory compactor      5. Tamper      6. Trench compactor      7. Hand-held compactor      8. Heavy-duty compactor      9. Pneumatic roller      10. Static roller   4. Construction plant compactors cleaning   5. Construction plant compactors detaching   6. Inspection of detaching construction plant compactors   7. Attaching of detaching construction plant compactors   8. Lubrication moving parts   9. Documenting service      1. Job cards      2. Checklists      3. Files      4. Logbooks   10. Housekeeping       1. Waste disposal methods       2. Recycling methods       3. Resource management       4. Pollution control | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |

**Suggested Methods of learning**

* + Practical
  + Projects
  + Demonstration
  + Group discussion
  + Direct instruction

**Recommended resources for 25 trainees.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/N o.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | For reference purpose | 5 pcs | 1:5 |
|  | Installation manuals | For reference purpose | 5 | 5:25 |
|  | Projectors | For trainer’s use | 1 | 1:25 |
|  | Laptops | For trainer’s use | 1 | 1:25 |
|  | Charts |  |  |  |
|  | PowerPoint presentations | For trainer’s use |  |  |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | Learning centre | 1 | 1:25 |
|  | Workshop | Practical centre | 1 | 1:25 |
|  | Work benches | For working on | 5 | 1:5 |
| **C** | **Consumable materials** |  |  |  |
|  | Track Chains and Links | For replacement | 4 rolls | 4:25 |
|  | Track Shoes | For machine | 5 | 1:5 |
|  | Idlers and Rollers | For machine used | 4 | 4:25 |
|  | Sprockets |  | 3 | 3:25 |
|  | Seals and Bearings | For replacement | 5 | 1:5 |
|  | Rubber Tracks (for Compact Equipment) | For replacement | 5 sets | 1:5 |
|  | Wear Plates and Guards | For replacement | 2 set | 2:25 |
|  | Track Adjusters | For replacement | 4 set | 4:25 |
|  | Grease and Lubricants | For lubrications | 1 bucket | 1:25 |
|  | Hardware Kits | For service | 5 pairs | 1:5 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Lifting and Supporting Equipment | For supporting machine | 4 set | 4:25 |
|  | Track Maintenance Tools | For doing minor and major service | 4 | 4:25 |
|  | Fastening Tools | For fastening joints | 4 | 4:25 |
|  | Cleaning and Inspection Tools | For cleaning undercarriage | 5 | 5:25 |
|  | Alignment and Measurement Tools | For aligning | 5 | 5:25 |
|  | Seal Installation Tools | For doing installation | 5 | 1:5 |
|  | General Tools | For doing services | 2 | 2:25 |
|  | Diagnostic Tools | For technical inspection | 2 | 2:25 |
|  | Safety Gear | For safety | 25 | 1:1 |
| **E.** | **Earth Moving machines** |  |  |  |
|  | Bulldozer | For training and  practice | 1 | 1:25 |
|  | Excavators | For training and  practice | 1 | 1:25 |
|  | Backhoe loader | For training and  practice | 1 | 1:25 |
|  | Grader | For training and  Practice | 1 | 1:25 |

# MODULE VI

# COMMON UNIT OF LEARNING

# COMPUTER AIDED DRAWING

**UNIT CODE:** 0732 541 19A

**UNIT DURATION: 140 HOURS**

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Perform computer aided drawing.

**Unit description**

This unit covers the competences required to perform computer aided drawing. It involves navigating CAD software, producing geometric, pictorial, orthographic and assembly drawings as well as designing mechanical components.

**Summary of Learning Outcomes**

By the end of the Unit of Learning, the trainee will be able to;

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Navigate CAD software | 10 |
|  | Produce geometric drawings | 30 |
|  | Produce pictorial drawings | 10 |
|  | Produce orthographic drawings. | 30 |
|  | Produce assembly drawings | 30 |
|  | Design mechanical components | 30 |
| TOTAL | | 140 |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Navigate CAD software | * 1. Overview of CAD      1. Definition and significance of CAD in engineering and design.      2. Historical development of CAD technologies.   2. Computing Equipment and Software      1. Identify hardware requirements for CAD operations.      2. List popular CAD software options (e.g., AutoCAD, SolidWorks, Inventor).   3. Drawing CAD Software      1. Overview of the software interface.      2. Functions and capabilities of CAD tools.   4. CAD Software Templates      1. Explore various templates available for different drawing requirements.   5. Importing CAD Files      1. Process of importing files (DWG, STL, DXF, STEP) into the working space.   6. User Interface Navigation      1. Familiarization with the CAD software interface.      2. Understanding toolbars, menus, and command lines.   7. Setting Up the Drawing Environment      1. Units and measurement settings.      2. Creating a new drawing and saving files.   8. Symbols, Codes, and Standards      1. Identify relevant symbols and codes according to software functionality.   9. Understand and utilize drawing Elements      1. Points      2. Line angles      3. Circles and arcs      4. Planes (horizontal, vertical)      5. Figures and solids      6. Shapes      7. Objects snapping settings      8. Polar tracking settings.      9. Orthomode utilization   10. Use editing commands Editing Tools       1. Delete, undo and redo commands       2. Fillet and chamfer commands       3. Trim, extend and break commands       4. Zoom and pan commands       5. Move, copy, and paste commands       6. Rotate and mirror commands       7. Object snapping and grouping commands       8. Dimension and scaling commands | * Practical * Project * Portfolio of evidence * Third party report * Written tests. |
| 1. Produce geometric drawings | * 1. Setting Drawing Lines      1. Recognize standard drawing line conventions * Dimension lines * Hidden detail lines * Extension lines * Section lines * Break lines * Chain   1. Using drawing lines   2. Constructing Types of Angles      1. Use trigonometry principles to construct acute, obtuse, and right angles.   3. Constructing Geometrical Forms      1. Create circles, rectangles, triangles, and polygons according to standards.   4. Developing Geometric Drawings      1. 2-Dimensional      2. Orthographic      3. Isometric | * Practical * Project * Portfolio of evidence * Third party report * Written tests. |
| 1. Produce pictorial drawings | * 1. Drawing Symbols and Abbreviations      1. Apply standard drawing symbols and abbreviations in pictorial drawings.   2. Producing Pictorial Drawings      1. Techniques for creating isometric, oblique, cabinet, and cavalier drawings.   3. Saving Pictorial Drawings      1. Procedures for saving drawings in appropriate formats. | * Practical * Project * Portfolio of evidence * Third party report * Written tests. |
| 1. Produce orthographic drawings. | * 1. Fundamentals of Orthographic Projection      1. Definition and importance of orthographic drawing.      2. Differences between orthographic and other drawing types (isometric, perspective).   2. Types of Orthographic Projections      1. First-angle projection.      2. Third-angle projection.   3. Understanding Views      1. Front, top, and side views.      2. Additional views (sectional, auxiliary).   4. First Angle Orthographic Drawings      1. Develop first-angle drawings adhering to standard conventions.   5. Third Angle Orthographic Drawings      1. Create third-angle drawings based on standard practices.   6. Saving Orthographic Drawings      1. Techniques for properly saving orthographic drawings.   7. Dimensioning Orthographic Views   8. Printing orthographic views   9. Creating isometric drawing      1. Choosing isometric cursor      2. Dimensioning isometric drawing      3. Printing isometric drawing   10. Creating 3D model       1. Choosing 3D workspace       2. 3D workspace modifying tool (3D orbit, 3D mirrors, union, extrude, press pull, e.t.c)       3. Rendering       4. Pring 3D models | * Practical * Project * Portfolio of evidence * Third party report * Written tests. |
| 1. Produce assembly drawings | * 1. Overview of Assembly Drawings      1. Definition and purpose of assembly drawings.      2. Importance in manufacturing and engineering.   2. Types of Assembly Drawings      1. General assembly drawings vs. detailed assembly drawings.      2. Exploded view vs. isometric assembly drawings.   3. Exploding Orthographic Views      1. Techniques for exploding views in accordance with standard conventions.   4. Exploding Pictorial Views      1. Create exploded pictorial views based on drawing specifications.   5. Assembling Views      1. Assemble orthographic and pictorial views accurately.   6. Producing Sectional Views      1. Generate sectional views according to drawing standards.   7. Developing Parts List      1. Creating a parts list based on the drawing schematic. | * Practical * Project * Portfolio of evidence * Third party report * Written tests. |
| 1. Design mechanical components | * 1. Designing Mechanical Components      1. Apply CAD principles to design mechanical components per work requirements.   2. Applying CAE in Simulation      1. Use computer-aided engineering tools for simulating mechanical designs.   3. Determining Improvements      1. Analyze design results to identify efficiency improvements.   4. Creating a Manufacturing Database      1. Develop a database to support the manufacturing process.   5. Improving Design Documents      1. Make enhancements to design documents based on manufacturing feedback.   6. Practical Activity | * Practical * Project * Portfolio of evidence * Third party report * Written tests. |

**Suggested Delivery Methods**

* Demonstration
* Group discussions
* Online materials
* Direct instructions
* Simulation

**Recommended resources for 30 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item)** |
| **A** | **Learning Materials** |  |  |  |
| 1 | Textbooks | Comprehensive texts on CAD basics, history, and hardware requirements. | 5 pcs | 1:5 |
| 2 | Charts | Visual aids covering CAD software evolution and industry applications. | 10 pcs | 1:2.5 |
| 3 | PowerPoint Presentations | For trainer’s use, covering CAD definitions, history, and hardware requirements. | 1 | 1:25 |
| **B** | **Learning Facilities & Infrastructure** |  |  |  |
| 1 | Lecture/Theory Room | Equipped with projector, seating for 25 trainees, ~60 sqm. | 1 | 1:25 |
| 2 | Computer Laboratory | Equipped with 25 computers installed with CAD software, ~80 sqm. | 25 | 1:1 |
| 3 | Printer/plotter | For printing CAD drawings | 2 | 1:13 |
| 4 | 3D printer | For printing 3D models | 2 | 1:13 |
| 5 | 3D printer filament | 3D printing material | 2 rolls | 1:13 |
| **C** | **Consumable Materials** |  |  |  |
| 1 | USB Drives | For storing and transferring CAD project files. | 25 pcs | 1:1 |
| 2 | Notebooks | For trainees to take notes during CAD sessions. | 25 pcs | 1:1 |
| **D** | **Tools and Equipment** |  |  |  |
| 1 | Computers | Equipped with CAD software and compatible hardware (e.g., high RAM, graphics support). | 25 pcs | 1:1 |
| 2 | Projector | For displaying CAD software demonstrations and presentations in lecture room. | 1 | 1:25 |
| 3 | External Hard Drives | For backing up CAD files and course materials. | 5 pcs | 1:5 |
| 4 | Drawing Tablets | For CAD software use, supporting stylus input for design precision. | 5 pcs | 1:5 |
| **E** | **Reference Materials** |  |  |  |
| 1 | CAD Software Manuals | Documentation detailing CAD software functionalities and hardware requirements. | 25 pcs | 1:1 |
| 2 | CAD Industry Case Studies | Case studies showcasing CAD applications in engineering and design. | 5 pcs | 1:5 |
| 3 | Practical Assessment Guides | Worksheets for practical assessments on CAD navigation and hardware requirements. | 25 pcs | 1:1 |
| 4 | Training Presentations/Slides | Digital format for shared access among trainees covering CAD course content. | 1 | 1:25 |

# CORE UNIT OF LEARNING

# CONSTRUCTION PLANT UNDERCARRIAGE MAINTENANCE

**UNIT CODE:** 0716 551 20 A

**UNIT DURATION: 180** Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency; Maintain construction plant undercarriage

**Unit Description**

This unit describes knowledge, skills and attitudes required by a construction plant technician to servicing construction plant wheels and tires, servicing construction plant rollers, servicing construction plant sprockets, replacing construction plant idlers, bushes, and pins, Greasing construction plant undercarriage parts.

**Summary of Learning Outcomes**

By the end of the Unit of Learning, the trainee will be able to;

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Service construction plant rollers | 40 |
|  | Service construction plant wheels and tires | 40 |
|  | Service construction plant sprockets | 40 |
|  | Replace construction plant idlers, bushes, and pins | 40 |
|  | Grease construction plant undercarriage parts | 40 |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| * + - 1. Service construction plant wheels and tires | * 1. Personal protective equipment (PPE)      1. Apron      2. Safety boots      3. Gloves      4. Goggles      5. Cartridges/ nose mask      6. Helmet      7. Ear muffs   2. Observing safety precautions      1. Personal protective gear      2. Training      3. Ventilation      4. Machine isolation      5. Machine stabilization      6. Hazard identification      7. Tool safety      8. Chemical handling   3. Introduction to construction plant wheels and tyres      1. Types of construction plant wheels and tyres         1. Steel wheels         2. Rubber tyre wheels         3. Solid rubber wheel         4. Polyurethane wheels         5. Magnesium alloy wheels         6. Radial ply tyres         7. Bias ply tires         8. Non-pneumatic tires         9. Lug tyres         10. Smooth tyres         11. All terrain tyres         12. Floatation tyres         13. Foam-filled tyres         14. Super-single tyres   4. Identification of tire and tube punctures      1. Through punctures      2. Sidewall punctures      3. Bead damages      4. Multiple punctures      5. Valve stem damage      6. Tread separation      7. Tube pinch flats      8. Blowouts   5. Tools and equipment needed for tyre and tube puncture repair      1. Tire iron or bead breaker      2. Tire lever      3. Rubber patches      4. Vulcanizing cement      5. Rubber bladder      6. Needle and insertion tools      7. Air compressor      8. Soap solution      9. Rim protector      10. Tire pressure gauge      11. Rim clamp or tyre changer machine   6. Removing of wheels and tyre from the equipment   7. Dismantle the wheels form tyre   8. Inspect wheel and tyre for puncture      1. Inspect the inner side of the tire      2. Clean the damaged area      3. Check the rim for damage or rust   9. Servicing and repairing tire and tube punctures      1. Patching      2. Plugging      3. Check for leaks   10. Reassemble and mount the tire   11. Inflating the tire       1. Check for leaks       2. Check the tyre pressure   12. Performing wheel balancing   13. Reinstall the tire on the equipment and test the equipment.   14. Service documentation       1. Job cards       2. Checklists       3. Files       4. Logbooks   15. Housekeeping       1. Tool and equipment organization       2. Work area cleanliness       3. Safe handling and disposal of hazardous materials       4. Inspection and maintenance of equipment       5. Personal protective equipment management       6. Air and ventilation maintenance       7. Incident prevention and reporting | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| * + - 1. Service construction plant rollers. | * 1. Preparing work area      1. Safety Precautions      2. Organize Tools and Equipment      3. Prepare for Cleanliness      4. Organize Parts and Components      5. Prepare the Vehicle      6. Review Service Manual and Instructions      7. Lighting and Visibility   2. Identifying construction plant rollers components      1. Drum      2. Frame      3. Engine      4. Hydraulic system      5. Control panel      6. Tires      7. Axles      8. Bearings      9. Vibration system      10. Chassis   3. Selecting correct tools and equipment      1. Wrenches and sockets      2. Hydraulic jacks      3. Impact wrenches      4. Tire repair kits      5. Grease gun      6. Diagnostic tool      7. Measuring tools      8. Replacement parts   4. Dismantling the construction plant rollers   5. Inspecting rollers components for faulty      1. Surface condition      2. Alignments      3. Inspect the bearing and axles      4. Check roller drum condition      5. Check pneumatic tyres      6. Check roller mechanism      7. Inspect the operator controls      8. Hydraulic leaks      9. Faulty pumps      10. Hydraulic pressure      11. Hydraulic hoses and fittings   6. Replacing worn out rollers components   7. Service documentation      1. Job cards      2. Checklists      3. Files      4. Logbooks   8. Housekeeping      1. Tool and equipment organization      2. Work area cleanliness      3. Safe handling and disposal of hazardous materials      4. Inspection and maintenance of equipment      5. Personal protective equipment management      6. Air and ventilation maintenance      7. Incident prevention and reporting | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| * + - 1. Service construction plant sprockets. | * 1. Preparation of work area      1. Safety Precautions      2. Organize Tools and Equipment      3. Prepare for Cleanliness      4. Organize Parts and Components      5. Prepare the Vehicle      6. Review Service Manual and Instructions      7. Lighting and Visibility   2. Identification of construction plants sprockets components      1. Teeth      2. Hub      3. Sprocket body      4. Keyway      5. Bearing      6. Chain interface      7. Mounting holes      8. Chain guide      9. Sprocket washer      10. Spacer   3. Selection of correct tools and equipment      1. Wrenches and sockets      2. Impact wrench      3. Torque wrench      4. Pullers      5. Grease gun      6. Measuring tools      7. Alignment tools      8. Replacement parts   4. Dismantling of construction plant sprocket   5. Cleaning of sprockets internal component   6. Inspection of sprockets components for faults      1. Excessive wear on the teeth      2. Cracks and deformation      3. Sprocket to track link engagement      4. Worn sprocket hub and mounting points      5. Lubrication and maintenance issues      6. Unusual noise   7. Replacement of worn-out sprocket components   8. Lubricating of sprocket components   9. Service documentation      1. Job cards      2. Checklists      3. Files      4. Logbooks   10. Housekeeping       1. Tool and equipment organization       2. Work area cleanliness       3. Safe handling and disposal of hazardous materials       4. Inspection and maintenance of equipment       5. Personal protective equipment management       6. Air and ventilation maintenance       7. Incident prevention and reporting | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| * + - 1. Replace construction plant tension components | * 1. Preparation of work area      1. Safety Precautions observation      2. Tools and Equipment Organization      3. Parts and Components Organizing      4. Review Service Manual and Instructions      5. Lighting and Visibility   2. Identification of construction plant tension components      1. Idler wheel      2. Tensioning cylinder      3. Track adjuster      4. Track chains      5. Bushings   3. Selection of correct tools and equipment      1. Wrenches and sockets      2. Impact wrench      3. Hammers      4. Pin punch sets      5. Bearing press      6. Service manual      7. Grease gun   4. Dismantling of track tension components   5. Inspection of track tension components for fault      1. Track alignment conditions      2. Track tension adjustment      3. Tension wear and damage      4. Track shoe wear   6. Servicing of faulty track components      1. Adjust track tension      2. Lubrication      3. Repair hydraulic licks      4. Sprocket replacement      5. Tooth resurfacing   7. Reinstallation of track components      + 1. Operation testing   8. Service documentation      1. Job cards      2. Checklists      3. Files      4. Logbooks   9. Housekeeping      1. Tool and equipment organization      2. Work area cleanliness      3. Safe handling and disposal of hazardous materials      4. Inspection and maintenance of equipment      5. Personal protective equipment management      6. Air and ventilation maintenance      7. Incident prevention and reporting | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| * + - 1. Greasing construction plant undercarriage parts | * 1. Plant undercarriage parts identification      1. Sprocket      2. Idler      3. Carrier roller      4. Track roller      5. Track Chain      6. Trach shoe/grouser      7. Chain links      8. Master pin   2. Selection of correct tools and equipment      1. Grease gun      2. Grease fittings      3. Lubricants      4. Protective equipment      5. Pneumatic and electric grease   3. Cleaning of lubricating points      1. Pins and bushings      2. Track chain joints      3. Bottom rollers      4. Top rollers      5. Front idlers      6. Drive sprockets      7. Equalizer bar joints      8. Track adjusters      9. Oscillating pins and bushings      10. Grease fittings for tensioner      11. Swing bearings   4. Selection of lubricants      1. Heavy duty multipurpose grease      2. High temperature grease   5. Application of grease   6. Rotation of undercarriage components   7. Service documentation      1. Job cards      2. Checklists      3. Files      4. Logbooks   8. Housekeeping      1. Tool and equipment organization      2. Work area cleanliness      3. Safe handling and disposal of hazardous materials      4. Inspection and maintenance of equipment      5. Personal protective equipment management      6. Air and ventilation maintenance | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstration
* Group discussion
* Direct discussion

The delivery may also be supplimented and enhanced by the following , if the opportunity allows;

Industral visit

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | For reference | 5 copies | 1:5 |
|  | Installation manuals | For reference | 1 | 1:25 |
|  | Projectors | For trainer’s use | 1 | 1:25 |
|  | Laptops | For trainer’s use | 1 | 1:25 |
|  | Charts | For illustration | 5 | 1:25 |
|  | PowerPoint presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | For training | 1 | 1:25 |
|  | Work benches | For working on | 5 | 1:5 |
|  | Workshop |  |  |  |
| C | **Consumable materials** |  |  |  |
|  | Track shoes | For machine use | 1 | 1:25 |
|  | Track links, | For machine use | 2 | 2:25 |
|  | pins | For machine use | 1 | 1:25 |
|  | Bushings | For machine use | 1 | 1:25 |
|  | Rollers | For machine use | 1 | 1:25 |
|  | Seals and gaskets | For machine use | 1 | 1:25 |
|  | Grease | For machine use | 1kgs | 1:25 |
|  | Tracks pads | For machine use | 1 | 1:25 |
|  | Wear plates and guards | For machine use | 1 | 1:25 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Fully operational earth Moving machine | For training purpose | 1 | 1:25 |
|  | Assorted spanners tools | Size 10-54mm  To be used in loosening and tightening nuts and bolts | 5 tool boxes | 1:5 |
|  | Welding equipment | For welding where necessary | 2 | 2:25 |
|  | Micrometre screw gauge | For measuring external diameter of components | 5 | 1:5 |
|  | Vernier calipers | For measuring internal diameters of components |  |  |
|  | Lifting chains equipment | For lifting up heavy components | 1 | 1:25 |

# MODULE VII

# COMMON UNIT OF LEARNING

# ELECTRONICS AND CONTROL PRINCIPLES

**UNIT CODE:** 0713 541 21A

**UNIT DURATION:** 160 Hours

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply Electrical and Control principles.

**Unit description**

This unit describes the competences required in order to apply electrical and electronics principles. It involves, apply Safety requirements for electricity, applying understanding of electronics, Perform Single and three phase power supply, Apply Sensors and transducers principles, Apply Control principles

**Summary of Learning Outcomes**

By the end of the Unit of Learning, the trainee will be able to;

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Apply Safety requirements for electricity | 10 |
|  | Apply understanding of electronics | 25 |
|  | Perform Single and three phase power supply | 35 |
|  | Apply Sensors and transducers principles | 45 |
|  | Apply Control principles | 45 |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply safety requirements for electricity | * 1. Personal Protective Equipment (PPE)      1. Types of PPE         1. Head protection, insulating gloves, eye protection         2. Usage guidelines and importance   2. Control of Electrical Hazards      1. Identification of Hazards         1. Shocks, explosions, electrocution, burns, fires, electric arcs         2. Risk assessment and management   3. Electric Hazard Prevention      1. Preventative Measures         1. Lockout/Tagout (LOTO) procedures         2. Safe work practices | * Practical * Portfolio of evidence * Third party report * Written tests. |
| 1. Apply understanding of electronics | * 1. Introduction to Electronic Components      1. Overview of electronics: What are electronic components?      2. Classification of components: Passive, active, and electromechanical.      3. Introduction to circuit symbols and schematic diagrams.      4. Basic electrical quantities and units (voltage, current, resistance).      5. Understanding datasheets and component specifications.      6. Overview of testing and measurement tools (multimeters, oscilloscopes).   2. Passive Components      1. Resistors: Types, color codes, power ratings, and applications.      2. Capacitors: Types (ceramic, electrolytic, film), capacitance value, and working voltage.      3. Charging and discharging of capacitors in D.C circuits.      4. Applications of capacitors in filtering, timing, and energy storage.      5. Inductors: Types, inductance value, and applications.      6. Inductor behavior in D.C and AC circuits.      7. Introduction to filters: RC, RL, and RLC circuits.   3. Semiconductor Devices      1. Diodes: Introduction to PN junctions, characteristics, and types (LEDs, Zener diodes, Schottky diodes).      2. Applications of diodes in rectification, voltage regulation, and signal clipping.      3. Transistors: Types (BJT and MOSFET), characteristics, and configurations.      4. Basic transistor circuits: Switches and amplifiers.      5. Hands-on lab: Building and testing simple diode and transistor circuits.      6. Special semiconductor devices: Thyristors, TRIACs, and optoelectronic devices.      7. Characteristics and applications in switching and control.   4. Integrated Circuits (ICs)      1. Overview of integrated circuits: Analog vs. digital ICs.      2. Operational amplifiers (Op-Amps): Characteristics and basic configurations.      3. Applications of Op-Amps in signal processing.      4. Timers and oscillators: 555 timer IC and its applications.      5. Voltage regulators: Linear and switching regulators.      6. Introduction to data converters (ADC and DAC).      7. Digital ICs: Logic gates and flip-flops.      8. Applications of digital ICs in basic logic circuits.      9. Hands-on lab: Building circuits using Op-Amps, timers, and logic gates.   5. Electromechanical and Specialized Components      1. Relays: Types, operation, and applications in switching.      2. Switches and connectors: Types and usage in electronic circuits.      3. Transformers: Basic operation, step-up/step-down functions, and isolation.      4. Displays: LED, LCD, and seven-segment displays.      5. Circuit Design and Practical Applications      6. Basic circuit design principles: Bread boarding, PCB layout, and soldering.      7. Introduction to circuit simulation tools (e.g., Multisim, LTSpice).      8. Testing and troubleshooting techniques.      9. Real-world applications of electronic components.      10. Building practical projects: Power supplies, audio amplifiers, and sensor-based circuits.      11. Hands-on lab: Final project assembly and testing. | * Practical * Portfolio of evidence * Third party report * Written tests. |
| 1. Perform single and three phase power supply principles | * 1. Overview of Electrical Power Systems      1. Definition and importance of power supply systems      2. Types of power systems: Single-phase vs. three-phase      3. Basic Electrical Concepts         1. Voltage, current, power, and frequency         2. Phase relationships and power factor   2. Single-Phase Power Supply      1. Characteristics of Single-Phase Systems         1. Voltage and current waveforms         2. Applications and limitations of single-phase power      2. Circuit Design and Implementation         1. Basic circuit configurations: Series and parallel         2. Wiring techniques and component selection      3. Measurement Techniques         1. Measuring voltage, current, and power in single-phase circuits         2. Tools and instruments for measurements   3. Three-Phase Power Supply      1. Fundamentals of Three-Phase Systems         1. Characteristics of three-phase power: Star (Y) and Delta (Δ) configurations         2. Advantages of three-phase systems over single-phase      2. Circuit Design and Implementation         1. Wiring and connection techniques for three-phase systems         2. Component selection and configuration      3. Measurement Techniques         1. Measuring line and phase voltages, currents, and power in three-phase circuits         2. Use of power analyzers and other measurement tools   4. Power Calculations and Analysis      1. Power Calculations         1. Active, reactive, and apparent power calculations         2. Understanding the power triangle in both single and three-phase systems      2. Power Factor Correction         1. Importance of power factor in electrical systems         2. Techniques for improving power factor in both types of systems   5. Troubleshooting and Maintenance      1. Common Issues in Power Supply Systems         1. Identifying and diagnosing faults in single and three-phase systems         2. Troubleshooting techniques and best practices | 1. Practical 2. Portfolio of evidence 3. Third party report 4. Written tests. |
| 1. Apply sensors and transducers principles | * 1. Introduction to Sensors and Transducers      1. Definitions and Concepts      2. Differences between sensors and transducers      3. Overview of their roles in measurement and control systems   2. Basic Principles of Operation      1. How sensors and transducers convert physical phenomena into electrical signals      2. Common physical quantities measured (e.g., temperature, pressure, moisture, position, oxygen, light)   3. Types of Sensors      1. Temperature Sensors      2. Thermocouples, thermistors, and infrared sensors         1. Principles of operations         2. Applications and selection criteria      3. **Pressure Sensors**         1. **Strain gauge, piezoelectric, and capacitive pressure sensors**         2. **Principles of operations**         3. **Measurement techniques and applications**      4. **Proximity and Displacement Sensors**         1. **Inductive, capacitive, and photoelectric sensors**         2. **Principles of operations**         3. **Use cases and installation considerations**      5. Other **Sensor Types**         1. Humidity, moisture, oxygen, flow, level, and gas sensors         2. Overview of their principles and applications   4. Types of Transducers      1. Definition **and Functionality**         1. Types of transducers (active vs. passive)         2. Examples and applications      2. Electrical **Transducers**         1. Strain gauges, load cells, and piezoelectric transducers         2. Principles of operation and usage      3. Mechanical **Transducers**         1. Overview of mechanical types and their applications         2. Integration into automated systems   5. Hands-on experiments on testing sensors and actuators. | * Practical * Portfolio of evidence * Third party report * Written tests. |
| 1. Apply control principles | * 1. Introduction to Control Systems      1. Definition of terms and Importance of control systems         1. Introduction to control systems in engineering and automation         2. Types of control systems: Open-loop vs. closed-loop      2. Basic Terminology         1. Key terms: feedback, set point, error, actuator, sensor         2. Understanding system dynamics   2. Types of Control Strategies      1. Proportional Control (P Control)         1. Principles and characteristics         2. Applications and limitations      2. Proportional-Integral Control (PI Control)         1. Understanding integral action and its effects         2. Applications in process control      3. Proportional-Integral-Derivative Control (PID Control)         1. Components of PID control and their significance         2. Tuning methods and practical applications      4. Advanced Control Strategies         1. Feedforward control, adaptive control, and fuzzy logic control         2. Overview of model predictive control (MPC)         3. Types of controllers.   3. Introduction to PLCs      1. Overview of PLCs,      2. Applications      3. PLC Hardware         1. PLC components (CPU, I/O modules, power supply) and wiring.         2. PLC Programming Basics Programming languages (Ladder Logic, Function Block, etc.) and         3. Software tools.   4. Ladder Logic Programming      1. Creating basic programs using timers, counters, logic gates, and arithmetic operations.      2. Inputs/Outputs      3. Digital/analog inputs and outputs,      4. Interfacing with sensors and actuators. | * Written tests * Practical |

**Suggested Methods of Instruction**

* Demonstration
* Field trips
* Discussions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Learning Materials** |  |  |  |
| 1 | Textbooks | Comprehensive texts on electrical and control principle. | 5 pcs | 1:5 |
| 2 | Charts | Visual aids covering electrical theories and safety protocols | 10 pcs | 1:2.5 |
| 3 | PowerPoint Presentations | For trainer’s use, covering course content and practical applications | 1 | 1:25 |
| **B** | **Learning Facilities & Infrastructure** |  |  |  |
| 1 | Lecture/Theory Room | Equipped with projectors and seating for 25 trainees, ~60 sqm | 1 | 1:25 |
| 2 | Workshop | Hands-on training area with workbenches, tools, and safety equipment, ~80 sqm | 1 | 1:25 |
| 3 | Computer Laboratory | Equipped with testing setups for electrical experiments, ~50 sqm.  Equipped with computers installed with Circuit simulation software. | 25 | 1:1 |
| **C** | **Consumable Materials** |  |  |  |
| 1 | Electrical Wires | Assorted sizes and color-coded (e.g., 1.5mm², 2.5mm², 4mm²) | 5 rolls | 1:5 |
| 2 | Insulation Tapes | For securing connections and insulation, assorted colors | 25 pcs | 1:1 |
| 3 | Breadboard | For prototyping and testing circuits | 5 pcs | 1:5 |
| 4 | Sensors | Assorted types (temperature, pressure, proximity) | 10 pcs | 1:2.5 |
| 5 | Signal generators | For generating AC signals | 5pcs | 1:5 |
| 6 | Transducers | Assorted | 10 pcs | 1:3 |
| 7 | Electronic components | Resistors, transistors, capacitors, relays, transformers. Integrated IC, OPAM. | 100pcs | 4:25 |
|  |  |  |  |  |
| **D** | **Tools and Equipment** |  |  |  |
| 1 | Screwdrivers | Assorted sets for various applications | 2 sets | 1:12.5 |
| 2 | Side Cutters | For cutting wires and cables | 4 pcs | 1:6.25 |
| 3 | Pliers | For gripping and bending wires | 3 pcs | 1:8.33 |
| 4 | Stripping Knives | For stripping insulation from wires | 4 pcs | 1:6.25 |
| 5 | Computers | Equipped with electrical and electronics simulation software | 5 pcs | 1:5 |
| 6 | Multimeters | For measuring voltage, current, and resistance | 5 pcs | 1:5 |
| 7 | Clamp Meters | For measuring current flow in circuits | 5 pcs | 1:5 |
| 8 | Oscilloscope | For observing waveforms and signals | 1 | 1:25 |
| 9 | Voltmeter | For measuring voltage | 1 | 1:25 |
| 10 | Ammeter | For measuring current | 1 | 1:25 |
| 11 | Signal Generator | For generating electrical signals for testing | 1 | 1:25 |
| 12 | Soldering gun | For soldering | 10 | 1:3 |
| 13 | Soldering wire | For making joints in electrical circuits | 10 | 1:3 |
| 14 | PLC | For program practice | 5 | 1:5 |
| 15 | Cells and batteries | For learning | 5 | 1:5 |
|  |  |  |  |  |
| **E** | **PPE (Personal Protective Equipment)** |  |  |  |
| 1 | PPE Sets | Includes helmets, gloves, safety goggles, shoes, and harnesses | 25 sets | 1:1 |
| 2 | Safety Signs and Barriers | For simulating safety zones and hazards | 10 sets | 1:2.5 |
| 3 | Earthing Test Kits | For ground testing and demonstrating earthing procedures | 5 pcs | 1:5 |
| 4 | Electrical Test Benches | For hands-on testing of functionality and circuit design | 5 pcs | 1:5 |
| **F** | **Reference Materials** |  |  |  |
| 1 | Industrial Automation Manuals | Covering principles and practices in automation | 25 pcs | 1:1 |
| 2 | Electrical Standards | Reference on industry standards (e.g., IEEE Guidelines) | 5 pcs | 1:5 |
| 3 | Technical Handbooks | On motors, drives, and wiring systems | 25 pcs | 1:1 |
| 4 | Training Presentations/Slides | Digital format for shared access among trainees | 1 | 1:25 |
| 5 | Multimedia Learning Modules | Digital licenses for videos and tutorials | 25 pcs | 1:1 |
| 6 | Practical Assessment Guides | Worksheets for practical assessments | 25 pcs | 1:1 |

# CORE UNIT OF LEARNING

# CONSTRUCTION PLANT ELECTRICAL SYSTEMS MAINTENANCE

**UNIT CODE: 0716 551 22A**

**UNIT DURATION: 180** Hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Maintain construction plant electrical systems

**Unit Description**

This unit describes knowledge, skills and attitudes required by a construction plant technician to repair construction plant charging system, inspect construction plant electronic control unit, repair construction plant starting system, service and repair construction plant instruments panel, repair construction plant lighting system, service construction plant heating, ventilation and air conditioning system, and install construction plant infotainment system.

**Summary of Learning Outcomes**

By the end of the Unit of Learning, the trainee will be able to;

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Repair construction plant charging system | 25 |
|  | Inspect construction plant electronic control unit | 25 |
|  | Repair construction plant starting system | 20 |
|  | Service and repair construction plant instruments panel | 30 |
|  | Repair construction plant lighting system | 30 |
|  | Service construction plant heating, Ventilation, and air conditioning system | 25 |
|  | Install construction plant infotainment system | 25 |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| * + 1. Repair construction plant charging system | * 1. Personal protective equipment (PPE)      1. Apron      2. Safety boots      3. Gloves      4. Goggles      5. Cartridges/nose mask      6. Helmet      7. Ear muffs   2. Safety precautions      1. Training      2. Ventilation      3. Machine isolation      4. Hazard identification      5. Tool safety      6. Chemical handling      7. Communication      8. Securing the earth moving machine   3. Preparation of the work area      1. Tiding the work area      2. Parts tray positioning   4. Tools and equipment selection      1. Fully equipped toolbox with assorted spanners      2. Multimeter      3. Assorted wires      4. 12 volts batteries      5. Battery charger      6. Set of screw drivers      7. Lamp tester      8. High-rate discharge tester      9. Wire strippers      10. Weighing scale   5. Battery servicing and testing      1. Cleaning of battery terminals      2. Repairing worn out battery terminals      3. Applying jelly on the battery terminals      4. Measuring of the battery specific weight      5. Checking electrolyte level      6. Inspection of battery cells plates      7. Electrolyte topping up      8. High-rate discharge test   6. Alternator removal      1. Battery disconnection      2. Alternator belt disconnection      3. Alternator external wiring disconnection   7. Dismantling of alternator   8. Cleaning of alternator components      1. Alternator housing      2. Stator      3. Rotor      4. pulley      5. brushes   9. Inspecting alternator component      1. Stator      2. Rotor      3. Diode rectifier      4. Voltage regulator      5. Bearings      6. End bells      7. Cooling fan      8. Housing      9. Brushes      10. Slip rings      11. Alternator pulley   10. Testing alternator components       1. Stator          1. Ground test          2. Continuity test       2. Rotor          1. Ground test          2. Continuity test       3. Brush and holder          1. ground          2. continuity       4. Diode rectifier          1. Continuity test          2. Reverse bias test       5. Voltage regulator   11. Replacement of faulty alternator components       1. Worn out brushes       2. Worn out brush holders       3. Worn out bearing       4. Worn out diode rectifier       5. Spoilt Rotor       6. Spoilt Stator       7. Cracked housing   12. Alternator assembly   13. Fitting back alternator   14. Inspection of alternator external cablings       1. Terminals       2. External wiring   15. Servicing alternator cablings/wiring connections   16. Inspection of alternator belt       1. Worn out signs       2. Looseness   17. Adjustment of alternator belt   18. Alternator assembly   19. Alternator control box testing       1. Output voltage test       2. Cleaning   20. Charging system testing       1. Starting engine       2. Charging voltage measurement       3. Measuring battery voltage when under load | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| * + 1. Inspect construction plant electronic control unit | * 1. Selection of tools and equipment      1. Diagnostic scanner      2. Multimeter      3. Insulation sensor      4. Terminal remover tool      5. Assorted spanners      6. Assorted screw drivers   2. Inspection and testing of electronic sensors      1. Temperature sensor      2. Pressure sensor      3. Proximity sensor      4. Speed sensor      5. Position sensor      6. Flow sensor      7. Level sensor      8. Vibration sensor      9. Humidity sensor      10. Light sensor   3. Replacement of faulty sensors   4. Updating of electronic control unit      1. Performing back up before operation      2. Updating the software      3. Verification of the update      4. Calibration and configuration   5. Cleaning electronic control unit      1. Dismantling      2. Cleaning using compressed air      3. Cleaning using isopropyl alcohol      4. Allowing drying      5. Assembly | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| * + 1. Repair construction plant starting system | * 1. Selection of tools and equipment      1. Diagnostic scanner      2. Multimeter      3. Insulation sensor      4. Terminal remover tool      5. Assorted spanners      6. Assorted screw drivers   2. Diagnosing starting system      1. Servicing starting system         1. Removal of starter motor            1. Dismantling            2. Cleaning and inspection of stator motor   Solenoid  Armature  Brushes  Commutator  Field winding  Bearing  Pinion drive  Over running clutch   * + - * 1. Testing of alternator components   Ground test  Continuity test   * + 1. Replacement of faulty starter motor components     2. Starter motor assembly     3. Testing stator motor   1. Ignition components inspection and testing      1. Ignition coil      2. Spark plugs      3. Distributor      4. Ignition switch      5. High tension lead cables   2. Replacement of faulty ignition system components   3. Testing starting system | 1. Practical assessment 2. Project 3. Third party report 4. Written test 5. Portfolio of evidence |
| * + 1. Service and repair construction plant instruments panel | * 1. Selection of tools and equipment      1. Assorted screw drivers      2. Pliers      3. Multimeter      4. Wire stripper      5. Insulation resistance tester      6. Soldering iron and solder      7. Diagnostic scanner      8. Assorted socket spanners   2. Disconnecting of battery terminal      1. Disconnecting of negative battery terminal   3. Locating instruments panel      1. Removal of components inhibiting access   4. Disassembly of instruments panel   5. Inspection of instrument gauges      1. Check for signs of damage, wear or corrosion      2. Loose connections, broken wires   6. Cleaning of instrumental panel components      1. Use of appropriate cleaning supply to clean the instruments panel components   7. Instruments panel components testing      1. Continuity test      2. Voltage measurements      3. Resistance testing   8. Replacing worn out instrument gauges   9. Calibrating instrument gauges   10. Maintaining cleanliness of the gauges | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| * + 1. Repair construction plant lighting system | * 1. Selecting tools and equipment      1. Assorted screw drivers      2. Wire stripper      3. Wire cutter      4. Multimeter      5. Assorted spanners      6. Beam setter   2. Identifying and inspecting lighting systems      1. Checking the condition of headlights      2. Checking the condition of tail lights      3. Checking the condition of bulb holders   3. Main beam and dip beam switch replacement      1. Replace if not in good condition   4. Connectors and wire harness replacement      1. Replacement of weak or broken connectors      2. Replacement of weak or broken wire harness   5. Servicing Construction plant lights      1. Replacing blown bulbs      2. Replacing damaged and bad bulb holders      3. Insulating naked wires      4. Rectifying loose connections   6. Direction indicator lights and flasher unit inspection      1. Checking condition of bulbs      2. Testing flasher unit      3. Checking for loose connections      4. Checking for rusted or clogged bulb holders   7. Headlight beam setting      1. Positioning lighting fixture      2. Lighting fixture adjustment      3. Fine tuning the beam direction   8. Lighting system test      1. Testing the lighting system | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| 1. Service construction plant heating, ventilation and air conditioning system | * 1. Tools and equipment selection      1. Assorted screw drivers      2. Pliers      3. Wire strippers      4. Multimeter      5. HVAC gauges      6. HVAC vacuum pump      7. Thermometer      8. Coil cleaning brush      9. Duct tape   2. Identification of air conditioning componets      1. Compressor      2. Condenser      3. Evaporator      4. Expansion valve      5. Air handler      6. Refrigerant lines      7. Thermostat      8. Ductwork      9. Filter      10. Blower motor   3. Initial inspection of air conditioning sytem      1. Inspecting system for         1. Visible damage         2. Leaks         3. Inspecting air filter condition         4. Inspecting ductwork for blockage, dirts or debris   4. Cleaning of condenser coil   5. Checking and servicing of air-con condenser and condenser cooling fans      1. Inspection the Air-Con Condenser         1. Visual Inspection         2. visible signs of damage such as dents, corrosion, or dirt accumulation.         3. Cleaning the coils         4. Check for refrigerant leaks         5. Check air flow      2. Inspecting the Condenser Cooling Fans         1. Visual inspection:            1. signs of damage (cracks, bends, or missing blades).         2. Manual spin test         3. Clean the fan blades         4. Check for unusual noises      3. Check the fan motor      4. Test the System         1. Turn the system back on and monitor the cooling performance.         2. Check the air temperature at the output of the condenser.         3. Monitor fan operation: Ensure the fan is running smoothly and providing adequate airflow.      5. Refrigerant level      * 1. Checking and servicing compressor and pressure switch   2. Recharging air conditioner      1. Inspecting system for leaks and repairing if necessary.      2. Connecting refrigerant gauge and recovery machine.      3. Evacuating air and moisture from the system.      4. Recharging with the correct amount of refrigerant.      5. Testing system performance and checking for proper cooling.   3. Service documentation      1. Recording system details (model, serial number, and maintenance history).      2. Documenting issues identified during inspection (e.g., filter condition, leaks, airflow).      3. Noting parts replaced or repaired (e.g., filters, belts, refrigerant).      4. Loging any system adjustments or calibrations performed.      5. Including test results (e.g., temperature, airflow, refrigerant levels) and system performance after service.   4. House keeping      1. Powering off and disconnect the HVAC system.      2. Cleaning and storing tools and equipment properly.      3. Disposing of used filters, old parts, and waste materials.      4. Wiping down surfaces and ensure the work area is clear of debris.      5. Verifying that system components are securely reassembled and operational. | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |
| 1. Install construction plant infotainment system | * 1. Tools and equipment selection      1. Multimeter      2. Wire Strippers      3. Crimping Tools      4. Soldering Iron & Solder      5. Cable Ties      6. Wire Loom/Conduit      7. Fuse Holders and Fuses      8. Drills and Drill Bits      9. Screwdrivers      10. Impact Wrench      11. Mounting Brackets and Racks      12. Double-Sided Tape or Industrial Tape      13. Amplifiers      14. Speakers      15. Audio/Video Cables      16. Signal Splitters      17. Adapters and Converters      18. OBD-II Scanner      19. Configuration Software      20. Firmware Update Tools      21. Portable Power Supply      22. Battery Chargers      23. Test Bench      24. Signal Testers      25. Compressed Air   2. Inspecting infotainment system      1. Initial Inspection      2. Power Test      3. Functionality Test      4. Diagnostic Check   3. Servicing infotainment system      1. Powering off system and disconnecting power supply.      2. Inspect and cleaning all components.      3. Updating software and firmware as needed.      4. Testing all functions and troubleshoot any issues.      5. Reassembling and performing final system check.   4. service documenting      1. Recording system details (model, serial number, etc.).      2. Noting document issues found during inspection and servicing.      3. Noting parts replaced or repaired.      4. Noting log software updates and configurations applied.      5. Noting test results and system performance post-service.   5. performing housekeeping      1. Powering off and disconnecting the system.      2. Cleaning and organizing work area, removing any tools and debris.      3. Disposing of any waste materials properly.      4. Verifying all components are securely reassembled.      5. Updating service logs and ensuring documentation is complete. | * Practical assessment * Project * Third party report * Written test * Portfolio of evidence |

**Suggested Methods of Instruction**

**Suggested Methods of Delivery**

* Practicals
* Projects
* Demonstration
* Group discussion
* Direct instruction

The delivery may also be supplimented and enhanced by the following , if the opportunity allows;

* Industral visit

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| A | **Learning Materials** |  |  |  |
|  | Textbooks | For reference | 5 copies | 1:5 |
|  | Installation manuals | For reference | 1 | 1:25 |
|  | Projectors | For trainer’s use | 1 | 1:25 |
|  | Laptops | For trainer’s use | 1 | 1:25 |
|  | Charts | For illustration | 5 | 1:25 |
|  | PowerPoint presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | For training | 1 | 1:25 |
|  | Work benches | For working on | 5 | 1:5 |
|  | Workshop |  |  |  |
| C | **Consumable materials** |  |  |  |
|  | Track shoes | For machine use | 1 | 1:25 |
|  | Track links, | For machine use | 2 | 2:25 |
|  | pins | For machine use | 1 | 1:25 |
|  | Bushings | For machine use | 1 | 1:25 |
|  | Rollers | For machine use | 1 | 1:25 |
|  | Seals and gaskets | For machine use | 1 | 1:25 |
|  | Grease | For machine use | 1kgs | 1:25 |
|  | Tracks pads | For machine use | 1 | 1:25 |
|  | Wear plates and guards | For machine use | 1 | 1:25 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Fully operational earth Moving machine | For training purpose | 1 | 1:25 |
|  | Assorted spanners tools | Size 10-54mm  To be used in loosening and tightening nuts and bolts | 5 tool boxes | 1:5 |
|  | Welding equipment | For welding where necessary | 2 | 2:25 |
|  | Micrometre screw gauge | For measuring external diameter of components | 5 | 5:25 |
|  | Vernier calipers | For measuring internal diameters of components | 10 | 2:5 |
|  | Lifting chains equipment | For lifting up heavy components | 1 | 1:25 |