

**THE REPUBLIC OF KENYA**

**COMPETENCY-BASED MODULAR CURRICULUM**

**FOR**

**TELECOMMUNICATION TECHNOLOGY**

**KNQF LEVEL 5**

**PROGRAMME ISCED CODE**: **: 0714 454A**

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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 Telecommunication 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.

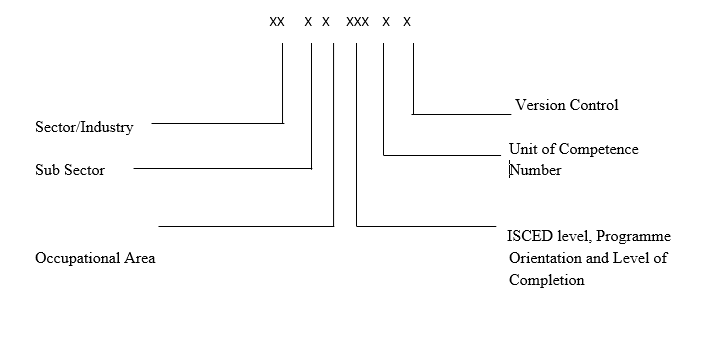
I recognize with appreciation the role of the National Sector Skills Committee (NSSC) in ensuring that competencies required by the industry are addressed in the curriculum. I also thank all stakeholders in the Telecommunication sector for their valuable input and everyone who participated in developing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

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

# ACRONYMS AND ABBREVIATIONS

| **Abbreviation** | **Meaning** |
| --- | --- |
| AC | Alternating Current |
| ACL | Access Control List |
| ADC | Analog-to-Digital Converter |
| ADSS | All-Dielectric Self-Supporting (Fiber Optic Cable) |
| AF | Audio Frequency |
| ALU | Arithmetic Logic Unit |
| AM | Amplitude Modulation |
| AND | Logical AND (Boolean Operation) |
| ANSI | American National Standards Institute |
| AP | Access Point |
| ARM | Advanced RISC Machine (Processor Architecture) |
| ASK | Amplitude Shift Keying |
| AT | Attention Command (Modem Command) |
| ATE | Automated Test Equipment |
| ATSC | Advanced Television Systems Committee |
| AVR | Automatic Voltage Regulator |
| BER | Bit Error Rate |
| BERT | Bit Error Rate Test |
| BJT | Bipolar Junction Transistor |
| BNC | Bayonet Neill-Concelman (Connector) |
| BOM | Bill of Materials |
| BS | Base Station |
| BSC | Base Station Controller |
| BSS | Base Station Subsystem |
| BTS | Base Transceiver Station |
| BUC | Block Upconverter |
| BW | Bandwidth |
| CAD | Computer-Aided Design |
| CAK | Carrier Aggregation Key |
| CAP | Carrierless Amplitude Phase Modulation |
| CAT | Category (e.g., CAT5, CAT6 cables) |
| CBET | Continuous Broadcast Enhancement Transmission |
| CD | Carrier Detect |
| CFP | C Form-Factor Pluggable (Transceiver) |
| CIRCUIT | Electrical Pathway |
| CNC | Computer Numerical Control |
| CPR | Common Public Radio Interface |
| CPU | Central Processing Unit |
| CT | Current Transformer |
| CV | Coefficient of Variation |
| DAC | Digital-to-Analog Converter |
| DC | Direct Current |
| DD | Data Dictionary |
| DHCP | Dynamic Host Configuration Protocol |
| DMM | Digital Multimeter |
| DNS | Domain Name System |
| DRC | Design Rule Check |
| DSL | Digital Subscriber Line |
| DSO | Digital Storage Oscilloscope |
| DVB | Digital Video Broadcasting |
| DVD | Digital Versatile Disc |
| DVI | Digital Visual Interface |
| EEPROM | Electrically Erasable Programmable Read-Only Memory |
| EHF | Extremely High Frequency |
| EIA | Electronic Industries Alliance |
| EIGRP | Enhanced Interior Gateway Routing Protocol |
| EMC | Electromagnetic Compatibility |
| EMCA | ElectroMagnetic Compatibility Assessment |
| EMF | Electromotive Force |
| EMI | Electromagnetic Interference |
| EPA | Environmental Protection Agency |
| ERC | Error Correction |
| ESD | Electrostatic Discharge |
| ESH | Environmental, Safety, and Health |
| FC | Fiber Channel |
| FET | Field-Effect Transistor |
| FIBER | Optical Fiber |
| FIFO | First In, First Out |
| FM | Frequency Modulation |
| FR | Frame Relay |
| FSK | Frequency Shift Keying |
| FSM | Finite State Machine |
| FTP | File Transfer Protocol |
| FTTH | Fiber to the Home |
| GB | Gigabyte |
| GH | Gigahertz |
| GIMP | GNU Image Manipulation Program |
| GNS | Global Navigation Satellite |
| GNSS | Global Navigation Satellite System |
| GPS | Global Positioning System |
| GPU | Graphics Processing Unit |
| GSM | Global System for Mobile Communications |
| HB | High Bandwidth |
| HC | High Current |
| HD | High Definition |
| HDD | Hard Disk Drive |
| HDMI | High-Definition Multimedia Interface |
| HEPA | High-Efficiency Particulate Air |
| HF | High Frequency |
| HPA | High Power Amplifier |
| HTTP | HyperText Transfer Protocol |
| HVAC | Heating, Ventilation, and Air Conditioning |
| IAM | Identity and Access Management |
| IC | Integrated Circuit |
| ICD | Interface Control Document |
| ICT | Information and Communication Technology |
| IDE | Integrated Development Environment |
| IEC | International Electrotechnical Commission |
| IEEE | Institute of Electrical and Electronics Engineers |
| IF | Intermediate Frequency |
| IP | Internet Protocol |
| IPC | Inter-Process Communication |
| IRF | Infrared Frequency |
| ISDN | Integrated Services Digital Network |
| ISO | International Organization for Standardization |
| ISR | Integrated Services Router |
| IT | Information Technology |
| ITU | International Telecommunication Union |
| JFET | Junction Field-Effect Transistor |
| JK | JK Flip-Flop (Digital Logic Circuit) |
| KCE | Key Circuit Element |
| KCL | Kirchhoff’s Current Law |
| KCSE | Kenya Certificate of Secondary Education |
| KNQF | Kenya National Qualifications Framework |
| KPI | Key Performance Indicator |
| KVL | Kirchhoff’s Voltage Law |
| LAN | Local Area Network |
| LC | Logical Circuit |
| LCD | Liquid Crystal Display |
| LCR | Logic Control Relay |
| LED | Light-Emitting Diode |
| LEO | Low Earth Orbit |
| LF | Low Frequency |
| LIFO | Last In, First Out |
| LM | Linear Modulation |
| LMR | Land Mobile Radio |
| LNA | Low Noise Amplifier |
| LNB | Low Noise Block Downconverter |
| LOS | Line of Sight |
| LOTO | Lockout/Tagout |
| LTE | Long-Term Evolution (Mobile Network) |
| LTS | Long-Term Support |
| MAN | Metropolitan Area Network |
| MATLAB | Matrix Laboratory (Software) |
| MC | Microcontroller |
| MCB | Miniature Circuit Breaker |
| MCCB | Molded Case Circuit Breaker |
| MEO | Medium Earth Orbit |
| MF | Medium Frequency |
| MH | Megahertz |
| MI | Modulation Index |
| MMF | Multimode Fiber |
| MOSFET | Metal-Oxide-Semiconductor Field-Effect Transistor |
| MP | Modulation Protocol |
| MPO | Multi-Fiber Push On Connector |
| MSC | Mobile Switching Center |
| MSP | Managed Service Provider |
| MTP | Multi-Fiber Termination Push-On Connector |
| NAT | Network Address Translation |
| NE | Network Element |
| NEC | National Electrical Code |
| NP | Network Processor |
| NPN | Negative-Positive-Negative (Transistor) |
| NSS | Network Switching Subsystem |
| NTP | Network Time Protocol |
| ODF | Optical Distribution Frame |
| OLT | Optical Line Terminal |
| OM | Optical Module |
| ONT | Optical Network Terminal |
| OPGW | Optical Ground Wire |
| OPM | Optical Power Meter |
| OPNET | Optimized Network Engineering Tools |
| OSHA | Occupational Safety and Health Administration |
| OSI | Open Systems Interconnection |
| OSRF | Open Shortest Path First |
| OTDR | Optical Time-Domain Reflectometer |
| PABX | Private Automatic Branch Exchange |
| PBX | Private Branch Exchange |
| PCB | Printed Circuit Board |
| PCI | Peripheral Component Interconnect |
| PCM | Pulse Code Modulation |
| PF | Power Factor |
| PFC | Power Factor Correction |
| PIC | Programmable Interface Controller |
| PIN | Personal Identification Number |
| PLD | Programmable Logic Device |
| PM | Power Management |
| PN | Positive-Negative (Diode) |
| PON | Passive Optical Network |
| POTS | Plain Old Telephone Service |
| PPE | Personal Protective Equipment |
| PWM | Pulse Width Modulation |
| QAM | Quadrature Amplitude Modulation |
| RAM | Random Access Memory |
| RF | Radio Frequency |
| RFID | Radio Frequency Identification |
| RJ | Registered Jack |
| ROM | Read-Only Memory |
| RTOS | Real-Time Operating System |
| SC | Subscriber Connector (Fiber) |
| SD | Secure Digital |
| SFP | Small Form-factor Pluggable |
| TCP | Transmission Control Protocol |
| UPS | Uninterruptible Power Supply |
| VLAN | Virtual Local Area Network |
| VPN | Virtual Private Network |
| WAN | Wide Area Network |
| WLAN | Wireless Local Area Network |
| WPA | Wi-Fi Protected Access |

**KEY TO UNIT CODE**



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# COURSE OVERVIEW

This course is designed to equip a Telecommunication Technician Level 6 with competences required to perform electrical installation, install computer networks, install fiber optical networks, maintan communication systems, fabricate electronic circuits, install broadcasting communication systems, install wireless transmission links, install specialized power systems, fabricate embedded and RF circuits, install telephony systems and install enterprise computer networks.

|  |  |  |  |
| --- | --- | --- | --- |
| **UNITS OF LEARNING** | | | |
| **UNIT CODE** | **UNIT TITLE** | **CREDIT HOURS** | **CREDIT FACTOR** |
| **BASIC UNITS OF LEARNING** | | | |
| 0611 451 01B | Digital Literacy | 40 | 4 |
| 0031 441 02B | Communication skills | 40 | 4 |
| 0417 441 03B | Apply work ethics and practices | 40 | 4 |
| 0413 441 04B | Entrepreneurial skills | 40 | 4 |
| **SUB TOTAL** | | **160** | **16** |
| **COMMON UNITS OF LEARNING** | | | |
| 0541 441 05A | Engineering technician mathematics | 240 | 24 |
| 0732 441 06A | Engineering drawing | 100 | 10 |
| 0713 441 07A | Electrical principles | 190 | 19 |
| **SUB TOTAL** | | **530** | **53** |
| **CORE UNITS OF LEARNING** | | | |
| 0714 451 08A | Electrical installation | 200 | 20 |
| 0612 451 09A | Computer networks installation | 160 | 16 |
| 0714 451 10A | Electronic circuits fabrication | 180 | 18 |
| 0714 451 11A | Specialized power systems installation | 190 | 19 |
| **SUB TOTAL** | | **730** | **73** |
| **INDUSTRIAL ATTACHMENT** | | **480** | **48** |
| **TOTAL** | | **1900** | **19** |

# MODULAR UNIT SUMMARY

The Telecommunication Technology Level 5 curriculum has been structured to be implemented in four (4) modules as shown on the table below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **MODULE** | **UNITS** | | | |
| **UNIT CATEGORY** | **UNIT CODE** | **UNIT NAME** | **DURATION(Hours)** |
| **ONE (I)** | CORE | 0714 451 08A | Electrical Installation | 200 |
| BASIC | 0611 451 01B | Digital Literacy | 40 |
| COMMON | 0732 441 06A | Engineering Drawing | 100 |
|  |  |  | **Total 340 HRS** |
| **TWO (2)** | COMMON | 0541 441 05A | Engineering Technician Mathematics | 240 |
| CORE | 0714 451 11A | Specialized Power Systems Installation | 190 |
|  |  |  | **Total 430 HRS** |
| **THREE (3)** | BASIC | 0417 441 03B | Apply Work Ethics and Practices | 40 |
| CORE | 0612 451 09A | Computer Networks Installation | 160 |
| COMMON | 0713 441 07A | Electrical Principles | 190 |
|  |  |  | **Total 390 HRS** |
| **FOUR (4)** | CORE | 0714 451 10A | Electronic Circuits Fabrication | 180 |
| BASIC | 0413 441 04B | Entrepreneurial Skills | 40 |
| BASIC | 0031 441 02B | Communication Skills | 40 |
|  |  |  | **Total 260 HRS** |
|  | CORE |  | Industrial Attachment | **Total 480 HRS** |
| **TOTAL HOURS** | | | | **1900 HRS** |

The total duration of the course is **1900** hours.

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

1. Kenya Certificate of Secondary Education (KCSE) mean grade D plain or DiV III or its equivalent as determined by the Kenya National Examination Council (KNEC).

1. Any other qualification equivalent as determined by the Technical and Vocational and Training Authority (TVETA).

**Industrial Attachment**

An individual enrolled in this course will be required to undergo an industrial attachment for a minimum period of 480 hours in a telecommunication technology field.

**Trainer qualification**

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

1. Have a minimum of KNQF Level 6 qualification or its equivalent in the related area of specialization.
2. Be registered by TVETA.
3. The assessors and verifiers must be registered by TVETA.

**Assessment Requirements**

1. The competence of trainee undertaking this course will be evaluated through formative and summative assessment as follows:
2. During formative assessment all performance criteria shall be assessed based on performance criteria weighting.
3. Number of formative assessments shall minimally be equal to the number of elements in a unit of competency.
4. During summative assessment basic and common units may be integrated in the core units or assessed as discrete units.
5. Theoretical and practical weight shall be 30:70 for each unit of learning.
6. Formative and summative assessments shall be weighted at 60% and 40% respectively in the overall unit of learning score
7. For a candidate to be declared competent in a unit of competency, the candidate must meet the following conditions:
8. Obtained at least 40% in theory assessment in formative and summative assessments.
9. Obtained at least 60% in practical assessment in formative and summative assessment where applicable.
10. Obtained at least 50% in the weighted results between formative assessment and summative assessment where the former constitutes 60% and the latter 40% of the overall score.
11. Assessment performance rating for each unit of competency 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 Certificate of Competency in Telecommunication Technology level 5.

**Certification**

An individual will be awarded a Certificate of Competency on demonstration of competence in a core unit of competency. To be awarded Kenya National TVET Certificate in Telecommunication Technology Level 5, an individual must demonstrate competence in all the units of competency in this qualification pack.

The qualification certificates in Telecommunication Technology Level 5 will be awarded and issued by **a QAI**.

# MODULE ONE

## DIGITAL LITERACY

**UNIT CODE:** 0611 451 01B

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply Digital Literacy

**Duration of Unit:** 40 Hours

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

**Summary of Learning Outcomes**

By the end of the unit the trainee should be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **LEARNING OUTCOMES** | **DURATION (HOURS)** |
|  | Operate Computer Devices | 6 |
|  | Solve Tasks Using Office Suite | 14 |
|  | Manage Data and Information | 6 |
|  | Perform Online Communication and Collaboration | 4 |
|  | Apply Cybersecurity Skills | 4 |
|  | Perform Online Jobs | 4 |
|  | Apply job entry techniques. | 2 |
|  | **TOTAL HOURS** | **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. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 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       3. Print presentations (slides and handouts) | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Manage Data and Information | * 1. Meaning of Data and information   2. Importance and Uses of data and information   3. Types of internet services      1. Communication Services      2. Information Retrieval Services      3. File Transfer      4. World Wide Web Services      5. Web Services      6. Automatic Network Address Configuration      7. NewsGroup      8. Ecommerce   4. Types of Internet Access Applications   5. Web browsing concepts      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 | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 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 | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 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 | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Perform Online Jobs | * 1. Introduction to online working      1. Types of online Jobs      2. Online job platforms         1. Remotask         2. Data annotation tech         3. Cloud worker         4. Upwork         5. Oneforma         6. Appen   2. Online account and profile management   3. Identifying online jobs/job bidding   4. Online digital identity   5. Executing online tasks   6. Management of online payment accounts. | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Apply job entry techniques. | * 1. Types of job opportunities      1. Self-employment      2. Service provision      3. product development      4. salaried employment   2. Sources of job opportunities   3. Resume/ curriculum vitae      1. What is a CV      2. How long should a CV be      3. What to include in a AC      4. Format of CV      5. How to write a good CV      6. Don’ts of writing a CV   4. Job application letter      1. What to include      2. Addressing a cover letter      3. Signing off a cover letter   5. Portfolio of Evidence      1. Academic credentials      2. Letters of commendations      3. Certification of participations      4. Awards and decorations   6. Interview skills      1. Listening skills      2. Grooming      3. Language command      4. Articulation of issues      5. Body language      6. Time management      7. Honesty   7. Generally knowledgeable in current affairs and technical area | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |

**Suggested Delivery Methods**

* + Demonstration
  + Practical
  + Multimedia
  + Group discussions
  + Project
  + Role play
  + Case study

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/**  **Specifications** | **Quantity** | **Recommended**  **Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | Digital Literacy: Concepts and Applications by Ben Brow | 10 pcs | 1:3 |
|  | Printed training materials | Sample CVs  Sample job applications | 5 pcs  5 pcs | 1:5  1:5 |
|  | Online Resources | Khan Academy, Coursera, and YouTube for supplementary video content. | Accessible in 25 computers | 1:1 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Computer workshop | 160 m2 | 1 | 1:25 |
|  | Computers | Operating System: 64-bit Windows 11 or 10 version 1809 or above  Processor: 2.5 GHz (3+ GHz recommended),  Memory: 8 GB (32GB recommended)  Disk space: 10 GB  Display: 1920 x 1080 resolution  Display Card: 2 GB GPU (8 GB recommended) and DirectX 11 compliant (DirectX 12 recommended) | 25 pcs | 1:1 |
|  | Projector | high-resolution projectors with HDMI input | 1 | 1:25 |
|  | Smartboard/Smart TV | Specifications: 77-inch interactive whiteboard with touch and pen functionality. | 1 | 1:25 |
|  | Whiteboard | Traditional whiteboard | 1 | 1:25 |
|  | External storage media | USB flash drives (32GB), External HDD/SSD | 25 pcs | 1:1 |
|  | Webcams | HD (1080p) | 25 pcs | 1:1 |
|  | Printers | With Print, Copy, Scan and Fax | 2 | 1:13 |
|  | Over-ear headphones | Large diaphragm | 25 pcs | 1:1 |
| **C** | **Software** |  |  |  |
|  | Operating systems | Windows/Linux/Macintosh Operating System | For 25 computers | 1:1 |
|  | Office | Microsoft Office Software | For 25 computers | 1:1 |
|  | Workspace | Google Workspace Account | For 25 computers | 1:1 |
|  | Antivirus Software |  | For 25 computers | 1:1 |
|  | Photo editing software | Adobe Photoshop, Canva, GIMP | For 25 computers | 1:1 |
|  | Video editing software | Adobe Premiere Pro, iMovie, DaVinci Resolve | For 25 computers | 1:1 |
|  | Web Browsers | Chrome, Firefox, Edge, Safari | For 25 computers | 1:1 |
| **D** | **Consumables** |  |  |  |
|  | Pens, pencils, rulers and paper | Whiteboard markers, 2H pencils, plastic rulers, A2 white papers | Enough |  |
|  | Printing papers | A4 and A3 | Enough |  |

## ELECTRICAL INSTALLATION

**UNIT CODE:** 0714 451 08A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Perform Electrical Installation

**Duration of Unit:** 200 hours

**Unit Description**

This unit specifies competencies required for installing electrical installation for telecommunication systems and facilities. These include preparing power supply electrical drawings, performing electrical installation system sizing, setting up telecommunication mains utility power supply system, and testing electrical power supply system

**Summary of Learning Outcomes**

By the end of the unit the trainee should be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **LEARNING OUTCOME** | **DURATION (HRS)** |
|  | Prepare power supply electrical drawings | 30 |
|  | Perform Electrical installation system sizing | 20 |
|  | Set up Telecommunication mains utility power supply system | 130 |
|  | Test electrical power supply system | 20 |
|  | **TOTAL HOURS** | 200 HRS |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Prepare power supply electrical drawings | * 1. Power Supply Site Survey      1. Purpose of a Power Supply Site Survey      2. Pre-Survey Planning         1. Review of project specifications and requirements         2. Gathering necessary equipment and tools         3. Obtaining permits and clearances      3. Safety Considerations         1. Electrical safety precautions         2. Personal protective equipment (PPE)         3. Hazard identification and risk assessment      4. Site Assessment and Data Collection         1. Site Inspection  1. Visual inspection of the site 2. Identifying existing power infrastructure 3. Assessing site accessibility and terrain 4. Evaluating environmental factors (temperature, humidity, weather)    * + 1. Data Collection 5. Measuring distances and elevations 6. Recording existing power supply conditions 7. Collecting data on load requirements 8. Documenting site photos and sketches    * 1. Site Survey Report Writing         1. Report Structure 9. Executive summary 10. Site description 11. Power load analysis 12. Power supply options and recommendations 13. Cost estimates 14. Appendices (data sheets, maps, photos)     * + 1. Report Writing Guidelines 15. Clear and concise language 16. Accurate data presentation 17. Professional formatting 18. Adherence to industry standards     1. Electrical Design and Drawing Preparation        1. Electrical Design Principles           1. Load Calculation and Power Factor Correction           2. Voltage Drop Calculations           3. Short Circuit Current Calculations           4. Earthing System Design           5. Lighting Design        2. Electrical Drawing Standards           1. Single-Line Diagrams           2. Three-Line Diagrams           3. Wiring Diagrams           4. Control Schematics           5. Panel Layouts        3. CAD Software           1. AutoCAD Basics           2. Electrical Symbol Libraries           3. Drawing Creation and Editing           4. Dimensioning and Annotation           5. Printing and Plotting | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Perform Electrical installation system sizing | * 1. Power distribution systems      1. Types Power Supply Sources         1. Grid power         2. Generator power         3. Solar power         4. Battery backup         5. Hybrid power systems         6. Uninterruptible Power Supply (UPS)      2. Factors in Selecting a Power Supply Source      3. Electrical loads         1. Load Types and Characteristic  1. Resistive, Inductive, and Capacitive Loads 2. Motor Loads 3. Lighting Loads 4. Heating and Cooling Load    * + 1. Load Estimation Techniques 5. Load diversity factor 6. Demand factor 7. Load growth projections    * 1. Power Factor Correction         1. Importance of Power Factor         2. Calculation of Power Factor         3. Methods of Power Factor Correction         4. Capacitor Bank Sizing    1. Cable Sizing and Selection       1. Cable Types and Construction          1. Copper and Aluminum Conductors          2. Cable Insulation Materials          3. Cable Ratings (Voltage, Current, Temperature)       2. Cable Sizing Standards          1. IEC Standards          2. NEC Standards          3. Importance of cable sizing       3. Cable Sizing Calculations          1. Factors affecting cable sizing          2. Voltage Drop Calculations          3. Current Carrying Capacity          4. Cable Derating Factor    2. Protection devices selection       1. Circuit Breaker Types          1. Molded Case Circuit Breakers (MCCBs)          2. Miniature Circuit Breakers (MCBs)          3. Circuit Breaker Ratings (Ampere, Voltage, Interrupting Capacity)       2. Fuse Types          1. Cartridge Fuses          2. Plug Fuses          3. Fuse Ratings (Ampere, Voltage, Interrupting Rating)       3. Circuit Breaker and Fuse Selection Criteria          1. Short-Circuit Current Rating          2. Overload Protection          3. Selective Coordination          4. Protection system principles: discrimination and redundancy       4. Surge protection devices       5. Overload relays    3. Transformer Sizing and Selection       1. Transformer Types          1. Single-Phase and Three-Phase Transformers          2. Core-Type and Shell-Type Transformers       2. Transformer Ratings          1. Voltage Rating          2. Current Rating          3. Power Rating          4. Efficiency          5. Impedance       3. Transformer Sizing Calculations          1. Load Calculation          2. Voltage Drop Calculation          3. Transformer Efficiency and Losses    4. Earthing Systems       1. Types of Earthing Systems          1. TN-S          2. TN-C-S          3. TT          4. IT Systems       2. Earthing system sizing    5. Sizing of Electrical Panels and Distribution Boards       1. Panelboard Components          1. Main Busbar          2. Circuit Breakers          3. Neutral Busbar          4. Ground Busbar          5. Enclosure       2. Distribution Board Components          1. Incoming Feeder          2. Outgoing Circuits          3. Circuit Breakers or Fuses          4. Enclosure       3. Panelboard and distribution board Layout          1. Incoming Feeder          2. Outgoing Circuits          3. Circuit Breaker or Fuse Arrangement          4. Wiring Layout          5. Grounding and Bonding       4. Panelboard and distribution board Sizing          1. Load Calculation          2. Short-Circuit Current Calculation          3. Voltage Drop Calculation          4. Board Rating Selection          5. Busbar Sizing          6. Allowance for Future Expansion       5. Code Compliance and Standards          1. NEC code          2. IEC standards | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Set up Telecommunication mains utility power supply system | * 1. Tools, Equipment, and Material Preparation      1. Tool Selection and Usage         1. Screwdrivers         2. Pliers         3. Wire Strippers         4. Cable Cutters         5. Cable Pullers         6. Drilling Machines      2. Equipment Selection and Usage:         1. Voltage Testers         2. Multimeters         3. Megger         4. Cable Fault Locators      3. Material Selection and Preparation         1. Cables (PVC, XLPE, armored)         2. Conduits and Fittings         3. Cable Trays and Accessories         4. Circuit Breakers and Fuses         5. Distribution Boards and Panels         6. Earthing and Bonding Materials   2. Utility Distribution Panel and Board Installation      1. Panel Selection         1. Choosing the Right Panel Type: indoor, outdoor, weatherproof         2. Panel Rating and Configuration      2. Panel Installation         1. Mounting the Panel         2. Installing Busbars and Circuit Breakers         3. Wiring the Panel         4. Grounding and Bonding      3. Distribution Board Installation         1. Mounting the Board         2. Installing Circuit Breakers or Fuses         3. Wiring the Board         4. Grounding and Bonding   3. Cable Laying and Termination      1. Cable Laying Techniques         1. Trenching and Cable Laying         2. Cable Tray and Conduit Installation         3. Cable Bending and Routing      2. Cable Termination Techniques         1. Stripping and Tinning Cable Ends         2. Crimping Connectors         3. Lug Termination         4. Cable Glanding and Sealing      3. Terminating metering units      4. Terminating control relays and conductors   4. Earthing and Bonding Installation      1. Installing Earth Electrodes         1. Earth rod         2. Earth pits      2. Connecting Equipment to the Earthing System      3. Bonding Conductive Parts   5. Testing and Commissioning      1. Pre-Commissioning Tests         1. Insulation Resistance Test         2. Continuity Test         3. Earth Resistance Test      2. Commissioning Procedures         1. Energizing the System         2. Load Testing         3. Protection System Testing      3. Handover Procedures         1. Preparing Documentation  1. As-built drawings 2. Test reports | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Test electrical power supply system | * 1. Electrical Safety      1. Safety Regulations and Standards: NEC, IEC      2. Personal Protective Equipment (PPE)      3. Electrical Shock Hazards      4. Lockout/Tagout Procedures   2. Test Equipment      1. Multimeter      2. Clamp Meter      3. Megger      4. Power Quality Analyzer      5. Oscilloscope   3. Electrical tests      1. Visual inspection: purpose and procedure      2. Insulation Resistance Test         1. Purpose and Significance         2. Test Procedure         3. Interpretation of Results      3. Continuity Test         1. Purpose and Significance         2. Test Procedure         3. Interpretation of Results      4. Earth Resistance test         1. Purpose and Significance         2. Test Procedure         3. Interpretation of Results      5. Voltage and Current Measurements         1. Measuring Voltage and Current Levels         2. Verifying Phase Sequence         3. Power Factor      6. Protection System Testing         1. Testing Overcurrent and Overvoltage Protection         2. Response of protection systems         3. Testing Earth Fault Protection      7. Transformer Testing         1. Voltage Ratio Test         2. Winding Resistance Test         3. Insulation Resistance Test         4. Load Test      8. Cable Testing         1. Cable Fault Location         2. Cable Impedance Measurement         3. Cable Insulation      9. Functional Testing      10. Documentation and Reporting of electrical tests          1. Importance of tests documentation          2. Test checklists          3. Creating Test Report | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |

**Suggested Methods of delivery**

* + 1. Practical
    2. Project
    3. Demonstration
    4. Group discussion
    5. Direct instruction
    6. Field visits
    7. Industry visits
    8. Case studies

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S No.** | **Item** | **Specifications for Purchase** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Tools & Equipment** |  |  |  |
| 1 | Laptops/Desktop Computers | 8GB RAM, 256GB SSD, CAD software compatible | 10 pcs | 1:3 |
| 2 | Drawing Tools | Includes T-squares, protractors, rulers | 25 sets | 1:1 |
| 3 | Plotter/Printer | Wide-format, high-resolution for CAD prints | 2 pcs | 1:13 |
| 4 | Digital Multimeters | Auto-ranging, backlit display | 5 pcs | 1:5 |
| 5 | Power Factor Meters | Measures 0.5-1.0 power factor | 5 pcs | 1:5 |
| 6 | Cable Cutters | Insulated, ergonomic handle | 10 pcs | 1:3 |
| 7 | Cable Strippers | Adjustable for different wire gauges | 10 pcs | 1:3 |
| 8 | Crimping Tools | High-quality, suitable for insulated terminals | 10 pcs | 1:3 |
| 9 | Torque Wrenches | Adjustable torque range, calibrated | 2 sets | 1:13 |
| 10 | Spanners and Socket Sets | Includes standard and metric sizes | 2 sets | 1:13 |
| **B** | **Reference Materials** |  |  |  |
| 11 | Electrical Symbols Reference Charts | Comprehensive symbols for schematic reference | 25 pcs | 1:1 |
| 12 | Paper and Pencils/Erasers | For drafting, includes erasers and HB pencils | 25 sets | 1:1 |
| 13 | Whiteboard and Markers | Magnetic whiteboard, assorted color markers | 1 set | 1 per class |
| **C** | **Electrical Materials** |  |  |  |
| 14 | Cables and Wires | Assorted gauges for electrical training | As needed | As needed |
| 15 | Electrical Panels and Enclosures | Weatherproof, lockable | 5 sets | 1:5 |
| 16 | Conduit and Trunking | Assorted sizes for wire management | As needed | As needed |
| 17 | Cable Ties, Connectors, and Lugs | Variety pack for secure electrical connections | As needed | As needed |
| 18 | Safety Labels and Tags | Assorted electrical hazard labels | 25 pcs | 1:1 |
| 22 | Scaffolding | Modular, adjustable height for safe access | 2 sets | 1:13 |
| **D** | **Testing & Measurement** |  |  |  |
| 23 | Multimeters | Digital, auto-ranging with multiple test functions | 10 pcs | 1:3 |
| 24 | Projector | High-resolution for presentations | 1 pc | 1 per class |
| 25 | Insulation Resistance Testers | 500V, accurate insulation resistance measurement | 5 pcs | 1:5 |
| 26 | Distribution Boards | With circuit breakers for demonstration purposes | 5 pcs | 1:5 |
| 27 | Switchgear | Assorted for learning different control methods | As needed | As needed |
| 28 | Power Meters | Monitors electrical parameters | 5 pcs | 1:5 |
| 32 | Ladders | Adjustable, anti-slip steps | 5 pcs | 1:5 |
| 34 | Power Distribution Units | With surge protection | 5 pcs | 1:5 |
| 36 | Racks/Cabinets | Secure storage for equipment | As needed | As needed |
| **E** | **Documentation** |  |  |  |
| 40 | Manufacturer’s Catalogues | Latest catalogs of electrical components | 5 pcs | 1:5 |
| 41 | Electrical Design Standards | Includes IEEE, IEC guidelines | 5 pcs | 1:5 |
| 42 | Electrical Codebooks | National Electrical Code, BS7671 | 5 pcs | 1:5 |
| 43 | EMCA Act | Environmental guidelines for electrical installations | 5 pcs | 1:5 |
| 44 | OSHA | Safety guidelines for electrical systems | 5 pcs | 1:5 |
| 45 | Cable Sizing Charts | For selecting correct cable gauge | 5 pcs | 1:5 |
| 46 | Cable Specification Catalogs | Specifications for different cable types | 5 pcs | 1:5 |
| 47 | Electrical Load Data Sheets | Load calculations and examples | 5 pcs | 1:5 |
| 48 | Specification Sheets | Manufacturer’s specs for key components | 5 pcs | 1:5 |
| 49 | Electrical Utility Standards | Guidelines from utility providers | 5 pcs | 1:5 |
| 50 | Site Layout Diagrams | Electrical schematics for practice | 5 sets | 1:5 |

## ENGINEERING DRAWINGS

**UNIT CODE:** 0732 451 05A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Prepare Engineering drawings

**Unit duration**: 100 hours.

**Unit Description:** This unit covers competences required to prepare technical drawings. Competences include preparing drawing equipment and materials, producing plane geometry drawings, managing basic operations in AutoCAD, developing 2D Drawings in AutoCAD and Producing pictorial and orthographic drawings of components.

**Summary of Learning Outcomes**

By the end of the unit the trainee should be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **LEARNING OUTCOME** | **DURATION (HRS)** |
|  | Prepare drawing equipment and materials | 10 |
|  | Produce plane geometry drawings | 10 |
|  | Manage basic operations in AutoCAD | 10 |
|  | Develop 2D Drawings in AutoCAD | 40 |
|  | Produce pictorial and orthographic drawings of components | 30 |
|  | **TOTAL HOURS** | **100 HRS** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Prepare drawing equipment and materials | * 1. Introduction to engineering Drawing      1. Importance of technical drawing in engineering and design.      2. Types of engineering technical drawings         1. Orthographic         2. Isometric         3. Perspective   2. Identifying Technical Drawing Tools and Equipment      1. Tools Overview         1. Drawing board, T-square, set squares, protractor.         2. Compass and dividers.         3. Scale rulers (linear, diagonal, isometric).         4. Drafting pencils and mechanical pencils.         5. Erasers and erasing shields.         6. Drawing paper and tracing sheets.      2. Equipment Overview         1. Adjustable drafting tables.         2. Lighting for technical drawing   3. Using Technical Drawing Tools      1. Drawing Lines and Shapes      2. Angles and Measurements      3. Creating Circles and Arcs      4. Lettering and Dimensioning   4. Care and Maintenance of Technical Drawing Tools      1. Cleaning and storing tools      2. Sharpening and handling drafting pencils and compasses.      3. Preventing rust or damage to metal tools.   5. Safety Practices in engineering drawing | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Produce plane geometry drawings | * 1. Introduction to Plane Geometry      1. Overview of plane geometry concepts         1. Points         2. Lines         3. Angles         4. Polygons         5. Circles      2. Real-life applications of plane geometry drawings   2. **Constructing Geometric** Shapes      1. Drawing and labelling         1. Freehand printing         2. Borderlines ad tittle blocks         3. Points and straight lines.         4. Angles: acute, right, obtuse, and reflex.         5. Basic shapes: triangles, squares, rectangles, parallelograms and circles.         6. Bisection of different angles and lines      2. Using tools for precision         1. Measuring lengths and angles accurately.         2. Using compasses for circles and arcs.      3. Constructing other geometric **shapes**         1. Drawing polygons: pentagons, hexagons, and octagons.         2. Pyramids         3. Conic sections         4. Prisms         5. Inscribing and circumscribing polygons within circles.         6. Drawing tangents and chords on circles.         7. Patterns development      4. Standards and conventions in drawing         1. Dimensioning: specifying lengths, angles, and radii.         2. Line types and their meanings Title blocks, scales, and annotations. | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Manage basic operations in AutoCAD | * 1. **Introduction** to CAD      1. Definition of CAD      2. Uses of CAD      3. Merits and demerits of AutoCAD over traditional method of engineering drawing.   2. AutoCAD **installation**      1. Computer system requirements for AutoCAD      2. CAD software type and versions         1. AutoCAD Electrical         2. AutoCAD Architecture         3. AutoCAD Mechanical   3. AutoCAD installation procedure   4. Getting started with CAD      1. Creating a new project in CAD.      2. AutoCAD user interface         1. Ribbon         2. Panels         3. Model space         4. Layout tabs         5. Status bar         6. Properties   5. Working with commands      1. Methods of inputting command in CAD.         1. Use icons on Ribbon         2. Use the commands box         3. Use Shortcuts      2. Selection methods in CAD.         1. One click         2. Window selection         3. Cross selection      3. 2D Cartesian workspace      4. Opening an existing project      5. Saving a new project. | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Develop 2D Drawings in AutoCAD | * 1. Basic Drawings and Editing Commands      1. Types of lines and application         1. Construction lines         2. Centre lines         3. Hidden detail lines         4. Border lines         5. Outline      2. Drawing lines         1. Vertical lines         2. Horizontal lines         3. Angular lines      3. Erasing objects         1. Use of command box         2. Selecting and pressing delete         3. Use of erase icon on ribbon      4. Drawing plane geometry         1. Triangles         2. Circles and tangents         3. Arcs         4. Quadrilaterals         5. Polygons         6. Orthographic projections  1. First angle orthographic 2. Third angle orthographic    * + 1. Surface development        2. Simpe floor plans        3. Electrical drawings 3. Block diagram 4. Schematic diagram 5. Line and wiring circuits    1. Drawing Precision in CAD       1. Using object snap overrides       2. Polar tracking at angles       3. Object snap tracking       4. Drawing with snap and grid    2. Making changes in your drawings       1. Selecting objects for editing       2. Moving       3. Copying       4. Rotating       5. Mirroring       6. Scaling       7. Trimming and extending       8. Stretching       9. Creating fillets and chamfers       10. Creating arrays    3. Annotations       1. Adding a text in a drawing       2. Modifying multiline text       3. Formatting multiline text       4. Creating tables          1. Title block          2. Modifying tables    4. Adding dimensions to drawings       1. Dimensioning concepts       2. Adding linear dimensions       3. Adding radial and angular dimensions       4. Editing dimensions    5. 2D drawings documentation       1. Printing concepts       2. Printing layouts       3. Print and plot settings | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Produce pictorial and orthographic drawings of components | * 1. Difference between pictorial and orthographic drawings   2. Drawing and interpretation of orthographic elevations using CAD   3. Dimensioning of orthographic elevations   4. 3D CAD user interface      1. Ribbon      2. Panels      3. Model space      4. Layout tabs      5. Status bar      6. Properties   5. Working with 3D commands      1. Methods of inputting command in CAD.         1. Use icons on Ribbon         2. Use the commands box         3. Use Shortcuts      2. Selection methods in CAD.         1. One click         2. Window selection         3. Cross selection   6. 3D Cartesian workspace      1. 3D CAD drawingsare drafted as per work requirement   7. Basic solids      1. Cylinder      2. Cubes      3. Cuboids      4. Prisms      5. Pyramids      6. Cones   8. Produce pictorial drawings      1. Oblique drawing      2. Isometric drawing   9. Produce Assembly drawings   10. 3D drawings documentation       1. Printing layouts       2. Print and plot settings | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |

**Suggested Delivery Methods**

* Demonstration
* Discussions
* Practical
* Project
* Direct instruction

**List of Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/**  **Specifications** | **Quantity** | **Recommended**  **Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | Introduction to Drafting and AutoCAD 2D  Comprehensive Guide for Beginners and Intermediate Users by CAD Artifex  Technical Drawing 101 with AutoCAD by Ashleigh Congdon-Fuller, Antonio Ramirez and Douglas Smith | 5 pcs  5 pcs  5 pcs | 1:5  1:5  1:5 |
|  | Installation manuals | AutoCAD software installation manual | 25 pcs | 1:51 |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Computer laboratory | 160m2 | 1 | 1:25 |
|  | Computer | Operating System: 64-bit Windows 11 or 10 version 1809 or above  Processor: 2.5 GHz (3+ GHz recommended),  Memory: 8 GB (32GB recommended)  Disk space: 10 GB  Display: 1920 x 1080 resolution  Display Card: 2 GB GPU (8 GB recommended) and DirectX 11 compliant (DirectX 12 recommended) | 25 pcs | 1:1 |
|  | Projector | At least 3000 lumens | 1 | 1:25 |
|  | Interactive screen | 75 inches | 1 | 1:25 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **C** | **Software** |  |  |  |
|  | Solid works | Solid works 2024 Standard | 1 | 1:25 |
|  | AutoCAD | AutoCAD 2025 | 1 | 1:25 |
|  | Solid works licenses | Solid works 2024 Standard version licenses | 25 | 1:1 |
|  | AutoCAD licenses | AutoCAD 2025 licenses | 25 | 1:1 |

# MODULE TWO

## ENGINEERING TECHNICIAN MATHEMATICS

**UNIT CODE:** 0541 441 04A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply Engineering technician mathematics

**Unit duration**: 240 hours.

**Unit Description:** This unit describes the competencies required by a technician in order to apply technician mathematics. It enables the learner to; apply algebra, apply trigonometry and hyperbolic functions, apply complex numbers perform coordinates geometry, carry out mensuration, applying calculus, carrying out binomial expansion, applying vector theory, applying statistics and probability and applying matrices.

**Summary of Learning Outcomes**

By the end of the unit the trainee should be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **LEARNING OUTCOME** | **DURATION (HRS)** |
|  | Apply algebra | 20 |
|  | Apply Trigonometry and hyperbolic functions | 20 |
|  | Apply complex numbers | 20 |
|  | Perform coordinate geometry | 20 |
|  | Apply Calculus | 60 |
|  | Carry out binomial expansion | 20 |
|  | Apply vector theory | 20 |
|  | Apply Statistics and probability | 20 |
|  | Apply matrices | 20 |
|  | **TOTAL HOURS** | 240 HRS |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply algebra | * 1. Importance of algebra in engineering   2. Indices and logarithms      1. Indices         1. Define Base and index         2. Laws of indices         3. Indicial equations      2. Logarithms         1. Laws of logarithm         2. Logarithmic equations         3. Conversion of bases      3. Use of calculator   3. Linear Equations      1. Definition and standard form.      2. Methods of solving: Graphical, substitution, and elimination methods.      3. Applications in engineering problems.   4. Quadratic Equations      1. Definition and standard form.      2. Methods of solving: Factoring, completing the square, and quadratic formula.      3. Real-world engineering applications.   5. Algebraic functions and graph      1. Types of functions         1. Linear, quadratic, polynomial, rational, and exponential functions         2. Characteristics and properties of each function type.      2. Graphing Functions         1. Cartesian coordinate system.         2. Plotting and interpreting graphs of algebraic functions.         3. Using graphs to solve engineering problems. | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Apply trigonometry and hyperbolic functions | * 1. Importance of trigonometry in engineering.   2. Trigonometric Ratios and Functions      1. Definitions of sine, cosine, tangent, cosecant, secant, and cotangent.      2. Unit circle and angle measurement         1. Degrees and radians         2. Graphs of trigonometric functions.   3. Trigonometric Identities      1. Fundamental identities         1. Pythagorean         2. Reciprocal         3. Quotient identities      2. Co-function identities and even-odd properties.      3. Sum and difference formulas, double-angle, and half-angle formulas.   4. Solving Trigonometric Equations      1. Basic Trigonometric Equations         1. Solving equations involving basic trigonometric functions.         2. Using identities to simplify and solve equations.      2. Inverse Trigonometric Functions         1. Definition and properties.         2. Solving equations using inverse trigonometric functions.      3. Applications of Trigonometric Equations         1. Engineering problems involving periodic functions and waveforms.         2. Harmonic motion and oscillations in mechanical systems.   5. Trigonometry in Triangles      1. Right-Angle Triangles         1. Solving for sides and angles using trigonometric ratios.         2. Applications in engineering problems such as inclined planes and forces.      2. Non-Right-Angle Triangles         1. Law of Sines and Law of Cosines.         2. Solving oblique triangles.         3. Applications in engineering fields of structural analysis and navigation.   6. Introduction to Hyperbolic Functions      1. Definitions of hyperbolic sine, cosine, tangent, and their reciprocals.      2. Graphs and properties of hyperbolic functions.   7. Hyperbolic Identities      1. Fundamental identities         1. Pythagorean-like identities      2. Sum and difference formulas, double-angle, and half-angle formulas.   8. Solving Hyperbolic Equations      1. Basic Hyperbolic Equations         1. Solving equations involving basic hyperbolic functions.         2. Using identities to simplify and solve equations.      2. Inverse Hyperbolic Functions         1. Definition and properties.         2. Solving equations using inverse hyperbolic functions.      3. Applications of Hyperbolic Functions in Engineering | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Apply complex numbers | * 1. Introduction to Complex Numbers      1. Definition of a complex number      2. Real and imaginary parts.      3. Complex plane: Argand diagram   2. Arithmetic Operations      1. Addition, subtraction, multiplication, and division of complex numbers.      2. Conjugate of a complex number.   3. Polar and Exponential Forms      1. Polar form of a complex number.      2. Conversion between Cartesian and polar forms.      3. Exponential form using Euler’s formula.   4. Complex Number Operations      1. Powers and Roots         1. Powers of complex numbers using De Moivre’s Theorem.         2. Finding roots of complex numbers.      2. Complex Exponential Functions         1. Definition and properties.         2. Applications in solving differential equations.   5. Solving Equations Using Complex Numbers      1. Quadratic Equations      2. Solving quadratic equations with complex coefficients.      3. Nature of roots         1. Real and complex      4. Systems of Linear Equations         1. Using complex numbers to solve linear systems.         2. Applications in AC circuit analysis. | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Perform coordinates geometry | * 1. Polar equations      1. Definition of polar coordinates      2. Definition and examples of polar equations.      3. Representing curves using polar equations.   2. Cartesian equation      1. Definition of Cartesian coordinates.      2. Definition of a point in cartesian coordinates      3. Relationship between Cartesian and polar coordinates.      4. Definition and examples of Cartesian equations.      5. Representing lines, circles, parabolas, ellipses, and hyperbolas using Cartesian equations.      6. Conversion Between Polar and Cartesian Equations.   3. Graphs of polar equations      1. Plotting Polar Equations         1. Definition of a point in polar coordinates         2. Steps to graph polar equations.         3. Using symmetry and periodicity in polar graphs.      2. Analyzing Polar Graphs         1. Identifying key features intercepts, maxima, minima      3. Applications in engineering   4. Normal and tangents      1. Tangents to Curves         1. Definition of a tangent line.         2. Finding the slope of a tangent to a curve at a given point.      2. Normals to Curves         1. Definition of a normal line.         2. Finding the equation of a normal to a curve at a given point.      3. Tangents and Normals in Polar Coordinates         1. Techniques for finding tangents and normals to curves defined by polar equations.   5. Loci      1. Introduction to Loci         1. Definition of Locus         2. Understanding the concept of a locus.         3. Importance of loci in engineering.      2. Locus in Relation to a Circle         1. Equations and properties of loci relative to circles.         2. Common loci problems involving circles      3. Applications in Engineering         1. Using loci to solve engineering problems: robotic arm movement         2. Analyzing Loci of Points: tracing the path of a point on a rotating arm         3. Using loci to optimize mechanical systems: designing cams, robotic path planning. | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Carry out binomial expansion | * 1. Basic concepts of binomial theorem      1. Binomial expressions and notation.      2. Factorials and their use in binomial coefficients.      3. Binomial Coefficients         1. Definition and calculation using combinations (nCr).         2. Pascal’s Triangle as a tool for finding binomial coefficients.   2. Binomial Expansion  1. General form of the binomial expansion expression 2. Binomial Expansion of where 3. Special cases    * + 1. When        2. Negative and fractional binomial expansions using the binomial series    1. Applications of Binomial Expansion       1. Simplifying algebraic expressions using binomial expansion.       2. Solving polynomial equations.    2. Engineering Applications    3. Estimating values in engineering calculations. | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Apply calculus | * 1. Definition of derivatives of a function   2. Differentiation from fist principle   3. Tables of some common derivatives   4. Rules of differentiation      1. Sum and difference rule      2. Product rule      3. Quotient rule      4. Chain rule      5. Parametric differentiation      6. Implicit differentiation   5. Rate of change and small change   6. Stationery points of functions of two variables   7. Definition of integration   8. Indefinite and definite integral   9. Methods of integration application of integration.      1. Substitution      2. Reduction formula      3. By parts      4. Partial fractions   10. Integrals of hyperbolic and inverse functions   11. Application of integration | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Apply statistics and probability | * 1. Measures of central tendency mean, mode and median   2. Measures of dispersion   3. Variance and standard deviation   4. Definition of probability   5. Laws of probability   6. Expectation variance and SD   7. Calculations involving discrete and continuous random variables.   8. Types of distributions      1. Binomial      2. Poisson      3. Normal   9. Mean, variance and SD of probability distributions   10. Application of probability distributions |  |
| 1. Apply vector theorem | * 1. Vectors and scalar in two and three dimensions   2. Operations on vectors: Addition and subtraction   3. Position vectors   4. Resolution of vectors   5. Scalar and vector product | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Apply matrices | * 1. Introduction to matrices      1. Definition of a matrix.      2. Different types of matrices: row, column, square, rectangular, diagonal, identity, zero.      3. Notation and elements of a matrix.      4. Basic operations: addition, subtraction, scalar multiplication.      5. Special Matrices         1. Identity matrix, diagonal matrix, symmetric matrix, skew-symmetric matrix.   2. Matrix Multiplication      1. Rules and properties of matrix multiplication.      2. Properties of Matrix Multiplication         1. Associative, distributive, and commutative properties.         2. Transpose of a matrix and properties.   3. Determinants and Inverses      1. Calculating determinants for 2x2 and 3x3 matrices.      2. Methods to find the inverse (adjoint method, Gauss-Jordan elimination).      3. Conditions for the existence of an inverse.   4. Solving Systems of Linear Equations      1. Representation of linear systems using matrices.      2. Application of Cramer's rule for solving systems of linear equations.      3. Using the inverse matrix inverse method to solve linear systems.   5. Using the inverse determinant method to solve linear systems. | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |

**Suggested Delivery Methods**

* Demonstration
* Discussions
* Practical
* Project work
* Direct instruction

**List of Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/**  **Specifications** | **Quantity** | **Recommended**  **Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | Engineering Mathematics by K.A. Stroud  Advanced Engineering Mathematics by Erwin Kreyszig | 5 pcs  5 pcs | 1:5  1:5 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Computer | Operating System: 64-bit Windows 11 or 10 version 1809 or above  Processor: 2.5 GHz (3+ GHz recommended),  Memory: 8 GB (32GB recommended)  Disk space: 10 GB  Display: 1920 x 1080 resolution  Display Card: 2 GB GPU (8 GB recommended) and DirectX 11 compliant (DirectX 12 recommended) | 25 pcs | 1:1 |
|  | Projector |  | 1 | 1:25 |
|  | Interactive screen | Specifications: 77-inch interactive whiteboard with touch and pen functionality. | 1 | 1:25 |
| **C** | **Software** |  |  |  |
|  | MATLAB | License: Educational licenses available.  Features: Matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, interfacing with programs in other languages. | Installed in 25 computers | 1:1 |
|  | GeoGebra | License: Free educational software.  Interactive geometry, algebra, statistics, and calculus applications | Installed in 25 computers | 1:1 |
| **D** | **Consumables** |  |  |  |
|  | Pens, pencils, rulers and paper | Whiteboard markers, 2H pencils, plastic rulers, A2 white papers | Enough |  |

## SPECIALIZED POWER SYSTEMS INSTALLATION

**UNIT CODE:** 0714 451 11A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Install Specialized Power Systems.

**Duration of Unit:** 190 hours

**Unit Description**

This unit specifies competences required for installing specialized power systems. These include preparing power supply electrical drawings, performing electrical installation system sizing, setting up telecommunication mains utility power supply system, setting up telecommunication solar power supply system, setting up telecommunication ups system and testing electrical power supply system

**Summary of Learning Outcomes**

By the end of the unit the trainee should be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **LEARNING OUTCOME** | **DURATION (HRS)** |
|  | Install Solar power supply systems | 40 |
|  | Set up Telecommunication UPS systems | 30 |
|  | Install Power Factor Correction Systems | 30 |
|  | Install HVAC systems | 60 |
|  | Test electrical power supply system | 20 |
|  | **TOTAL HOURS** | 190 |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Set up Telecommunication Solar power supply system | * 1. Solar Power Fundamental Concepts      1. Solar Radiation      2. Photovoltaic Effect      3. Solar Panel Characteristics      4. Solar Inverter Operation   2. Preparing Solar Power Supply Equipment and Materials      1. Solar Panel Selection         1. Understanding Solar Panel Ratings: Watts, Voltage, Amperes         2. Choosing the Right Solar Panel Type: monocrystalline, polycrystalline, amorphous      2. Solar Inverter Selection         1. Understanding Inverter Ratings: Watts, Voltage, Frequency         2. Choosing the Right Inverter Type: on-grid, off-grid, hybrid      3. Battery Bank Selection         1. Understanding Battery Bank Capacity (Ah, kWh)         2. Choosing the Right Battery Type: lead-acid, lithium-ion      4. Cable Selection         1. Choosing the Right Cable Type         2. Cable Sizing based on Load Requirements and Voltage Drop      5. Mounting Structure Selection:         1. Choosing the Right Mounting Structure: roof-mounted, ground-mounted         2. Tracking Systems: Single-Axis Tracker, Dual-Axis Tracker         3. Erection of Support Structures         4. Inclination and Orientation         5. Determining Optimal Tilt Angle and Azimuth         6. Adjusting the Mounting Structure   3. Installing Solar Panels      1. Securing Solar Panels with Clamps and Bolts      2. Weatherproofing      3. Interconnecting Solar Panels         1. Connecting Solar Panels in Series and Parallel         2. Using MC4 Connectors         3. Cable Laying and Termination      4. Cable Routing         1. Planning Cable Routes procedures         2. Securing Cables      5. Cable Termination         1. Stripping and Tinning Cable Ends         2. Crimping Connectors         3. Connecting Cables to Solar Panels, Inverters, and Batteries      6. Installing Solar Panel Combiner Boxes      7. Combiner Box Selection: Box Size and Rating         1. Combiner Box Installation         2. Mounting the Combiner Box         3. Connecting Solar Panels to the Combiner Box         4. Connecting the Combiner Box to the Inverter   4. Installing Solar System Protection Systems      1. Sizing and installation of DC Circuit Breakers and Fuses      2. Surge Protection Devices (SPDs)   5. Installing Solar System Inverters and Battery Banks      1. Connecting Batteries in Series and Parallel      2. Ventilation and Cooling systems      3. Connecting the Inverter to Solar Panels, Batteries, and AC Load      4. Configuring Inverter Settings   6. Solar Power System Testing      1. Pre-Commissioning Tests         1. Insulation Resistance Test         2. Continuity Test         3. Earth Resistance Test         4. Open-circuit tests         5. Short-circuit tests         6. Voltage and current tests      2. Commissioning Procedures         1. Energizing the System         2. Load Testing         3. Performance Monitoring   7. Preparing Documentation      1. As-built drawings      2. Test reports | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Set up Telecommunication UPS system | * 1. Introduction to UPS Systems      1. Definition and purpose of a UPS system.      2. Importance in telecommunication systems      3. Types of UPS System         1. Standby (offline), Line-interactive, and Online double conversion UPS systems.         2. Application cases for each in telecommunications.   2. Telecommunication system power requirements      1. Power Supply Systems in Telecommunication         1. AC vs. DC power in telecom systems.         2. Voltage and current considerations      2. Load Analysis         1. Calculating total load requirements         2. UPS sizing   3. UPS System Components      1. UPS Unit         1. Inverter, rectifier, and battery charger functions.         2. Power capacity rating (kVA or kW).      2. Batteries         1. Types: Lead-acid, Lithium-ion, or Nickel-Cadmium (NiCd).         2. Battery banks and their configuration.         3. Battery runtime and backup capacity calculations.      3. Monitoring and Control Interfaces         1. LCD display         2. Alarms         3. Network interfaces for remote monitoring.   4. Installing the UPS System      1. UPS Placement         1. Factors to consider when choosing an optimal UPS location         2. Rack-mounting and standalone installations.      2. Electrical Connections         1. Main AC supply to UPS termination.         2. System load termination         3. Grounding UPS system      3. Battery bank Installation         1. Battery banks configurations.         2. Verification of battery bank health.   5. Testing and Commissioning      1. Initial System Checks         1. Verification of input voltage, load capacity, and system settings.         2. UPS Error codes and warnings.      2. Load Testing         1. Simulated power failure test         2. Load performance and battery discharge rates.      3. System Configuration         1. Remote monitoring and alert settings configuration         2. UPS integration to existing telecom network management systems   6. Maintenance and Troubleshooting      1. Routine Maintenance         1. Battery health monitoring.         2. Cleaning Ventilation.      2. Troubleshooting Common Issues         1. UPS not switching to battery mode.         2. Overload and temperature warnings.         3. Degraded battery performance.   7. Documentation and Reporting      1. Installation Report      2. Maintenance Logs         1. Tracking performance         2. Service dates         3. Battery replacements. | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Install Power Factor Correction Systems | * 1. Fundamentals of Power Factor & PFC Systems      1. Introduction to Power Factor         1. Understanding real, reactive, and apparent power         2. Definition and importance of power factor (PF)         3. Causes and effects of poor power factor         4. Effects of low power factor on electrical systems         5. Power factor measurement methods         6. Industrial and commercial applications      2. Power Factor Correction (PFC) Concepts         1. Types of power factor correction: passive, active, hybrid         2. Components of PFC systems: capacitor banks, reactors, controllers         3. Fixed vs. automatic PFC         4. Harmonic distortion and filtering techniques         5. Selection criteria for PFC systems      3. Safety Procedures & Compliance         1. Electrical safety regulations (IEC, IEEE, NEC)         2. PPE and handling high-voltage capacitors         3. Lockout/Tagout (LOTO) and earthing procedures   2. Power Factor Correction System Installation      1. Site Survey & System Sizing         1. Load analysis and reactive power calculation         2. Selection of capacitor banks based on demand         3. Harmonics analysis and mitigation techniques      2. Installation of PFC Equipment         1. Mounting capacitor banks and reactors         2. Wiring capacitor bank         3. Electrical wiring and busbar connections         4. Integrating controllers and protection devices      3. Testing & Initial Commissioning         1. Checking voltage, current, and power factor levels         2. Verifying automatic switching of capacitor banks         3. Identifying and troubleshooting installation issues   3. Maintenance & Troubleshooting      1. Detecting capacitor degradation and failures      2. Identifying harmonic interference problems      3. Ensuring long-term reliability of PFC systems | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Install HVAC systems | * 1. Fundamentals of HVAC Systems      1. Introduction to HVAC Systems         1. Basics of heating, ventilation, and air conditioning  1. Psychrometric principles 2. Heat transfer mechanisms    * + 1. Types of HVAC systems: split, packaged, VRF, ductless        2. Applications in residential, commercial, and industrial setups      1. HVAC Components & Working Principles         1. Refrigeration cycle overview         2. Compressors, condensers, evaporators, expansion valves         3. Types of Ducts, air handling units, filters, fans         4. Refrigerants and their environmental impact      2. Safety Procedures & Regulations         1. Personal protective equipment (PPE)         2. Handling refrigerants & compliance with EPA guidelines         3. Electrical safety and lockout/tagout (LOTO) procedures    1. HVAC Installation Techniques       1. Reading blueprints and schematics       2. Selecting appropriate HVAC units       3. Mounting indoor and outdoor units    2. Ductwork & Piping       1. Designing and installing duct systems       2. Leak testing and vacuuming procedures       3. Insulation and sealing techniques       4. Copper tubing, pipe bending, and brazing       5. Charging refrigerants and pressure testing    3. Electrical Wiring & Controls       1. Electrical Connections          1. Wiring diagrams and control circuit installation          2. Connecting thermostats and relay and sensors          3. Checking voltage, current, and electrical continuity       2. Ventilation & Air Balancing          1. Adjusting airflows and testing pressure differences          2. Filter installation and replacement          3. Identifying airflow obstructions and fixing leaks    4. System Testing & Commissioning       1. System Start-up & Performance Testing          1. Checking operational efficiency          2. Troubleshooting common startup issues          3. Analyzing system parameters and making adjustments       2. HVAC Troubleshooting & Repairs          1. Diagnosing electrical, mechanical, and refrigerant issues          2. Common fault codes and diagnostic tools          3. Fixing airflow, compressor, and coil problems       3. Documentation & Customer Handover          1. Creating HVAC installation reports          2. Explaining system operation to clients          3. Maintenance best practices and service scheduling | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Test electrical power supply system | * 1. Electrical Safety      1. Safety Regulations and Standards: NEC, IEC      2. Personal Protective Equipment (PPE)      3. Electrical Shock Hazards      4. Lockout/Tagout Procedures   2. Test Equipment      1. Multimeter      2. Clamp Meter      3. Megger      4. Power Quality Analyzer      5. Oscilloscope   3. Electrical tests      1. Visual inspection: purpose and procedure      2. Insulation Resistance Test         1. Purpose and Significance         2. Test Procedure         3. Interpretation of Results      3. Continuity Test         1. Purpose and Significance         2. Test Procedure         3. Interpretation of Results      4. Earth Resistance test         1. Purpose and Significance         2. Test Procedure         3. Interpretation of Results      5. Voltage and Current Measurements         1. Measuring Voltage and Current Levels         2. Verifying Phase Sequence         3. Power Factor      6. Protection System Testing         1. Testing Overcurrent and Overvoltage Protection         2. Response of protection systems         3. Testing Earth Fault Protection      7. Transformer Testing         1. Voltage Ratio Test         2. Winding Resistance Test         3. Insulation Resistance Test         4. Load Test      8. Cable Testing         1. Cable Fault Location         2. Cable Impedance Measurement         3. Cable Insulation      9. Functional Testing      10. Documentation and Reporting of electrical tests          1. Importance of tests documentation          2. Test checklists          3. Creating Test Report | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |

**Suggested Methods of delivery**

* + 1. Practical
    2. Project
    3. Demonstration
    4. Group discussion
    5. Direct instruction
    6. Field visits
    7. Industry visits
    8. Case studies

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S No.** | **Item** | **Specifications for Purchase** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Tools & Equipment** |  |  |  |
| 1 | Laptops/Desktop Computers | 8GB RAM, 256GB SSD, CAD software compatible | 10 pcs | 1:3 |
| 2 | Drawing Tools | Includes T-squares, protractors, rulers | 25 sets | 1:1 |
| 3 | Plotter/Printer | Wide-format, high-resolution for CAD prints | 2 pcs | 1:13 |
| 4 | Digital Multimeters | Auto-ranging, backlit display | 5 pcs | 1:5 |
| 5 | Power Factor Meters | Measures 0.5-1.0 power factor | 5 pcs | 1:5 |
| 6 | Cable Cutters | Insulated, ergonomic handle | 10 pcs | 1:3 |
| 7 | Cable Strippers | Adjustable for different wire gauges | 10 pcs | 1:3 |
| 8 | Crimping Tools | High-quality, suitable for insulated terminals | 10 pcs | 1:3 |
| 9 | Torque Wrenches | Adjustable torque range, calibrated | 2 sets | 1:13 |
| 10 | Spanners and Socket Sets | Includes standard and metric sizes | 2 sets | 1:13 |
| **B** | **Reference Materials** |  |  |  |
| 11 | Electrical Symbols Reference Charts | Comprehensive symbols for schematic reference | 25 pcs | 1:1 |
| 12 | Paper and Pencils/Erasers | For drafting, includes erasers and HB pencils | 25 sets | 1:1 |
| 13 | Whiteboard and Markers | Magnetic whiteboard, assorted color markers | 1 set | 1 per class |
| **C** | **Electrical Materials** |  |  |  |
| 14 | Cables and Wires | Assorted gauges for electrical training | As needed | As needed |
| 15 | Electrical Panels and Enclosures | Weatherproof, lockable | 5 sets | 1:5 |
| 16 | Conduit and Trunking | Assorted sizes for wire management | As needed | As needed |
| 17 | Cable Ties, Connectors, and Lugs | Variety pack for secure electrical connections | As needed | As needed |
| 18 | Safety Labels and Tags | Assorted electrical hazard labels | 25 pcs | 1:1 |
| 19 | DC Cables | Proper gauge for low voltage applications | As needed | As needed |
| 20 | Battery Banks | Rechargeable, assorted capacities | 5 sets | 1:5 |
| 21 | Solar Panel Mounts and Brackets | Adjustable for solar panel installation | 5 sets | 1:5 |
| 22 | Scaffolding | Modular, adjustable height for safe access | 2 sets | 1:13 |
| **D** | **Testing & Measurement** |  |  |  |
| 23 | Multimeters | Digital, auto-ranging with multiple test functions | 10 pcs | 1:3 |
| 24 | Projector | High-resolution for presentations | 1 pc | 1 per class |
| 25 | Insulation Resistance Testers | 500V, accurate insulation resistance measurement | 5 pcs | 1:5 |
| 26 | Distribution Boards | With circuit breakers for demonstration purposes | 5 pcs | 1:5 |
| 27 | Switchgear | Assorted for learning different control methods | As needed | As needed |
| 28 | Power Meters | Monitors electrical parameters | 5 pcs | 1:5 |
| 29 | Solar Irradiance Meter | Measures solar panel exposure accurately | 5 pcs | 1:5 |
| 30 | DC Disconnect Switch | Safety switch for DC power | 5 pcs | 1:5 |
| 31 | Battery Tester | Measures voltage and charge level | 5 pcs | 1:5 |
| 32 | Ladders | Adjustable, anti-slip steps | 5 pcs | 1:5 |
| 33 | UPS Units | Backup power, 1000VA capacity | 5 pcs | 1:5 |
| 34 | Power Distribution Units | With surge protection | 5 pcs | 1:5 |
| 35 | Batteries | Assorted types for various testing needs | As needed | As needed |
| 36 | Racks/Cabinets | Secure storage for equipment | As needed | As needed |
| 37 | Inverters | 1000W, pure sine wave | 5 pcs | 1:5 |
| 38 | Solar Panels | Assorted, rated 200W or higher | As needed | As needed |
| 39 | Charge Controllers | For battery charging regulation | 5 pcs | 1:5 |
| **E** | **Documentation** |  |  |  |
| 40 | Manufacturer’s Catalogues | Latest catalogs of electrical components | 5 pcs | 1:5 |
| 41 | Electrical Design Standards | Includes IEEE, IEC guidelines | 5 pcs | 1:5 |
| 42 | Electrical Codebooks | National Electrical Code, BS7671 | 5 pcs | 1:5 |
| 43 | EMCA Act | Environmental guidelines for electrical installations | 5 pcs | 1:5 |
| 44 | OSHA | Safety guidelines for electrical systems | 5 pcs | 1:5 |
| 45 | Cable Sizing Charts | For selecting correct cable gauge | 5 pcs | 1:5 |
| 46 | Cable Specification Catalogs | Specifications for different cable types | 5 pcs | 1:5 |
| 47 | Electrical Load Data Sheets | Load calculations and examples | 5 pcs | 1:5 |
| 48 | Specification Sheets | Manufacturer’s specs for key components | 5 pcs | 1:5 |
| 49 | Electrical Utility Standards | Guidelines from utility providers | 5 pcs | 1:5 |
| 50 | Site Layout Diagrams | Electrical schematics for practice | 5 sets | 1:5 |
| 51 | Solar Power System Sizing Guides | Guides for sizing solar installations | 5 pcs | 1:5 |
| 52 | Battery Storage Design Manuals | Guidelines for setting up battery storage | 5 pcs | 1:5 |

# MODULE THREE

## COMPUTER NETWORKS INSTALLATION

**UNIT CODE:** 0713 441 09A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Install Computer Networks

**Duration of Unit:** 160 hours

**Unit Description**

This unit specifies competencies required for installing computer networks. These include: conducting computer network site preparation, preparing computer network technical drawing, carrying out computer network structured cabling and installing SOHO networks

**Summary of Learning Outcomes**

By the end of the unit the trainee should be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **LEARNING OUTCOME** | **DURATION (HRS)** |
|  | Conduct Computer Network Site preparation | 10 |
|  | Prepare Computer Network Technical Drawings | 40 |
|  | Carry out Computer Network Structured Cabling | 60 |
|  | Install SOHO networks | 50 |
|  | **TOTAL HOURS** | 160 |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Conduct Computer Network Site preparation | * 1. Introduction to network types      1. LAN      2. MAN      3. WAN   2. Introduction to site survey      1. Definition of site survey      2. Terms used in site survey         1. Site Survey         2. Network Topology         3. Coverage Area         4. Bandwidth         5. Latency      3. Components of site survey         1. Physical Layout Assessment         2. Coverage Area Analysis         3. Capacity Planning         4. Power and Cabling Requirements         5. Security      4. Tools and equipment required during site survey         1. Basic tools:  1. Cable strippers, 2. crimping tool, 3. wire cutter, 4. screwdriver set, 5. pliers, 6. cable tester    * + 1. Network installation tools: 7. Cable puller, 8. fish tape, 9. cable labels and markers, 10. cable ties, 11. punch down tool     * + 1. Network testing equipment: 12. Network analyzer, 13. power meter, 14. protocol analyzer     1. Network site preparation and planning        1. Site requirements assessment           1. Number of workstations and devices           2. Required bandwidth and data rates           3. Security requirements           4. Future expansion plans | 1. Practical assessment 2. Project 3. Written assessment 4. Observation 5. Oral questioning 6. Portfolio of evidence 7. Third party report |
| 1. Prepare Computer Network Technical Drawings | * 1. Network topology diagram      1. Types of network topology:         1. Star         2. Bus         3. Ring         4. Mesh         5. Hybrid      2. Components of network topology:         1. Routers         2. Workstations         3. Switches         4. Hubs         5. Access point.         6. Servers      3. Physical and logical topology   2. Site floor plan and layout   3. Cabling diagram      1. Structure cabling representation      2. Cable routing         1. Horizontal         2. Vertical      3. Patch panel and wall jack mapping      4. Cabling diagram components:         1. Ethernet cables,         2. Fiber optic cable         3. Coaxial cables         4. Patch panel         5. Wall jacks         6. conduits      5. Rack elevation diagram:         1. Arrangement of equipment in rack         2. Labelling and color code standards | 1. Practical assessment 2. Project 3. Written assessment 4. Observation 5. Oral questioning 6. Portfolio of evidence 7. Third party report |
| 1. Carry out Computer Network Structured Cabling | * 1. Computer network structured cabling      1. Definition of Structured Cabling      2. Components of structured cabling         1. Patch Panels         2. Cable Trays         3. Conduits and raceways         4. Switches & Routers         5. Network Cabinets and racks         6. Patch cords and jumpers   2. Introduction to Network media      1. Analog and Digital data      2. Analog and Digital Signals      3. Line Coding      4. Multiplexing      5. Types of network cables and their capacities         1. Twisted pair  1. UTP 2. STP    * + 1. Coaxial cable 3. RG 6, 4. RG 11 5. RG 59    * + 1. Fibre optic cable 6. single mode 7. multimode    * 1. Cable standards and application         1. Ethernet cable standards         2. Coaxial cable standards         3. Fiber optic cable standards    1. Cable installation techniques       1. Cable routing and management       2. Cable path planning       3. Distance limitation       4. Securing and protecting cables       5. Environmental consideration    2. Termination Techniques       1. Twisted Pair Cable Termination          1. Attaching RJ45 connectors using crimping tools.          2. Terminating cables on patch panels and keystone jacks       2. Fiber Optic Termination          1. Fusion splicing and mechanical splicing.          2. Attaching fiber connectors (LC, SC).       3. Patch panel and Equipment Termination          1. Connecting terminated cables to patch panels and switches.          2. Routing and securing within cabinets.          3. Labeling standards and documentation       4. Introduction to IP addressing       5. IPv4 and IPv6       6. Sub-netting       7. Private and public IP addressing       8. DHCP and static IP | 1. Practical assessment 2. Project 3. Written assessment 4. Observation 5. Oral questioning 6. Portfolio of evidence 7. Third party report |
| 1. Install SOHO network | * 1. Install SOHO network      1. Introduction to network models         1. OSI model         2. TCP/IP model         3. Comparison of network models.      2. Introduction to network protocols         1. TCP/IP protocol         2. UDP protocol         3. HTTP protocol         4. FTP protocol         5. SMTP         6. DNS         7. Roles of protocols in network communication      3. Definition of SOHO      4. Components of a SOHO network         1. Router         2. Modem         3. Switch         4. Ethernet         5. Firewall      5. Steps in installing SOHO network         1. Setting up internet access         2. Configuring router         3. Setting up wired and wireless connections         4. Testing and troubleshooting network connectivity         5. Documentation | 1. Practical assessment 2. Project 3. Written assessment 4. Observation 5. Oral questioning 6. Portfolio of evidence 7. Third party report |

**Suggested Methods of Instruction**

* + 1. Practical
    2. Project
    3. Demonstration
    4. Group discussion
    5. Direct instruction
    6. Field trips

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/**  **Specifications** | **Quantity** | **Recommended**  **Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Training Manuals | Manuals on network installation, covering topology, configuration, and testing. | 5 copies | 1:5 |
|  | Networking Simulators | Software such as Cisco Packet Tracer or GNS3 | Enough | - |
|  | Network Configuration Guides | Documentation for setting up routers, switches, and firewalls. | 5 copies | 1:5 |
|  | Topology Diagrams | Pre-designed network layout diagrams for training exercises. | 5 copies | 1:5 |
|  | Safety Guidelines | OSHA-compliant guidelines for handling electrical and networking equipment safely. | 5 copies | 1:5 |
|  | Reference Books | Books such as Networking All-in-One For Dummies or CompTIA Network+ Certification Guide. | Online access | - |
|  | Tutorial Videos | Step-by-step video tutorials on cable termination, network setup, and troubleshooting. | Enough | - |
|  | Power point presentations | For trainer’s use | Enough | - |
| **C** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 160m2 | 1 | 1:25 |
|  | Computers and laptop with internet access | Processor: Intel Core i5/i7 or equivalent  RAM: 8GB or higher  Storage: 256GB SSD or higher | 10 pcs | 1:3 |
|  | Projectors | At least 3000 lumens  With HDMI and VGA ports | 1 | 1:25 |
| **D** | **Materials, tools and equipment** |  |  |  |
|  | Ethernet Cables | Cat6a cables | 200 m | 8 m:1 |
|  | Patch Cords | Pre-terminated patch cables with RJ45 connectors, Cat6 standard, lengths from 0.5m to 5m. | 50 pcs each category | 2:1 |
|  | Cable Management Supplies | Velcro straps, cable ties, cable sleeves | Enough | - |
|  | RJ45 Connectors | Compatible with Cat5e/Cat6 cables. | 1000 pcs | 40:1 |
|  | Keystone Jacks | Ethernet jacks for wall plate installation; Cat6 or higher standard. | 500 pcs | 20:1 |
|  | Network Racks | 9U and 12U network racks with mounting brackets and lockable glass doors. | 5 pcs | 1:5 |
|  | Faceplates | Single and dual-port wall plates for Ethernet jack installation. | 200 pcs each category | 8:1 |
|  | Labeling Supplies | Label tapes and markers. | 2 pcs | 1:13 |
|  | Network Switches | Managed and unmanaged switches, 8-port and 24-port models with Gigabit Ethernet. | 4 pcs each category | 1:6.25 |
|  | Routers | Wireless and wired routers with dual-band (2.4 GHz/5 GHz) support and firewall capabilities. | 10 pcs | 1:3 |
|  | Access Points | Wi-Fi 6 or Wi-Fi 5 APs with PoE support for wireless network coverage. | 5 pcs | 1:5 |
|  | Servers | Entry-level servers for network hosting, with Intel Xeon processors and at least 16GB RAM. | 1 pc | 1:25 |
|  | Network Interface Cards | PCIe-based Ethernet adapters supporting Gigabit or 10Gbps speeds. | 5 pcs | 1:5 |
|  | Patch Panels | 24-port and 48-port Cat6 patch panels for central cable management. | 10 pcs | 1:3 |
|  | Modems | DSL, cable, or fiber modems for internet access. | 5 pcs | 1:5 |
|  | UPS Units | Uninterruptible power supplies with minimum 500VA capacity for backup power. | 1 pc | 1:25 |
|  | Crimping Tool | Compatible with RJ45 connectors. | 5 pcs | 1:5 |
|  | Cable Tester | Multi-function cable tester with capability to verify continuity, pin configuration, and speed compatibility. | 5 pcs | 1:5 |
|  | Punch-Down Tool | Capable of terminating wires into keystone jacks and patch panels; includes spare blades. | 5 pcs | 1:5 |
|  | Wire Stripper | Adjustable stripper for Ethernet cables, supporting Cat5e, Cat6, and Cat6a. | 5 pcs | 1:5 |
|  | Label Printer | Portable printer. | 2 pcs | 1:13 |
|  | Multimeter | Digital multimeter capable of testing voltage, current, and continuity of network power supplies. | 10 pcs | 1:3 |
|  | Fiber Optic Splicing Kit | Includes fusion splicer, cleaver, and cleaning tools for fiber optic cable preparation and installation. | 2 pcs | 1:13 |

## ELECTRICAL PRINCIPLES

**UNIT CODE:** 0713 441 06A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply electrical principles

**Unit duration**: 190 hours

**Unit Description:** This unit describes the competencies required by a technician in order to apply Electrical principles in their work. It involves Applying Electrical quantities, using cells and batteries, Apply Concepts of DC circuit, Applying Electrostatics principles, applying magnetism and electromagnetism, applying AC circuits and performing electrical measurements.

**Summary of Learning Outcomes**

By the end of the unit the trainee should be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **LEARNING OUTCOME** | **DURATION (HRS)** |
|  | Apply Electrical quantities | 10 |
|  | Use cells and batteries | 10 |
|  | Apply Concepts of DC circuit | 40 |
|  | Apply Electrostatics principles | 30 |
|  | Apply magnetism and electromagnetism | 40 |
|  | Apply AC circuits | 30 |
|  | Perform electrical measurements | 30 |
|  | **TOTAL HOURS** | **190 HRS** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply Electrical quantities | * 1. Fundamental Electrical Concepts      1. Electrical quantities         1. Charge         2. Current         3. Voltage         4. Power         5. Energy      2. Units of measurement (SI units)         1. SI unit definition         2. Electrical quantities SI units      3. Practical calculations involving electrical quantities      4. Measuring electrical quantities         1. Using electrical quantities measuring instruments  1. Voltmeters 2. Ammeters 3. Ohmmeters 4. Multimeters 5. Power meters 6. Oscilloscope | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Use cells and batteries | * 1. Introduction to Cells and Batteries      1. Role of cells and batteries as sources of electrical energy in various systems.      2. Basic Concepts         1. Cell         2. Battery   2. Types of Cells      1. Primary Cells and Secondary Cells      2. Examples of Primary Cells and Secondary Cells      3. Applications of Primary Cells and Secondary Cells   3. Battery Configurations and Ratings      1. Series Connection      2. Parallel Connection.      3. Ratings         1. Voltage         2. Capacity (mAh or Ah)         3. Energy Density   4. Working Principles of Cells and Batteries      1. Electrochemical Reaction      2. Basic Components         1. Anode         2. Cathode.         3. Electrolyte      3. Operation Cycle         1. Discharge         2. Recharge      4. e.m.f and internal resistance of cells   5. Types of Batteries and Applications      1. Lead-Acid Batteries         1. Advantages and disadvantages         2. Applications      2. Nickel-Cadmium (NiCd) Batteries         1. Advantages and disadvantages         2. Applications      3. Nickel-Metal Hydride (NiMH) Batteries         1. Advantages and disadvantages         2. Applications      4. Lithium-Ion (Li-ion) Batteries         1. Advantages and disadvantages         2. Applications      5. Lithium-Polymer (Li-Po) Batteries         1. Advantages and disadvantages         2. Applications   6. Battery Maintenance and Safety | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Apply Concepts of DC circuit | * 1. Basics of DC Circuits      1. Definition of a DC circuit      2. Key Components in a DC circuit         1. Voltage (V)         2. Current (I)         3. Resistance (R)      3. Ohm's Law         1. Relationship between voltage, current, and resistance         2. Applying Ohm’s law   2. Series and Parallel Circuits      1. Series Circuits      2. Parallel Circuits      3. Series-parallel circuits   3. Kirchhoff's Laws      1. Kirchhoff's Current Law (KCL)      2. Kirchhoff's Voltage Law (KVL)      3. Applications of KCL and KVL   4. Voltage and current dividers   5. Power in DC Circuits      1. Power definition      2. or or      3. Applications         1. Calculating energy consumption         2. Heat dissipation         3. Efficiency of DC circuit components.   6. Energy Stored in DC Circuits      1. Energy (E) definition      2. where *t* is time      3. Applications         1. Estimating battery life         2. Capacitor charge/discharge         3. Energy storage.   7. Capacitors and Inductors in DC Circuits      1. Capacitors         1. Functions in DC circuits         2. Behaviour in DC Circuits      2. Inductors         1. Functions in DC circuits         2. Behaviour in DC Circuits   8. DC Circuit Applications      + 1. Lighting circuits        2. Motor control circuits | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Apply Electrostatics principles | * 1. Fundamental Concepts of Electrostatics      1. Electric Charge      2. Coulomb's Law      3. Electric Field         1. Definition and properties         2. Electric field lines         3. Electric field intensity      4. Electric Potential and Potential Energy         1. Electric potential difference (voltage)         2. Electric potential energy         3. Relationship between electric field and potential      5. Electrostatic Induction      6. Electrostatic Shielding         1. Protection from external electric fields         2. Faraday cage principle   2. Capacitance and Capacitors      1. Capacitance         1. Definition and unit of capacitance         2. Factors affecting capacitance      2. Capacitors         1. Types of capacitors         2. Capacitor charging and discharging         3. Voltage-current relationship.         4. Capacitor behavior in AC and DC circuits.      3. Capacitor circuits         1. Series and parallel connection         2. RC circuits         3. LC circuits         4. RLC circuits         5. Filters using capacitors         6. Power factor correction      4. Capacitor Applications         1. Energy storage.         2. Filtering in power supplies.         3. Signal coupling and decoupling in circuits.         4. Timing circuits         5. Tuning and oscillation in radios and audio circuits.      5. Capacitor Testing and Maintenance         1. Multimeter Capacitance and leakage test.         2. Visual inspection         3. Safety considerations | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Apply magnetism and electromagnetism | * 1. Introduction to Magnetism      1. Definition of terms         1. Magnetism         2. Magnetic field         3. Magnetic field lines         4. Magnetic field strength units         5. Magnetization   2. Magnetism and magnetic fields      1. Types of Magnetic Materials:         1. Ferromagnetic         2. Paramagnetic         3. Diamagnetic.         4. Permanent and Temporary Magnets   3. Electromagnetism Basics      1. Magnetic Field Around a Current-Carrying Conductor      2. Right-Hand Rule      3. Electromagnet      4. Applications of electromagnets      5. Key Principles of Electromagnetism         1. Ampere’s Law         2. Faraday’s Law of Electromagnetic Induction         3. Lenz’s Law         4. Magnetic Flux      6. Applications of Electromagnetism         1. Transformers         2. Electric Motors and Generators         3. Relays and Solenoids         4. Magnetic Storage   4. Magnetic Circuits and Permeability      1. Introduction to Magnetic Circuits         1. Definition and components of magnetic circuits.         2. Difference between magnetic and electric circuits.         3. Overview of magnetic flux, MMF, reluctance, and permeability.      2. Magnetic Flux and MMF         1. Magnetic flux calculation and interpretation.         2. Concepts of magnetomotive force (MMF) and its importance in magnetic circuits.         3. Introduction to magnetic field strength (H) and flux density (B).      3. Permeability and Reluctance         1. Definition of permeability and how it affects magnetic materials.         2. Reluctance calculation and role in magnetic circuits.      4. Ohm’s Law for Magnetic Circuits         1. Application of Ohm’s Law analogy to magnetic circuits.         2. Calculation exercises​.         3. Analyzing magnetic circuit diagrams.      5. Transformer and Motor Magnetic Circuits         1. Components of a Transformer  1. Primary windings 2. Secondary windings 3. Core materials    * + 1. Application of magnetic circuits in transformers.        2. Overview of DC and AC motor magnetic circuits        3. Operational principles of DC and AC motor magnetic circuits.      1. Inductors         1. Magnetic circuits in inductors         2. Relationship between inductance, flux linkage, and stored energy.         3. Hands-on inductor circuit building and testing.         4. Applications of inductors 4. Filter circuits 5. Storage devices    1. Magnetic and Electromagnetic Devices in Industrial Applications       1. Magnetic Sensors       2. Electromagnetic Brakes and Clutches.    2. Electromagnetic Safety and Shielding       1. Electromagnetic Interference (EMI).       2. Shielding    3. Safety Precautions | 1. Practical 2. Project 3. Third party report 4. Portfolio of evidence 5. Written tests 6. Oral questioning |
| 1. Apply AC circuits | 1. Introduction to AC Circuits 2. Definitions and characteristics of AC vs. DC 3. Historical context and significance of AC power 4. Applications of AC in modern technology 5. Fundamental Concepts of AC 6. Waveforms: Sinusoidal, square, triangular, and sawtooth 7. Frequency, period, amplitude, and phase 8. Phasors: Representation of AC signals, phasor addition 9. Complex Numbers and Phasor Analysis 10. Basics of complex numbers 11. Impedance, reactance, and resistance in AC circuits 12. Converting between time domain and phasor domain 13. Circuit Elements in AC 14. Resistors, inductors, and capacitors in AC 15. Impedance calculations for R, L, and C 16. Series and parallel combinations of RLC circuits 17. AC Circuit Analysis Techniques 18. Ohm's Law in AC circuits 19. Kirchhoff's laws for AC circuits 20. Nodal and mesh analysis in AC circuits 21. Thevenin's and Norton's Theorems in AC analysis 22. Power in AC Circuits 23. Real, reactive, and apparent power calculations 24. Power factor and its significance 25. Power factor correction 26. Three-phase AC systems: Delta and wye connection 27. Frequency Response and Resonance 28. Resonance in RLC circuits 29. Bandwidth and quality factor (Q) 30. Series and parallel resonance 31. Applications of resonance in tuning circuits 32. Transformers 33. Principles of operation 34. Turns ratio and voltage transformation 35. Efficiency and losses in transformers 36. Applications of transformers in AC circuits 37. AC Circuit Theorems and Calculations 38. Superposition theorem in AC circuits 39. Maximum power transfer theorem 40. AC circuit simplification techniques 41. Measurement Techniques 42. Instruments for measuring AC voltage and current (multimeters, oscilloscopes) 43. Phase measurement and power factor meters 44. Harmonics and distortion analysis in AC systems 45. Applications of AC Circuits 46. Electric power generation and distribution 47. AC motors and generators 48. Audio and communication systems 49. Switch-mode power supplies and inverters | 1.Practical  2.Project  3.Third party report  4.Portfolio of evidence  5.Written tests  Oral questioning |
| 1. Perform electrical measurements | * 1. Introduction to Electrical Measurements      1. Importance of Electrical Measurements         1. Role in system maintenance and troubleshooting.         2. Applications in industrial telecommunication and electrical systems.      2. Overview of Measurement Quantities         1. Voltage, current, resistance, power, energy, frequency, phase and RMS values.         2. Difference between AC and DC         3. Waveforms: sine, square, triangular   2. Metering Circuits      1. Basic meter movement         1. PMMC         2. Moving iron         3. Electrodynamometer      2. D'Arsonval meter movement      3. Series and shunt resistance connections   3. Electrical Measuring Instruments      1. Classification of Instruments         1. Analog vs. Digital instruments.         2. Absolute and secondary instruments.      2. Analog Meters         1. PMMC meters         2. Moving iron meters         3. Electrodynamometer meters         4. Multimeters      3. Digital Meters         1. Digital multimeter (DMM)         2. Basic meter movement         3. Digital storage oscilloscope (DSO)         4. Clamp meter         5. Power analyzer      4. Specialized Instruments         1. LCR meter         2. Frequency counter         3. Function generator      5. Electrical instruments selection Criteria      6. Instrument Calibration         1. Calibration Standards  1. Primary and secondary standards 2. Calibration procedures    * 1. Measuring instrument range extension Methods         1. Shunts and Multipliers 3. Principle and design. 4. Application in extending current and voltage ranges.    * + 1. Use of Current Transformers (CTs) and Potential Transformers (PTs).    1. Electrical Measurements Techniques       1. Voltage          1. Using voltmeters (analog and digital)          2. Voltage divider circuits       2. Current          1. Using ammeters (analog and digital)          2. Current shunt       3. Resistance          1. Using ohmmeters          2. Wheatstone bridge       4. Power          1. Wattmeter method          2. Two-wattmeter method       5. Frequency          1. Using frequency counters       6. Phase angle measurements          1. Using oscilloscopes and phase meters    2. Measurement Errors       1. Types of errors          1. Systematic errors: Instrument, environmental, and observational.          2. Random errors.          3. Gross errors.       2. Sources of Errors in measuring instruments       3. Error Mitigation Techniques       4. Calculations Involving Instruments and Errors          1. Measurement of unknown quantities using known resistances, voltages, and currents.          2. Scaling factors for extended ranges.          3. Absolute error, relative error, and percentage error.    3. Propagation of errors in measurement systems | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |

**Suggested Delivery Methods**

* Practical
* Project
* Demonstration
* Discussions
* Direct instruction
* Industry visits

**List of Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/**  **Specifications** | **Quantity** | **Recommended**  **Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | Comprehensive guides on electrical principles, such as Electrical Engineering Fundamentals by Vincent Del Toro.  Electrical and Electronic Principles and Technology  By[John Bird](https://www.taylorfrancis.com/search?contributorName=John%20Bird&contributorRole=author&redirectFromPDP=true&context=), [John Bird](https://www.taylorfrancis.com/search?contributorName=John%20Bird&contributorRole=author&redirectFromPDP=true&context=) | 5 pcs  5 pcs | 1:5  1:5 |
|  | Lab Manuals | |  | | --- | |  |   Manuals detailing step-by-step experimental procedures for basic electrical concepts | Enough | - |
|  | Charts and Posters | Visual aids illustrating Ohm’s Law, Kirchhoff’s Laws, AC/DC principles, and single/three-phase power concep | 5 copies | 1:5 |
|  | Safety Guidelines | OSHA-compliant electrical safety procedures and best practices. | 5 copies | 1:5 |
|  | Videos and Tutorials | Demonstrations of key electrical concepts and principles in practical scenarios. | Enough | - |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 160m2  With ventilation system of specifications: Fume extractor with HEPA filter, adjustable airflow  With fire extinguishers, first aid kits, ESD mats, grounding straps  With workbenches of specifications: ESD-safe, adjustable height, 1500mm x 750mm  With soldering stations Specifications: Adjustable temperature control (200°C - 480°C), ESD-safe  With hot air rework stations | 1  25 pcs  25 pcs  10 pcs | 1:25  1:1  1:1  1:3 |
|  | Projector | 3000 lumens | 1 pc | 1:25 |
|  | Interactive display screen | 75 inches | 1 pc | 1:25 |
|  | Computers with internet access | Processor: Intel Core i5/i7 or equivalent  RAM: 8GB or higher  Storage: 256GB SSD or higher | 10 pcs | 1:3 |
| **C** | **Equipment** | | | |
|  | Oscilloscope | Specifications: Digital, 100MHz bandwidth, 4 channels | 5 pcs | 1:5 |
|  | Multimeter | Specifications: Digital, true RMS, auto-ranging, measure voltage, current, resistance, capacitance | 25 pcs | 1:1 |
|  | Function generator | Specifications: Frequency range 0.1Hz to 10MHz, various waveforms (sine, square, triangle) | 10 pcs | 1:3 |
|  | Transformers | Single-phase step-down transformers (230V/12V). | 25 pcs | 1:1 |
|  | Power supply | Specifications: Dual output, 0-30V, 0-5A, adjustable | 10 pcs | 1:3 |
|  | Component tester | Specifications: Test resistors, capacitors, inductors, diodes, transistors | 5 pcs | 1:5 |
|  | Tweezers | Specifications: ESD-safe, various tips (straight, angled) | 25 pcs each category | 1:1 |
|  | Cutters | ESD-safe, flush cutters | 25 pcs | 1:1 |
|  | Pliers | ESD-safe needle-nose pliers | 25 pcs | 1:1 |
|  | Screwdrivers | Specifications: Precision set, various sizes (Phillips, flathead) | 5 sets | 1:5 |
|  | ESD mats | Specifications: Workbench and floor mats, grounding cords | 10 pcs | 1:3 |
|  | Wrist straps | Specifications: Adjustable, grounding cord with 1MΩ resistor | 25 pcs | 1:1 |
|  | Electrical Trainers | Modular trainer kits for basic electrical circuits, including resistors, capacitors, and inductors. | 5 sets | 1:5 |
| **C** | **Consumable materials** |  |  |  |
|  | Resistors | Specifications: 1/4 watt, 1%, various values (10Ω - 1MΩ) | 100 pcs each category | 4:1 |
|  | Capacitors | Specifications: Ceramic, electrolytic, tantalum, various values (1pF - 1000µF) | 100 pcs each category | 4:1 |
|  | Inductors | Specifications: Various values (1µH - 10mH) | 100 pcs each category | 4:1 |
|  | Diodes | Specifications: 1N4001, 1N4148, Zener diodes of various voltages | 100 pcs each category | 4:1 |
|  | Transistors | Specifications: NPN (2N2222), PNP (2N2907), MOSFET (IRF540N) | 100 pcs each category | 4:1 |
|  | Integrated Circuits | Specifications: Op-amps (LM741), Timers (NE555) | 100 pcs each category | 4:1 |
|  | Connectors and headers | Specifications: Male and female headers, USB connectors, screw terminals | Enough |  |
|  | Solder wire | Specifications: Lead-free, 0.8mm diameter, Sn63/Pb37 composition | 25 rolls | 1:1 |
|  | Soldering Flux | Specifications: Rosin flux, liquid and paste | Enough |  |
|  | Cleaning reagents | Isopropyl of 99% purity | 20 litres | 1:1.25 |
|  | Brushes | Specifications: Anti-static, soft bristles | 25 | 1:1 |
|  | Solder wires | Red and black | 5 rolls each category | 1:5 |
|  | Bread boards | Specifications: 830 tie-points, solderless, multiple power rails | 50 pcs | 1:2 |
|  | Printed Circuit Boards | Pre-designed PCBs and blank boards for soldering exercises and circuit prototyping. | 50 pcs | 1:2 |
|  | Strip boards |  | 200 | 1:8 |
|  | 100 Light Emitting Diodes | Red/yellow/green/white | 100 pcs each category | 4:1 |
| **D** | **Software** |  |  |  |
|  | Simulation software | LTSpice, Proteus and Multisim  Specifications: Simulate electronic circuits, support for various components and models | Installed in 25 computers | 1:1 |

## WORK ETHICS AND PRACTICES

**UNIT CODE:** 0417 441 03B

**Duration of Unit:** 40 hours

**Relationship to Occupational Standards**

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

**UNIT DESCRIPTION**

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

**Summary of Learning Outcomes**

By the end of this unit the trainee should be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **LEARNING OUTCOMES** | **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 HOURS** | **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   8. Developing and maintaining high self-esteem   9. Developing and maintaining positive self-image   10. Time management   11. Setting performance targets   12. Monitoring and evaluating performance targets | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Promote ethical 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 | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Promote Teamwork | * 1. Types of teams   2. Team building   3. Individual responsibilities in a team   4. Determination of team roles and objectives   5. Team parameters and relationships   6. Benefits of teamwork   7. Qualities of a team player   8. Leading a team   9. Team performance and evaluation   10. Conflicts and conflict resolution   11. Gender and diversity mainstreaming   12. Developing Healthy workplace relationships   13. Adaptability and flexibility   14. Coaching and mentoring skills | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Maintain professional and personal development | * 1. Personal vs professional development and growth   2. Avenues for professional growth   3. Recognizing career advancement   4. Training and career opportunities   5. Assessing training needs   6. Mobilizing training resources   7. Licenses and certifications for professional growth and development   8. Pursuing personal and organizational goals   9. Managing work priorities and commitments   10. Dynamism and on-the-job learning | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 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 | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 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 | 1. Observation 2. Written assessment 3. Oral assessment 4. Third party reports 5. Portfolio of evidence |

**Suggested Delivery Methods**

* Demonstrations
* Simulation
* Role play
* Group Discussion
* Presentations
* Projects
* Case studies
* Assignments

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/**  **Specifications** | **Quantity** | **Recommended**  **Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | The 7 Habits of Highly Effective People by Stephen R. Covey.  The Courage to Meet the Demands of Reality by Dr. Henry Cloud.  The Five Dysfunctions of a Team by Patrick Lencioni.  Drive: The Surprising Truth About What Motivates Us by Daniel H. Pink | 10 pcs  10 pcs  10 pcs  10 pcs | 1:3  1:3  1:3  1:3 |
|  | Online resources | MindTools, Coursera, and LinkedIn | Online |  |
|  | Ethical guidelines | Industry-specific ethical guidelines and codes of conduct | 10 copies | 1:3 |
|  | Workplace etiquette manuals | Guides on professional behavior, dress code, punctuality, and communication in the workplace | 10 copies | 1:3 |
|  | Employee handbooks | Sample handbooks that outline expectations, policies, and procedures related to work ethics | 10 copies | 1:3 |
|  | Videos | Short films or documentaries on ethics | 25 samples | 1:1 |
|  | Podcasts | Episodes focused on work ethics | 5 samples | 1:5 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Computer workshop | 160 m2 | 1 | 1:25 |
|  | Computers | Operating System: 64-bit Windows 11 or 10 version 1809 or above  Processor: 3 GHz (3+ GHz recommended),  Memory: 8 GB (32GB recommended)  Disk space: 10 GB  Display: 1920 x 1080 resolution  Display Card: 2 GB GPU (8 GB recommended) and DirectX 11 compliant (DirectX 12 recommended) | 25 pcs | 1:1 |
|  | Projector | high-resolution projectors with HDMI input | 1 | 1:25 |
|  | Smartboard/Smart TV | Specifications: 77-inch interactive whiteboard with touch and pen functionality. | 1 | 1:25 |
|  | Whiteboard | Traditional whiteboard | 1 | 1:25 |
|  | Printers | With Print, Copy, Scan and Fax | 2 | 1:13 |
| **C** | **Software** |  |  |  |
|  | Operating systems | Windows/Linux/Macintosh Operating System | Installed in 25 computers | 1:1 |
|  | Web Browsers | Chrome, Firefox, Edge, Safari | Installed in 25 computers | 1:1 |
|  | Ethical decision-making tools | Online simulations that present ethical dilemmas for trainees to navigate | Installed in 25 computers | 1:1 |
|  | Survey and Feedback Tools | Google Forms, SurveyMonkey | Installed in 25 computers | 1:1 |
| **D** | **Consumables** |  |  |  |
|  | Pens, pencils, rulers and paper | Whiteboard markers, 2H pencils, plastic rulers, A2 white papers | Enough |  |
|  | Printing papers | A4 and A3 | Enough |  |
|  | Flashcards | Assorted colours | Enough |  |
|  | Charts | Assorted colours | Enough |  |

# MODULE FOUR

## ELECTRONIC CIRCUITS FABRICATION

**UNIT CODE:** 0714 451 10A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Fabricate Electronic Circuits

**Unit duration**: 180 Hours

**Unit Description:** This unit covers the competencies required in Fabrication of electronic circuits. These competencies include; preparing electronic components, fabricating digital logic circuits, fabricating analogue circuits and fabricating PCB circuits.

**Summary of Learning Outcomes**

By the end of the unit the trainee should able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **LEARNING OUTCOME** | **DURATION (HRS)** |
|  | Prepare Electronic Components | 20 |
|  | Fabricate analog circuits | 60 |
|  | Fabricate digital logic circuits | 60 |
|  | Fabricate PCB circuits | 40 |
|  | **TOTAL HOURS** | 180 |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Prepare Electronic Components | * 1. Introduction to Electronic Communication Systems      1. Overview of basic electronic components and their characteristics         1. Resistors         2. Capacitors         3. Inductors         4. Diodes         5. Transistors         6. ICs: Op-amps, counters, multivibrators, amplifiers      2. Reading component values      3. Polarity-sensitive components      4. ESD precautions and component storage      5. Active and passive components      6. Power suppliers      7. Linear      8. Switching   2. Radio frequency fundamentals      1. Introduction to radio frequency (RF) signals         1. Definition of Electromagnetic waves         2. Frequency spectrum concepts         3. Significance of Impedance matching      2. Role of RF components         1. Antennas         2. Filters and their applications.         3. Amplifiers | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Fabricate digital logic circuits | * 1. Introduction to Digital Logic      1. Number Systems and Codes      2. Boolean Algebra and Logic Gates      3. K-map      4. Logic Gates Implementation         1. Transistor-level         2. ICs   2. Combinational Circuit Design      1. Multiplexers and Demultiplexers      2. Encoders and Decoders      3. Adders and Subtractors      4. Arithmetic Logic Units (ALUs)      5. Combinational Circuit Design and Analysis Techniques      6. Introduction to Programmable Logic Devices (PLDs)   3. Sequential Circuit Design      1. Latches and Flip-Flops (SR, D, JK, T)      2. Registers      3. Counters: Asynchronous and Synchronous      4. Shift Registers      5. Finite State Machines (FSMs)      6. Sequential Circuit Design and Analysis Techniques   4. Digital Logic Circuit Design and Simulation Tools      1. Introduction to a specific CAD tool: EAGLE, Logisim      2. Basic operations: project creation, file management, simulation setup      3. Introduction to Circuit Simulation Software: SPICE, LTSpice      4. Producing Printed Circuit Boards (PCBs   5. Digital Logic Circuit Implementation      1. Breadboarding Techniques      2. Prototyping Boards and Kits      3. Soldering techniques      4. Introduction to PCB Design      5. Using Digital Logic ICs      6. Interfacing with Microcontrollers and   6. Digital electronic circuit tests      1. Importance of testing      2. Types of digital circuit tests         1. Functional testing         2. Input/Output Verification         3. Truth Table Testing         4. Sequential Logic Testing      3. Reporting and Documentation         1. Results, and observations | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Fabricate Analog circuits | * 1. Foundational Concepts      1. Semiconductor Physics         1. Energy bands, doping, PN junctions         2. Diode characteristics, applications         3. Bipolar Junction Transistors (BJTs): structure, operation, biasing         4. Field-Effect Transistors (FETs): MOSFETs, JFETs, operation, biasing      2. Operational Amplifiers (Op Amps)         1. Ideal op-amp model         2. Inverting, non-inverting, and summing amplifiers         3. Differential amplifiers         4. Filters: low-pass, high-pass, band-pass         5. Oscillators         6. Comparators      3. Signal Analysis         1. Signal types: DC, AC, sinusoidal, square, triangular         2. Noise sources and their effects   2. Analog Circuit Design      1. Amplifier Design         1. Small-signal amplifiers: common emitter, common source         2. Power amplifiers: class A, B, AB         3. Feedback amplifiers         4. Stability and oscillation      2. Filter Design         1. Active filters: using op-amps         2. Passive filters: using RLC components         3. Switched-capacitor filters      3. Data Converters         1. Analog-to-Digital Converters (ADCs): sampling, quantization, resolution         2. Digital-to-Analog Converters (DACs)      4. Oscillator Design         1. LC oscillators         2. Crystal oscillators   3. Testing and Measurement      1. Measurement Instruments         1. Oscilloscope         2. Function generator         3. Multimeter         4. Spectrum analyzer         5. Network analyzer      2. Testing Procedures         1. DC and AC measurements         2. Noise and distortion measurements         3. Frequency response measurements         4. Troubleshooting techniques         5. Automated test equipment (ATE) | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Fabricate PCB circuits | * 1. PCB Materials & Components      1. Types of boards and copper cladding         1. Single-sided, double-sided, multilayer         2. Overview of fabrication steps      2. Identifying electronic components      3. Understanding datasheets and packaging types   2. Tools and Equipment      1. Soldering iron, desoldering pump, hot air station      2. Magnifier, tweezers, multimeter, test jigs      3. Safety gear and ESD protection   3. PCB Material Preparation      1. Handling blank PCBs      2. Cleaning PCBs before assembly      3. Applying solder mask      4. Silkscreen usage   4. Assembly Process      1. Through-hole mounting techniques      2. Surface mount (SMD) techniques      3. Using tweezers, magnifiers, and reflow stencils      4. Reflow soldering overview      5. Wire harnessing and header alignment   5. Soldering & Rework Techniques      1. Lead and lead-free solder differences      2. Temperature control & tip care      3. Manual and hot-air soldering      4. Soldering fine-pitch ICs and connectors      5. Heat-sensitive component handling      6. Desoldering and component replacement      7. Preventing cold solder joints & solder bridges      8. Desoldering and rework best practices   6. Assembly of Full Circuit Boards      1. Interpreting BOM (Bill of Materials) and layout      2. Populating and assembling a functional circuit   7. Inspection & Testing      1. Cleaning agents and techniques      2. Visual inspection standards (IPC-A-610 basic intro)      3. Electrical continuity and functionality testing   8. Maintenance & Troubleshooting      1. Diagnosing common fabrication faults      2. Replacing and re-soldering components      3. Record keeping and quality logs | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |

**Suggested Delivery Methods**

* Practical
* Project
* Demonstration
* Discussions
* Direct instruction
* Industry visits

**List of Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/**  **Specifications** | **Quantity** | **Recommended**  **Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | Digital Design by M. Morris Mano and Michael D. Ciletti  Digital Fundamentals by Thomas L. Floyd | 5 pcs  5 pcs | 1:5  1:5 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 160m2  With ventilation system of specifications: Fume extractor with HEPA filter, adjustable airflow  With fire extinguishers, first aid kits, ESD mats, grounding straps  With workbenches of specifications: ESD-safe, adjustable height, 1500mm x 750mm  With soldering stations Specifications: Adjustable temperature control (200°C - 480°C), ESD-safe  With hot air rework stations | 1  25 pcs  25 pcs  10 pcs | 1:25  1:1  1:1  1:2.5 |
|  | Projector | 3000 lumens | 1 pc | 1:25 |
|  | Interactive display screen | 75 inches | 1 pc | 1:25 |
|  | Computers with internet access | Processor: Intel Core i5/i7 or equivalent  RAM: 8GB or higher  Storage: 256GB SSD or higher | 25 pcs | 1:1 |
|  | PCB prototyping machine | Specifications: CNC router for PCB, precision ±0.01mm, spindle speed 20,000 RPM | 1 pc | 1:25 |
|  | Printed Circuit Boards | Single-sided, double-sided, and multi-layer PCBs  Specifications: FR4 material, 1.6mm thickness, copper thickness 1oz | 100 pcs each category | 4:1 |
|  | Oscilloscope | Specifications: Digital, 100MHz bandwidth, 4 channels | 5 pcs | 1:5 |
|  | Multimeter | Specifications: Digital, true RMS, auto-ranging, measure voltage, current, resistance, capacitance | 25 pcs | 1:1 |
|  | Function generator | Specifications: Frequency range 0.1Hz to 10MHz, various waveforms (sine, square, triangle) | 10 pcs | 1:2.5 |
|  | Power supply | Specifications: Dual output, 0-30V, 0-5A, adjustable | 10 pcs | 1:2.5 |
|  | Component tester | Specifications: Test resistors, capacitors, inductors, diodes, transistors | 5 pcs | 1:5 |
|  | Microscope | Specifications: 10x - 40x magnification, LED illumination | 5 pcs | 1:5 |
|  | Magnifying lamps | Specifications: 5x magnification, adjustable arm | 25 pcs | 1:1 |
|  | PCB etching tank | Specifications: 300mm x 200mm, temperature control, bubble agitation | 5 pcs | 1:5 |
|  | Etching solution | Specifications: Ferric chloride or sodium persulfate | 20 litres | 1:1.25 |
|  | Drilling machine | Specifications: Precision PCB drill, drill bits 0.8mm - 1.5mm | 5 pcs | 1:5 |
|  | Tweezers | Specifications: ESD-safe, various tips (straight, angled) | 25 pcs each category | 1:1 |
|  | Cutters | ESD-safe, flush cutters | 25 pcs | 1:1 |
|  | Pliers | ESD-safe needle-nose pliers | 25 pcs | 1:1 |
|  | Screwdrivers | Specifications: Precision set, various sizes (Phillips, flathead) | 5 sets | 1:5 |
|  | ESD mats | Specifications: Workbench and floor mats, grounding cords | 10 pcs | 1:2.5 |
|  | Wrist straps | Specifications: Adjustable, grounding cord with 1MΩ resistor | 25 pcs | 1:1 |
|  | Logic analyzer | Specifications: 16 channels, 100MHz sampling rate, USB interface | 5 pcs | 1:5 |
| **C** | **Consumable materials** |  |  |  |
|  | Resistors | Specifications: 1/4 watt, 1%, various values (10Ω - 1MΩ) | 100 pcs each category | 4:1 |
|  | Capacitors | Specifications: Ceramic, electrolytic, tantalum, various values (1pF - 1000µF) | 100 pcs each category | 4:1 |
|  | Inductors | Specifications: Various values (1µH - 10mH) | 100 pcs each category | 4:1 |
|  | Diodes | Specifications: 1N4001, 1N4148, Zener diodes of various voltages | 100 pcs each category | 4:1 |
|  | Transistors | Specifications: NPN (2N2222), PNP (2N2907), MOSFET (IRF540N) | 100 pcs each category | 4:1 |
|  | Integrated Circuits | Specifications: Op-amps (LM741), Timers (NE555) | 100 pcs each category | 4:1 |
|  | Connectors and headers | Specifications: Male and female headers, USB connectors, screw terminals | Enough |  |
|  | Solder wire | Specifications: Lead-free, 0.8mm diameter, Sn63/Pb37 composition | 25 rolls | 1:1 |
|  | Soldering Flux | Specifications: Rosin flux, liquid and paste | Enough |  |
|  | Cleaning reagents | Isopropyl of 99% purity | 20 litres | 1:1.25 |
|  | Brushes | Specifications: Anti-static, soft bristles | 25 | 1:1 |
|  | Solder wires | Red and black | 5 rolls each category | 1:5 |
|  | Bread boards | Specifications: 830 tie-points, solderless, multiple power rails | 50 pcs | 1:2 |
|  | Strip boards |  | 200 | 1:8 |
|  | Logic gates ICs | Specifications: 74HC series (7400, 7402, 7404, 7408, 7432) | 100 pcs each category | 4:1 |
|  | 100 Light Emitting Diodes | Red/yellow/green/white | 100 pcs each category | 4:1 |
|  | Flip-flops IC | Specifications: 74HC series (7474, 7476) | 100 pcs each category | 4:1 |
|  | Counters and register ICs | Specifications: 74HC series (7490, 7493, 74161, 74164) | 100 pcs each category | 4:1 |
|  | Multiplexers and demultiplexers ICs | Specifications: 74HC series (74151, 74154) | 100 pcs each category | 4:1 |
|  | Encoders and Decoders ICs | Specifications: 74HC series (74138, 74147) | 100 pcs each category | 4:1 |
|  | Analog-to-digital converters | Specifications: 8-bit, 10-bit, 12-bit resolution, various interfaces (I2C, SPI) | 50 pcs each category | 2:1 |
|  | Digital-to-analog converters | Specifications: 8-bit, 10-bit, 12-bit resolution, various interfaces (I2C, SPI) | 50 pcs each category | 2:1 |
|  | Microcontrollers | Specifications: 8-bit (ATmega328), 16-bit (MSP430), 32-bit (ARM Cortex-M) | 25 pcs each category | 1:1 |
|  | Development boards | Specifications: Arduino, Raspberry Pi, STM32 Nucleo, including necessary accessories (sensors, shields) | 25 sets each category | 1:1 |
| **D** | **Software** |  |  |  |
|  | PCB design software | Eagle, KiCad, Altium Designer  Specifications: Ability to design schematic diagrams and PCB layouts | Installed in 25 computers | 1:1 |
|  | Simulation software | LTSpice, Proteus and Multisim  Specifications: Simulate electronic circuits, support for various components and models | Installed in 25 computers | 1:1 |
|  | Programming tools  Arduino IDE | Specifications: Integrated development environment for Arduino boards | Installed in 25 computers | 1:1 |
|  | Keil uVision | Specifications: IDE for ARM microcontroller programming | Installed in 25 computers | 1:1 |

## COMMUNICATION SKILLS

**UNIT CODE:** 0031 441 02B

**Duration of Unit:** 40 hours

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply Communication Skills

**UNIT DESCRIPTION**

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

**Summary of Learning Outcomes**

By the end of the unit the trainee should be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **LEARNNG OUTCOMES** | **DURATION (HOURS)** |
|  | Apply communication channels. | 10 |
|  | Apply written communication skills. | 12 |
|  | Apply non-verbal skills. | 4 |
|  | Apply oral communication skills. | 4 |
|  | Apply group communication skills. | 10 |
|  | **TOTAL HOURS** | **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 | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Apply written communication skills. | * 1. Types of written communication   2. Elements of communication   3. Organization requirements for written communication | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Apply non-verbal skills. | * 1. Utilize body language and gestures   2. Apply body posture   3. Apply workplace dressing code | 1. Oral assessment 2. Written assessment 3. Observation 4. Portfolio of Evidence 5. Practical assessment 6. Third party report |
| 1. Apply oral communication skills. | * 1. Types of oral communication pathways   2. Effective questioning techniques   3. Workplace etiquette   4. Active listening | 1. Oral assessment 2. Written assessment 3. Observation 4. Portfolio of Evidence 5. Practical assessment 6. Third party report |
| 1. Apply group communication skills. | * 1. Establishing rapport   2. Facilitating resolution of issues   3. Developing action plans   4. Group organization techniques   5. Turn-taking techniques   6. Conflict resolution techniques   7. Team-work | 1. Oral assessment 2. Written assessment 3. Observation 4. Portfolio of Evidence 5. Practical assessment |

**Suggested delivery methods**

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

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/**  **Specifications** | **Quantity** | **Recommended**  **Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | Crucial Conversations: Tools for Talking When Stakes Are High by Kerry Patterson, Joseph Grenny, et al.  How to Win Friends and Influence People by Dale Carnegie.  The Art of Communicating by Thich Nhat Hanh  Talk Like TED: The 9 Public-Speaking Secrets of the World’s Top Minds by Carmine Gallo | 10 pcs  10 pcs  10 pcs  Online | 1:3  1:3  1:3 |
|  | Online resources | MindTools, Coursera, and LinkedIn  TED talks  YouTube channels  Webinars | Online  Online  Online  Online |  |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Computer workshop | 160 m2 | 1 | 1:25 |
|  | Computers | Operating System: 64-bit Windows 11 or 10 version 1809 or above  Processor: 2.5 GHz (3+ GHz recommended),  Memory: 8 GB (32GB recommended)  Disk space: 10 GB  Display: 1920 x 1080 resolution  Display Card: 2 GB GPU (8 GB recommended) and DirectX 11 compliant (DirectX 12 recommended) | 25 pcs | 1:1 |
|  | Projector | high-resolution projectors with HDMI input | 1 | 1:25 |
|  | Smartboard/Smart TV | Specifications: 77-inch interactive whiteboard with touch and pen functionality. | 1 | 1:25 |
|  | Whiteboard | Traditional whiteboard | 1 | 1:25 |
|  | External storage media | USB flash drives (32GB), External HDD/SSD | 25 pcs | 1:1 |
|  | Webcams | HD (1080p) | 25 pcs | 1:1 |
|  | Microphones | Wireless | 5 pcs | 1:5 |
|  | Printers | With Print, Copy, Scan and Fax | 2 | 1:13 |
|  | Over-ear headphones | Large diaphragm | 25 pcs | 1:1 |
| **C** | **Software** |  |  |  |
|  | Operating systems | Windows/Linux/Macintosh Operating System | For 25 computers | 1:1 |
|  | Presentation software | Microsoft power point, Prezi, Google slides | For 25 computers | 1:1 |
|  | Speech practice Tools | Orai or Ummo | For 25 computers | 1:1 |
|  | Writing tools | Microsoft word, Grammarly, Hemingway editor | For 25 computers | 1:1 |
|  | Survey tools | Google Forms, SurveyMonkey | For 25 computers | 1:1 |
|  | Video conferencing tools | Zoom, Microsoft Teams, Google Meet | For 25 computers | 1:1 |
|  | Web Browsers | Chrome, Firefox, Edge, Safari | For 25 computers | 1:1 |
| **D** | **Consumables** |  |  |  |
|  | Pens, pencils, rulers and paper | Whiteboard markers, 2H pencils, plastic rulers, A2 white papers | Enough |  |
|  | Printing papers | A4 and A3 | Enough |  |
|  | Flashcards | Assorted colours | Enough |  |

## ENTREPRENEURIAL SKILLS

**UNIT CODE:** 0413 441 04B

**Duration of unit:** 40 hours

**Relationship to occupational standards**

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

**UNIT DESCRIPTION**

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

**Summary of Learning Outcomes**

By the end of the unit the trainee should 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 a business plan | 12 |
|  | **TOTAL HOURS** | **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 | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Apply the entrepreneurial concept | * 1. Difference between Entrepreneurs and Business persons   2. Types of entrepreneurs   3. Ways of becoming an entrepreneur   4. Characteristics of Entrepreneurs   5. salaried employment and self-employment   6. Requirements for entry into self-employment   7. Roles of an Entrepreneur in an enterprise   8. Contributions of Entrepreneurship | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Identify entrepreneurship opportunities | * 1. Sources of business ideas   2. Factors to consider when evaluating business opportunity   3. Business life cycle | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 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 | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Innovate Business Strategies | * 1. Creativity in business   2. Innovative business strategies   3. Entrepreneurial Linkages   4. ICT in business growth and development | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Develop a business plan | * 1. Business description   2. Marketing plan   3. Organizational/Management plan   4. Production/operation plan   5. Financial plan   6. Executive summary   7. Business plan presentation   8. Business idea incubation | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |

**Suggested Delivery Methods**

* Case studies
* Field trips
* Group Discussions
* Demonstration
* Team training
* Guest speakers

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/**  **Specifications** | **Quantity** | **Recommended**  **Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | The Lean Startup by Eric Ries.  Zero to One by Peter Thiel  Start with Why by Simon Sinek | 10 pcs  10 pcs  10 pcs | 1:3  1:3  1:3 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Computer workshop | 160 m2 | 1 | 1:25 |
|  | Computers | Operating System: 64-bit Windows 11 or 10 version 1809 or above  Processor: 2.5 GHz (3+ GHz recommended),  Memory: 8 GB (32GB recommended)  Disk space: 10 GB  Display: 1920 x 1080 resolution  Display Card: 2 GB GPU (8 GB recommended) and DirectX 11 compliant (DirectX 12 recommended) | 25 pcs | 1:1 |
|  | Projector | high-resolution projectors with HDMI input | 1 | 1:25 |
|  | Smartboard/Smart TV | Specifications: 77-inch interactive whiteboard with touch and pen functionality. | 1 | 1:25 |
|  | Whiteboard | Traditional whiteboard | 1 | 1:25 |
|  | Printers | With Print, Copy, Scan and Fax | 2 | 1:13 |
| **C** | **Software** |  |  |  |
|  | Operating systems | Windows/Linux/Macintosh Operating System | Installed in 25 computers | 1:1 |
|  | Web Browsers | Chrome, Firefox, Edge, Safari | Installed in 25 computers | 1:1 |
|  | Software for business planning | LivePlan, Bizplan | Installed in 25 computers | 1:1 |
|  | Market research tools | Google Trends or SurveyMonkey or Statista | Installed in 25 computers | 1:1 |
|  | Marketing platforms | Google Ads or Hootsuite | Installed in 25 computers | 1:1 |
|  | Graphic design software | Adobe creative cloud or canva | Installed in 25 computers | 1:1 |
| **D** | **Consumables** |  |  |  |
|  | Pens, pencils, rulers and paper | Whiteboard markers, 2H pencils, plastic rulers, A2 white papers | Enough |  |
|  | Printing papers | A4 and A3 | Enough |  |