

**REPUBLIC OF KENYA**

**NATIONAL OCCUPATIONAL STANDARDS**

**FOR**

**INDUSTRIAL AUTOMATION AND ROBOTICS CRAFTSPERSON**

**LEVEL 5**

**OCCUPATIONAL STANDARD ISCED CODE: 0714 454A**

**FOREWORD**

The provision of quality education and training is fundamental to the government’s overall strategy for social economic development. Quality education and training will contribute to achievement of Kenya’s development blueprint, Vision 2030 and sustainable development goals.

Reforms in the education sector are necessary for the achievement of Kenya Vision 2030 and meeting the provisions of the Constitution of Kenya 2010. The education sector had to be aligned to the Constitution of Kenya 2010 and this resulted in the formulation of the Policy Framework for Reforming Education and Training (Sessional Paper No. 4 of 2016). A key feature of this policy is the radical change in the design and delivery of the TVET training.

This policy document requires that training in TVET institutions be competency based, curriculum development be industry led, certification be based on demonstration of competence and mode of delivery to allow for multiple entry and exit in TVET programmes. These reforms demand that industry takes a leading role in occupational standards development to ensure it addresses competence needs.

It is against this background that these Occupational Standards have been developed for a competency-based Industrial Automation and Robotics standard. These Occupational Standards will also be the basis for assessment of an individual for competence certification.

It is my conviction that these Occupational Standards will play a key role towards development of competent human resource for the engineering sector’s growth and development.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**PREFACE**

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

The Technical and Vocational Education and Training (TVET) Act No. 29 of 2013 and Sessional Paper No. 4 of 2016 on Reforming Education and Training in Kenya, emphasized the need to reform curriculum development, assessment and certification. This called for a shift to CBET in order to address the mismatch between skills acquired through training and skills needed by industry as well as increase the global competitiveness of Kenyan labour force.

Incumbent Industrial Automation and Robotics industry experts in conjunction with expert subject trainers and other related stakeholders have developed these Occupational Standards for Industrial Automation and Robotics Level 5. These standards will be the basis for development of competency-based curriculum for Industrial Automation and Robotics Level 5.

The Occupational Standards are designed and organized with clear performance criteria for each element of a unit of competency. These standards also outline the required knowledge and skills as well as evidence guide.

I am grateful to everyone who participated in the development of these Occupational Standards.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**TABLE** **OF CONTENTS**

[**FOREWORD** ii](#_Toc196913124)

[**PREFACE** iii](#_Toc196913125)

[**TABLE** **OF CONTENTS** iv](#_Toc196913126)

[**ABBREVIATIONS AND ACRONYMS** v](#_Toc196913127)

[**KEY TO UNIT CODE** vi](#_Toc196913128)

[**OVERVIEW** 1](#_Toc196913129)

[BASIC UNITS OF COMPETENCY 2](#_Toc196913130)

[APPLY DIGITAL LITERACY 2](#_Toc196913131)

[APPLY COMMUNICATION SKILLS 9](#_Toc196913132)

[APPLY WORK ETHICS AND PRACTICES 14](#_Toc196913133)

[APPLY ENTREPRENEURIAL SKILLS 22](#_Toc196913134)

[COMMON UNITS OF COMPETENCY 31](#_Toc196913135)

[APPLY ENGINEERING MATHEMATICS 31](#_Toc196913136)

[CORE UNITS OF COMPETENCY 36](#_Toc196913137)

[OPERATE INDUSTRIAL AUTOMATION AND ROBOTIC SYSTEMS 37](#_Toc196913138)

[MAINTAIN PRODUCT QUALITY 42](#_Toc196913139)

[MAINTAIN INDUSTRIAL AUTOMATION AND ROBOTIC SYSTEMS 45](#_Toc196913140)

[INSTALL AND MAINTAIN INDUSTRIAL AUTOMATION ELECTRICAL SYSTEMS 51](#_Toc196913141)

[INSTALL AND MAINTAIN STAND-ALONE CONTROLLED SYSTEMS 56](#_Toc196913142)

[INSTALL AND MAINTAIN PNEUMATIC SYSTEMS 62](#_Toc196913143)

[INSTALL AND MAINTAIN HYDRAULIC SYSTEMS 69](#_Toc196913144)

**ABBREVIATIONS AND ACRONYMS**

|  |  |
| --- | --- |
| ISCED | International Standard Classification of Education |
| CV | Curriculum Vitae |
| CPU | Central Programming Unit |
| RAM | Random Access Memory |
| CD | Compact Disc |
| DVD | Digital Video Disc |
| HDMI | High-Definition Multimedia Interface |
| DVI | Digital Visual Interface |
| VGA | Video Graphics Array |
| USB | Universal Serial Bus |
| OS | Operating System |
| TV | Television |
| APT | Advanced Persistent Threat |
| ICT | Information Computer Technology |
| PPE | Personal Protective Equipment |
| DC | Direct Current |
| ICs | Integrated Circuits |
| AC | Alternating Current |
| DCS | Distributed Control System |
| PLC | Programmable Logic Controller |
| IEC | International Electro technical Commission |
| HMI | Human Machine Interface |

**KEY TO UNIT CODE**

**Sector / Industry**

**Sub Sector**

**Occupational Area**

**Version Control**

**Unit of Competence Number**

**ISCED level, Programme Orientation and Level of Completion**

xx

x

xxx

x

x

x

**OVERVIEW**

The industrial automation and robotics craftsperson occupational standard serves as framework defining the key skills, knowledge and competencies required by crafts persons engaged in the field of industrial automation and robotics. The standard is divided into three sections as summarized in the table below. The core competency standards include; install and maintain industrial automation electrical systems, install and maintain programmable logic controllers, install and maintain pneumatic systems, and install and maintain industrial robotic systems.

**SUMMARY OF UNITS OF COMPETENCY**

**SUMMARY OF UNITS OF COMPETENCY**

|  |  |
| --- | --- |
| **UNIT CODE** | **UNIT TITLE** |
| **BASIC UNITS OF COMPETENCY** | |
| 0611 441 01A | APPLY DIGITAL LITERACY |
| 0031 441 02A | APPLY COMMUNICATION SKILLS |
| 0417 441 03A | APPLY WORK ETHICS AND PRACTICES |
| 0413 541 04A | APPLY ENTREPRENEURIAL SKILLS |
| **COMMON UNITS OF COMPETENCY** | |
| 0541 441 05A | APPLY ENGINEERING MATHEMATICS |
| **CORE UNITS OF COMPETENCY** | |
| 0714 351 06A | OPERATE INDUSTRIAL AUTOMATION AND ROBOTIC SYSTEMS |
| 0714 351 07A | MAINTAIN INDUSTRIAL AUTOMATION AND ROBOTIC SYSTEMS |
| 0714 351 08A | MAINTAIN PRODUCT QUALITY |
| 0714 451 09A | INSTALL AND MAINTAIN INDUSTRIAL AUTOMATION ELECTRICAL SYSTEMS |
| 0714 451 10A | INSTALL AND MAINTAIN STAND-ALONE CONTROLLED SYSTEMS |
| 0714 451 11A | INSTALL AND MAINTAIN PNEUMATIC SYSTEMS |
| 0714 451 12A | INSTALL AND MAINTAIN HYDRAULIC SYSTEMS |
|  |  |

BASIC UNITS OF COMPETENCY

## APPLY DIGITAL LITERACY

UNIT CODE: 0611 441 01A

**UNIT DESCRIPTION:**

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

**ELEMENTS AND PERFORMANCE CRITERIA**

| **ELEMENT**  These describe the key outcomes that make up workplace functions | **PERFORMANCE CRITERIA**  These are assessable statements which specify the required level of performance for each of the elements  ***(Bold and italicized terms are elaborated in the range)*** |
| --- | --- |
| 1. Solve tasks using Office suite | * 1. ***Word processing concepts***are applied in solving workplace tasks as per job requirements.   2. Worksheet data is entered and prepared in accordance with work procedures.   3. Worksheet data is built and edited in accordance with workplace procedures.   4. Data manipulation on a worksheet is undertaken in accordance with work requirements.   5. Worksheets are saved and printed in accordance with job requirements.   6. Electronic presentation concepts are applied in solving workplace tasks as per job requirements. |
| 1. Manage data and information | * 1. Office ***internet services*** are identified and applied in accordance with office procedures.   2. ***Internet access applications*** are determined in accordance with office operation procedures.   3. Internet search is performed as per job requirements.   4. Online digital content is downloaded in accordance with workplace requirements.   5. Digital content is identified and backed up in accordance with workplace procedures. |
| 1. Perform online communication and collaborations | * 1. Netiquette principles are observed as per work requirements.   2. Electronic mail communication is executed in accordance with workplace policy.   3. Digital content copyright and licenses are identified and applied according to workplace policies and regulatory requirements.   4. ***Online*** ***collaboration tools*** are applied in accordance with workplace policies and regulatory requirements. |
| 1. Apply cybersecurity skills | * 1. ***Data protection*** and ***privacy*** is classified in accordance with workplace policies and regulatory requirements.   2. ***Internet security threats*** are identified as per workplace policies and regulatory requirements.   3. Computer threats and crimes are detected in accordance to Information Management security guidelines   4. ***Cybersecurity control measures*** are applied in accordance with workplace policies and regulatory requirements. |
| 1. Perform online jobs | * 1. ***Online job platforms*** are identified as per the job requirements.   2. Online accounts and profiles are created in accordance with the work requirements.   3. Online jobs are identified according to the bidder’s skillset.   4. Online digital identity is managed according to industry best practices.   5. Online job bidding is done as per the specific job requirements.   6. Online tasks are executed according to the job requirements.   7. Personal online payment account is managed in accordance with financial regulations. |
| 1. Apply job entry techniques | * 1. ***Job opportunities*** are sought based on competencies.   2. A winning resume/CV is developed as per job advertisement.   3. An application/cover letter is developed based on the job advertisement.   4. ***certificates and testimonials*** are organized as per resume.   5. ***Interview skills*** are demonstrated as per job advertisement. |

**RANGE**

This section provides a work environment and conditions to which the performance criteria apply. It allows for a different work environment and situations that will affect performance.

| **Variable** | **Range** |
| --- | --- |
| 1. Computer devices may include but are not limited to: | * Desktops * Laptops * Smartphones * Tablets * Smartwatches |
| 1. Computer hardware may include but are not limited to: | * The System Unit E.g. Motherboard, CPU, casing, * Input Devices e.g. Pointing, keying, scanning, voice/speech recognition, direct data capture devices. * Output Devices e.g. hardcopy output and softcopy output * Storage Devices e.g. main memory e.g. RAM, secondary storage (Solid state devices, Hard Drives, CDs & DVDs, Memory cards, Flash drives * Computer Ports e.g. HDMI, DVI, VGA, USB type C |
| 1. Computer software may include but are not limited to: | * System software e.g. Operating System (Windows, Macintosh, Linux, Android, iOS) * Application Software e.g. Word Processors, Spreadsheets, Presentations etc. * Utility Software e.g. Antivirus programs |
| 1. External devices may include but are not limited to: | * Printers * Projectors * Smart Boards * Speakers * External storage drives * Digital/Smart TVs |
| 1. Word processing concepts may include but are not limited to: | * Creating word documents * Editing word documents * Formatting word documents * Saving word documents * Printing word documents |
| 1. Mouse techniques may include but are not limited to: | * Clicking * Double-clicking * Right-clicking * Drag and drop |
| 1. Internet connection options may include but are not limited to: | * Mobile Networks/Data Plans * Wireless Hotspots * Cabled (Ethernet/Fiber) * Dial-Up * Satellite * ISDN (Integrated Services Digital Network) |
| 1. Data manipulation may include but are not limited to: | * Use of formulae * Use of functions * Sorting * Filtering * Visual representation using charts |
| 1. Electronic presentation concepts may include but are not limited to: | * Creating slides * Editing slides * Formatting slides * Applying slide effects and transitions * Creating and playing slideshows * Saving presentations * Printing slides and handouts |
| 1. Internet services may include but are not limited to: | * Communication Services * Information Retrieval Services * File Transfer * World Wide Web Services * Web Services * Directory Services * Automatic Network Address Configuration * Newsgroup * Ecommerce |
| 1. Internet access applications/software may include but are not limited to: | * Browsers * Email Apps * eCommerce Apps |
| 1. Online collaboration tools may include but are not limited to: | * Online Storage * Online productivity applications * Online meetings, * Online learning environments, * Online calendars * Social networks |
| 1. Data protection and privacy may include but not limited to: | * Confidentiality of data/information * Integrity of data/information * Availability of data/information |
| 1. Internet security threats may include but not limited to: | * Malware attacks * Social engineering attacks * Software supply chain attacks * Advanced persistent threats (APT) * Distributed denial of service (DDoS) * Man-in-the-middle attack (MitM) * Password attacks * IoT Attacks * [Phishing Attacks](https://onlinedegrees.sandiego.edu/top-cyber-security-threats/#phishing-attacks) * [Ransomware](https://onlinedegrees.sandiego.edu/top-cyber-security-threats/#ransomware) |
| 1. Security threats control measures may include but not limited to: | * Counter measures against cyber terrorism * Physical Controls * Technical/Logical Controls * Operational Controls |
| 1. Online job platforms may include but are not limited to: | * Remo task * Data annotation.tech * Cloud worker * Upwork * Oneforma * Appen |
| 1. Job opportunities may include but not limited to: | * Self-employment * Service provision * product development * salaried employment |
| 1. Certificates and testimonialsmay include but not limited to: | * Academic credentials * Letters of previous employments/ services rendered * Letters of commendation * Certifications of participation * Awards |
| 1. Interview skills may include but not limited to: | * Listening skills * Grooming * Language command * Articulation of issues * Body language * Time management * Honesty * Generally knowledgeable in current affairs and technical area |

**REQUIRED KNOWLEDGE AND SKILLS**

This section describes the knowledge and skills required for this unit of competency.

**Required knowledge**

The individual needs to demonstrate knowledge of:

* Computer Hardware and Software Concepts
* Computer Security Concepts (Data security and privacy)
* Cyber security threats and control measures
* Understanding Computer Crimes
* Detection and protection against computer crimes
* Laws governing protection of ICT in Kenya
* Digital Identity Management
* Netiquette Principles
* Fundamentals of Copyright and Licenses
* Word processing;
* Functions and concepts of word processing;
* Documents and tables creation and manipulations;
* Document editing;
* Document formatting;
* Word processing utilities
* Spreadsheets;
* Meaning, types and importance of spreadsheets;
* Components of spreadsheets;
* Functions, formulae, and charts, uses and layout;
* Data formulation, manipulation and application to cells;
* Editing & formatting spreadsheets;
* Presentation Packages;
* Types of presentation Packages.
* Creating, formulating, running, editing, printing and presenting slides and handouts
* Networking and Internet;
* Internet connectivity.
* Browser and digital content management;
* Managing data, information, and digital content
* Electronic mail and World Wide Web
* Fundamentals of Online Working;
* Online Profile Management;
* e-Portfolio Management;
* Online Jobs Bidding;
* Online Payment Systems;
* Job entry techniques
* Job searching sites
* Interview preparation skills
* Interview handling

**Required skills**

The individual needs to demonstrate the following skills:

* Active listening
* Keyboard Skills
* Mouse Skills
* Analytical skills
* Creativity
* Interpretation Skills
* Communication
* Spreadsheet operations (applying fundamental operations such as addition, subtraction, division and multiplication)
* Computer Use Safety Skills
* Document Editing Skills
* Document Formatting Skills
* Document Printing Skills
* Netiquette Skills
* Internet Browsing Skills
* Problem Solving Skills
* Online Collaboration Skills
* Cybersecurity Skills
* CV writing
* grooming

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required knowledge, and skills range.

|  |  |
| --- | --- |
| 1. Critical aspects of competency | ***Assessment requires evidence that the candidate:***   * 1. Solved tasks using the office suite as per workplace policies and regulations.   2. Manage data and information as per workplace policies and regulations.   3. Performed online communication and collaboration as per workplace policies and regulations.   4. Applied cybersecurity skills in accordance with workplace policies and regulations.   5. Executed online tasks according to the job requirements.   6. Searched for job opportunity based on competencies.   7. Prepared job requirement documentations based on job opportunity.   8. Demonstrated interview skills based on the job opportunity. |
| 1. Resource implications | The following resources should be provided:   * 1. Appropriately simulated environment where assessment can take place.   2. Access to relevant work environments where assessment can take place.   3. Resources relevant to the proposed activities or task. |
| 1. Methods of assessment | Competency in this unit may be assessed through:   * 1. Oral assessment   2. Portfolio of evidence   3. Interviews   4. Third party report   5. Written assessment   6. Practical assessment   7. Projects |
| 1. Context of assessment | Competency may be assessed:   * 1. On the job   2. In a simulated work environment. |
| 1. Guidance information for assessment | * 1. Holistic assessment with other units relevant to the industry sector and workplace job role is recommended. |

APPLY COMMUNICATION SKILLS

**UNIT CODE:** 0031 441 02A

**UNIT DESCRIPTION**

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

**ELEMENTS AND PERFORMANCE CRITERIA**

| **ELEMENT**  These describe the key outcomes that make up workplace function | **PERFORMANCE CRITERIA**  These are assessable statements that specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in the Range*** |
| --- | --- |
| 1. Apply communication channels | 1. Specific communication channels are identified and applied based on workplace requirements. 2. Challenges are identified and addressed as per the operational standards of the organization. 3. Communication channels are evaluated to meet workplace needs. |
| 1. Apply written communication skills | * 1. Types of written communication are identified and applied according to the workplace requirements.   2. Written communication needs are identified and implemented according to workplace procedures.   3. Written communication guidelines are analyzed, evaluated, and revised based on workplace needs. |
| 1. Apply non-verbal communication skills | 3.1 Existing non-verbal communication techniques are identified and applied based on organization policy.  3.2 Non-verbal communication techniques are articulated to enhance inclusivity according to workplace requirements.  3.3 Non-verbal communication techniques are modeled to enhance inclusivity according to workplace requirements. |
| 1. Apply oral communication skills | 4.1 Types of oral communication are identified and established as per organization policy.  4.2 Pathways of oral communication are identified and established as per organization policy.  4.3 Pathways of oral communication are reviewed according to organization procedures.  4.4 Pathways of oral communication are maintained according to the organization standards. |
| 1. Apply group communication skills | 1. Group communication strategies are appliedbased on the workplace needs. 2. Groups are organized in accordance with workplace procedures. 3. Effective questioning, listening and non-verbal communication techniques are used as per needs.   5.4 Group communication challenges are identified and addressed according to the workplace needs. |

**RANGE**

This section provides the work environment and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

| **Variable** | **Range** |
| --- | --- |
| 1. Communication strategies may include but are not limited to: | * Language switch * Comprehension check * Repetition * Asking confirmation * Paraphrasing * Clarification request * Translation * Restructuring * Generalization |
| 1. Effective group interaction may include but not limited to: | * Identifying and evaluating what is occurring within an interaction in a non-judgmental way. * Using active listening. * Making decision about appropriate words, behavior. * Putting together response which is culturally appropriate. * Expressing an individual perspective. * Expressing own philosophy, ideology and background and exploring impact with relevance to communication |
| 1. Situations may include but are not limited to: | * Establishing rapport * Eliciting facts and information * Facilitating resolution of issues * Developing action plans |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Active listening
* Interpretation
* Negotiation
* Writing
* Oral skills
* Creative thinking
* Critical thinking
* Decision making
* Analytical
* Innovation
* Conflict skills
* Leadership
* Problem solving skills
* Management
* Organizational
* Teamwork

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Communication process
* Dynamics of groups
* Styles of group leadership
* Key elements of communications strategy
* Principles of effective communication
* Turn-taking techniques
* Conflict resolution techniques
* Work planning
* Work organization
* Company policies
* Company operations and procedure standards
* Fundamental rights at the workplace
* Personal hygiene
* Accountability
* Workplace problems and how to deal with them

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills, knowledge, and range.

|  |  |
| --- | --- |
| 1. Critical aspects of Competency. | Assessment requires evidence that the candidate:   * 1. Identified and applied specific communication channels based on workplace requirements.   2. Identified and applied specific written communication correspondence according to the workplace requirements.   3. Applied and developed non-verbal strategies to communicate in all areas of the workplace requirements.   4. Established pathways of oral communication as per workplace policy.   5. Applied group communication strategies based on workplace needs. |
| 1. Resource Implications | The following resources should be provided:   1. Access to relevant workplace where assessment can take place. 2. Appropriately simulated environment where assessment can take place. 3. Resources relevant to the proposed activity or tasks. |
| 1. Methods of Assessment | Competency in this unit may be assessed through:   * 1. Oral assessment   2. Portfolio of evidence   3. Interviews   4. Third party report   5. Written assessment   6. Practical assessment   7. Projects |
| 1. Context of Assessment | Competency may be assessed:   1. On-the-job 2. In a simulated work environment |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## APPLY WORK ETHICS AND PRACTICES

**ISCED UNIT CODE:** 0417 441 03A

**UNIT DESCRIPTION**

This unit covers competencies required to effectively apply work ethics and practices. 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.

**ELEMENTS AND PERFORMANCE CRITERIA**

| **ELEMENT**  These describe the key outcomes which make up workplace function. | **PERFORMANCE CRITERIA**  These are assessable statements which specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in Range*** |
| --- | --- |
| 1. Apply self-management skills | 1. Personal vision, mission and goals are formulated based on potential and concerning organization objectives and strategic plan 2. Self-esteem and a positive self-image are developed and maintained based on value 3. Emotional intelligence and stress management are demonstrated as per workplace requirements. 4. Assertiveness is developed and maintained based on the requirements of the job. 5. Accountability and responsibility for one's actions are demonstrated based on workplace instructions. 6. Time management, attendance and punctuality are observed as per the organization’s policy. 7. Personal goals are managed as per the organization’s objective 8. Self-strengths and weaknesses are identified based on personal objectives 9. Motivation, initiative and proactivity are utilized as per the organization policy 10. Individual performance is evaluated and monitored according to the agreed targets. |
| 1. Promote ethical work practices and values | 1. Integrity is demonstrated as per acceptable norms 2. Codes of conduct is applied as per the workplace requirements 3. Policies and guidelines are observed as per the workplace requirements 4. Professionalism is exercised in line with organizational policies |
| 1. Promote Team work | 3.1 ***Teams*** are formed to enhance productivity based on organization’s objectives  3.2 Duties are assigned to teams under the organization policy.  3.3 Team activities are managed and coordinated as per set objectives.  3.4 Team performance is evaluated based on set targets as per workplace policy.  3.5 ***Conflicts*** are resolved between team members in line with organization policy.  3.6 Gender and diversity-related issues are identified and mainstreamed in accordance with workplace policy.  3.7 Healthy ***relationships*** are developed and maintained in line with the workplace.  3.8 Adaptability and flexibility are applied in dealing with team members as per workplace policies |
| 1. Maintain professional and personal development | 4.1 ***Personal growth and development*** needs are identified and assessed in line with the requirements of the job.  ***4.2 Training and career opportunities*** are identified and utilized based on job requirements.  4.3 ***Resources*** for training are mobilized and allocated based on organizations and individual skills needs.  4.4 Licenses and certifications relevant to the job and career are obtained and renewed as per policy.  4.5 Recognitions are sought as proof of career advancement in line with professional requirements.  4.6 Work priorities and personal commitments are balanced and managed based on the requirements of the job and personal objectives.  4.7 Dynamism and on-the-job learning are embraced in line with the organization’s goals and objectives. |
| 1. Apply Problem solving skills | 5.1 ***Creative, innovative*** and practical solutions are developed based on the problem  5.2 Independence and initiative in identifying and solving problems are demonstrated based on the requirements of the job.  5.3 Team problems are solved as per the workplace guidelines  5.4 Problem-solving strategies are applied as per the workplace guidelines  5.5 Problems are analyzed and assumptions tested as per the context of data and circumstances |
| 1. Promote Customer Care | 6.1 Customers' needs are identified based on their characteristics  6.2 Customer ***feedback*** is allowed and facilitated in line with organization policies.  6.3 Customer concerns and complaints are analyzed and resolved in line with the set organizational culture.  6.4 Proactive customer outreach programs are implemented as per organizational policies  6.5 Customer retention strategies are developed and implemented in line with the organizational policy |

**RANGE**

This section provides work environment and conditions to which the performance criteria apply. It allows for different work environment and situations that will affect performance.

| **Variable** | **Range** |
| --- | --- |
| 1. Feedback may include but not limited to: | * Verbal * Written * Informal * Formal |
| 1. Conflicts include but are not limited to: | * Interpersonal Conflict. * Intrapersonal Conflict. * Intergroup Conflict. * Intragroup Conflict. |
| 1. Relationships may include but not limited to: | * Man/Woman * Trainer/trainee * Employee/employer * Client/service provider * Husband/wife * Boy/girl * Parent/child * Sibling relationships |
| 1. Team may include but not limited to: | * Small work group * Staff in a section/department * Inter-agency group * Virtual teams |
| 1. Personal growth may include but not limited to: | * Growth in the job * Career mobility * Gains and exposure the job gives * Net workings * Benefits that accrue to the individual as a result of noteworthy performance |
| 1. Personal objectives may include but not limited to: | * Long term * Short term * Broad * Specific |
| 1. Trainings and career opportunities may include but not limited to | * Participation in training programs * Serving as Resource Persons in conferences and workshops * Capacity building |
| 1. Resource may include may but not limited to: | * Human * Financial * Technology |
| 1. Creative and innovative may include but not limited to: | * New ideas * Original ideas * Different ideas * Methods/procedures * Processes * New tools |
| 1. Emerging issues may include but not limited to: | * Artificial Intelligence * Data confidentiality * National cohesion * Open offices |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Active listening
* Critical thinking
* Organizational
* Negotiation
* Monitoring
* Evaluation
* Problem solving
* Decision Making
* Leadership
* Creative/innovative thinking
* Adaptability
* Conflict management
* Emotional intelligence
* Teamwork

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Work values and ethics
* Company policies and procedures
* Company operations, procedures and standards
* Flexibility and adaptability
* Concept of time and leisure time
* Decision making
* Work planning
* Organizing work
* Monitoring and evaluation
* Record keeping
* Gender and diversity mainstreaming
* Drug and substance abuse
* Professional growth and development
* creativity
* Innovation
* problem solving
* customer care
* mentoring and coaching.
* Emerging issues

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical aspects of Competency | Assessment require evidence that the candidate:   * 1. Applied self-management skills as per organizational procedures.   2. Promoted ethical practices and values as per organizational procedures.   3. Promoted Teamwork as per workplace assignments.   4. Maintained professional and personal development as per organizational procedures.   5. Applied Problem-solving skills based on work requirements.   6. Identified customer needs based on their characteristics.   7. Gave back Customer feedback in line with organization policies. |
| 1. Resource Implications | The following resources should be provided:   1. Access to relevant workplace where assessment can take place 2. Appropriately simulated environment where assessment can take place. 3. Resources relevant to the proposed activity or tasks. |
| 1. Methods of Assessment | Competency in this unit may be assessed through:   1. Oral questioning 2. Written test 3. Portfolio of Evidence 4. Interview 5. Third party report |
| 1. Context of Assessment | Competency may be assessed:   1. On-the-job 2. In a simulated work environment |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## APPLY ENTREPRENEURIAL SKILLS

**ISCED UNIT CODE:** 0413 541 04A

**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, developing business innovative strategies, and developing business plans.

**ELEMENTS AND PERFORMANCE CRITERIA**

| **ELEMENT**  These describe the key outcomes that make up workplace function. | **PERFORMANCE CRITERIA**  These are assessable statements that specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in Range*** |
| --- | --- |
| 1. Apply financial literacy | 1. **Sources of personal and business** ***funds*** are identified as per financial procedures and standards 2. Personal finances are managed as per financial procedures and standards 3. Savings are managed as per financial procedures and standards 4. Debts are managed as per financial procedures and standards 5. Investments are undertaken as per financial procedures and standards 6. Insurance services are procured as per financial procedures and standards |
| 1. Apply entrepreneurial concept | 1. Entrepreneurs and Business persons are distinguished as per principles of entrepreneurship 2. ***Types of entrepreneurs*** are identified as per principles of entrepreneurship 3. Ways of becoming an entrepreneur are identified as per principles of Entrepreneurship 4. ***Characteristics of Entrepreneurs*** are identified as per principles of Entrepreneurship 5. Salaried employment and self-employment are distinguished as per principles of entrepreneurship 6. ***Requirements for entry into self-employment*** are identified according to business procedures and standards 7. Roles of an Entrepreneur in an enterprise are determined according to business procedures and standards 8. **Contributions of entrepreneurship** to National development are identified as per business procedures and standards |
| 1. Identify entrepreneurial opportunities | 1. Business ideas are identified as per business procedures and standards 2. Factors to consider when evaluating business opportunity viability are explored based on business procedure and standards 3. Entrepreneurial opportunities are evaluated as per business procedures and standards 4. Business ideas and opportunities are generated as per business procedures and standards 5. Business life cycle is analysed as per business procedures and standards |
| 1. Apply business legal aspects | 1. ***Forms of business ownership*** are identified as per legal procedures and practices 2. Business Registration and Licensing processes are identified as per legal procedures and practices 3. Types of Contracts and Agreements are analysed as per legal procedures and practices 4. Employment Laws are identified as per legal procedures and practices 5. Taxation laws are identified as per legal procedures and practices |
| 1. Innovate business strategies | 1. Business innovation strategies are determined by the organization standards 2. Creativity in business development is demonstrated in accordance with business standards 3. ***Innovative business standards***  are developed as per business principles 4. Linkages with other entrepreneurs are created as per best practice 5. ICT is incorporated in business growth and development as per best practice |
| 1. Develop business plan | 1. Business idea is described as per business procedures and standards 2. Business description is developed as per business plan format 3. Marketing plan is developed as per business plan format 4. Organizational/Management plan is prepared in accordance with business plan format 5. Production/operation plan is prepared in accordance with business plan format 6. Financial plan is prepared in accordance with the business plan format 7. Executive summary is prepared in accordance with business plan format 8. Business plan is presented as per best practice 9. Business ideas are incubated as per institutional policy. |

**RANGE**

This section provides work environment and conditions to which the performance criteria apply. It allows for different work environment and situations that will affect performance.

| **Variable** | **Range** |
| --- | --- |
| 1. Sources of personal funds mayinclude but not limited to: | * Salary/Wages * Investments * Savings * Inheritance * Government Benefits |
| 1. Sources of business finance mayinclude but not limited to: | * Equity Financing * Debt Financing, * Personal Savings/Investment * Retained Earnings * Grants and Subsidies * Crowdfunding * supplier Credit: * Leasing and Asset Financing: |
| 1. Types of entrepreneurs may include but not limited to: | * Innovators * Imitators * Craft * Opportunistic * Speculators |
| 1. Characteristics of entrepreneurs may include but not limited to: | * Creative * Innovative * Planner * Risk taker * Networker * Confident * Flexible * Persistent * Patient * Independent * Future oriented * Goal oriented |
| 1. Requirements for entry into self-employment may include but not limited to | * Technical skills * Management skills * Entrepreneurial skills * Resources * Infrastructure |
| 1. Forms of businesses ownership may include but not limited to: | * Sole proprietorship * Partnership * Limited companies * Cooperatives |
| 1. Innovative business standards may include but not limited to: | * New products * New methods of production * New markets * New sources of supplies * Change in industrialization |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Analytical
* Management
* Problem-solving
* Root-cause analysis
* Communication

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Decision making
* Business communication
* Change management
* Competition
* Risk
* Net working
* Time management
* Leadership
* Factors affecting entrepreneurship development
* Principles of Entrepreneurship
* Features and benefits of common operational practices, e. g., continuous improvement (kaizen), waste elimination,
* Conflict resolution
* Health, safety and environment (HSE) principles and requirements
* Customer care standards
* Basic financial management
* Business strategic planning
* Impact of change on individuals, groups and industries
* Government and regulatory processes
* Local and international market trends
* Product promotion standards
* Market and feasibility studies
* Government and regulatory processes
* Local and international business environment
* Relevant developments in other industries
* Regional/ County business expansion standards

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency | Assessment requires evidence that the candidate:   1. Identified Sources of personal and business finance as per financial procedures and standards 2. Managed Personal finances as per financial procedures and standards 3. Made Investment decisions as per financial procedures and standards 4. GeneratedBusiness ideas and opportunities based on business procedure and standards 5. Analysed business life cycle based on business procedure and standards 6. Determined business innovative standards as per business principles 7. Developed and presented a business plan as per regulatory framework. |
| 1. Resource Implications | The following resources should be provided:   1. Access to relevant workplace where assessment can take place 2. Appropriately simulated environment where assessment can take place |
| 1. Methods of Assessment | Competency may be assessed through:   1. Written tests 2. Oral questions 3. Third party report 4. Interviews 5. Portfolio |
| 1. Context of Assessment | Competency may be assessed:   1. On-the-job 2. In a simulated work environment |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

COMMON UNITS OF COMPETENCY

## APPLY ENGINEERING MATHEMATICS

**UNIT CODE:** 0541 441 05A

**UNIT DESCRIPTION:**

This unit describes the competences required in order to apply algebra, trigonometric and hyperbolic functions, coordinate geometry, statistics, vector theorem, matrices and to carry out mensuration.

**ELEMENTS AND PERFORMANCE CRITERIA**

| **ELEMENT**  These describe the key outcomes which make up workplace function. | **PERFORMANCE CRITERIA**  These are assessable statements which specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in the Range.*** |
| --- | --- |
| * 1. Apply algebra | * 1. Calculations involving indices are performed as per task requirement   2. Calculations involving logarithms are performed as per task requirement   3. Scientific calculator is used in solving mathematical problems as per task requirement   4. Simultaneous equations are solved as per task requirement   5. Quadratic equations are solved as per as per task requirement |
| * 1. Apply trigonometric and hyperbolic functions | * 1. Calculations involving trigonometry are performed as per task requirement   2. Calculations involving hyperbolic functions are performed as per task requirement   3. Trigonometric identities are applied as per task requirement |
| * 1. Apply coordinate geometry | * 1. Polar equations are calculated as per task requirement   2. Graphs of given polar equations are drawn as per task requirement   3. Normal and tangents are determined as per task requirement |
| * 1. Carry out mensuration | * 1. Units of measurements and their symbols are determined as per task requirement   2. Conversion of units of measurement are performed as per task requirement   3. Calculation of length, width, height, perimeter, area and angles of figures is performed as per task requirement   4. Measurements and estimations of quantities is performed as per task requirement |
| * 1. Apply statistics | * 1. Presentation of data is done as per task requirement   2. Measures of ***central tendency*** are obtained as per task requirement   3. Measures of ***dispersion*** are obtained as per task requirement |
| * 1. Apply vector theorem | * 1. Vectors and scalar quantities are determined as per task requirement   2. Operations on vectors are performed as per task requirement   3. Resolution of vectors is performed as per task requirement   4. Vector and scalar products are obtained as per task requirement |
| * 1. Apply matrices | * 1. Matrices operations are performed as per mathematical methods   2. Inverse of matrices are obtained as per task requirement   3. Simultaneous equations are solved using matrices as per task requirement |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

| **Variable** | **Range** |
| --- | --- |
| 1. Central tendency may include but not limited to: | * 1. Mean   2. Mode   3. Median |
| 1. Dispersion may include but not limited to: | * 1. Variance   2. Standard deviation |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Applying fundamental operations (addition, subtraction, division, multiplication)
* Using and applying mathematical formulas
* Logical thinking
* Problem solving
* Drawing graphs
* Using different measuring tools

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Fundamental operations (addition, subtraction, division, multiplication)
* Calculating area and volume
* Types and purpose of measuring instruments
* Units of measurement and abbreviations
* Rounding techniques
* Types of fractions
* Types of tables and graphs
* Presentation of data in tables and graphs

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical aspects of Competency | Assessment requires evidence that the candidate:   * 1. Solved simultaneous equations as per task requirement   2. Solved quadratic equations as per as per task requirement   3. Performed calculations involving trigonometry as per task requirement   4. Determined normal and tangents as per task requirement   5. Performed calculation of length, width, height, perimeter, area and angles of figures as per task requirement   6. Obtained measures of central tendency as per task requirement   7. Performed resolution of vectors as per task requirement   8. Solved simultaneous equations using matrices as per task requirement |
| 1. Resource Implications | The following resources should be provided:   * 1. Appropriately simulated environment where assessment can take place   2. Access to relevant work environment   3. Resources relevant to the proposed activities or tasks |
| 1. Methods of Assessment | Competency in this unit may be assessed through:   * 1. Oral questioning   2. Portfolio of evidence   3. Third party report   4. Written tests |
| 1. Context of Assessment | Competency may be assessed in the workplace or simulated workplace |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector and workplace job role is recommended. |

CORE UNITS OF COMPETENCY

## OPERATE INDUSTRIAL AUTOMATION AND ROBOTIC SYSTEMS

**UNIT CODE: 0714 351 06A**

**UNIT DESCRIPTION**

This unit covers the competencies required in operation of an industrial automation and robotics systems. The competencies include; operating computer devices, applying digital electronic principles, controlling industrial automation and robotic systems, monitoring industrial automation and robotic systems and setting industrial automation and robotic system parameters.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**  These describe the key outcomes which make up workplace function | **PERFORMANCE CRITERIA**  These are assessable statements, which specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in the Range*** |
| 1. Operate computer devices | * 1. C***omputer device*** usage is determined in accordance with workplace requirements.   2. ***Computer hardware and software*** is identified according to job requirements.   3. Computer devices are turned on or off as per the correct workplace procedure.   4. ***Mouse techniques*** are applied in solving tasks as per workplace requirements.   5. Keyboardtechniques are applied in solving tasks as per workplace requirements.   6. Computer files and folders are created and managed as per scope of work.   7. ***Internet connection option***s are identified and applied in connecting computer devices to the internet.   8. ***External devices*** are identified and connected to the computer devices as per the job requirement. |
| 1. Apply digital electronic principles | * 1. Number system conceptsare applied as per work requirement   2. ***Digital logic gate*** concepts are applied as per work requirement   3. ***Sequential circuit*** concepts are applied as per work requirement   4. Digital electronic device memory technology is identified as per work requirement   5. ***Digital sensing units*** are identified as per work requirements   ***Digital actuating units*** are identified as per work requirement |
| 1. Control industrial automation and robotic system | * 1. Industrial automation and robotic control systems are identified as per installation   2. PPE are donned as per work requirement   3. Industrial automation and robotic system start up and shut down is performed according to operating manual   4. Material flow is controlled as per work requirement   5. Industrial automation and robotic system safety devices are used as per equipment safety requirement |
| 1. Monitor industrial automation and robotic system | * 1. ***Industrial automation and robotic monitoring systems*** are identified as per installation   2. PPE are donned as per work requirement   3. Industrial automation and robotic system alarms are managed as manufacturer’s manual   4. Industrial automation and robotic system visualization tools are utilized as per workplace procedures   5. ***Monitored industrial automation and robotic system technical parameters*** are recorded as per workplace procedures |
| 1. Set industrial automation and robotic system parameters | 1. Industrial automation and robotic system process recipe is loaded as per work requirement 2. Industrial automation and robotic system ***process parameters*** are identified as per work requirement 3. Industrial automation and robotic system process parametersare configured as per work requirement 4. Industrial automation and robotic system set parameters are recorded as per workplace procedures |

**RANGE**

This section provides work environment and conditions to which the performance criteria apply. It allows for different work environment and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. Computer devices: | * Desktops * Laptops * Smartphones * Tablets   + Smartwatches |
| 1. Computer hardware: | * The System Unit e.g., Motherboard, CPU, casing, * Input Devices e.g., Pointing, keying, scanning, voice/speech recognition, direct data capture devices. * Output Devices e.g. hardcopy output and softcopy output * Storage Devices e.g. main memory e.g. RAM, secondary storage (Solid state devices, Hard Drives, CDs & DVDs, Memory cards, Flash drives   + Computer Ports e.g. HDMI, DVI, VGA, USB type C etc. |
| 1. Computer software include but are not limited to: | * System software e.g. Operating System (Windows, Macintosh, Linux, Android, iOS) * Application Software (Word Processors).   + Utility Software e.g. Antivirus programs |
| 1. ***Digital logic gate*** include but not limited to: | * AND Gate * OR Gate * NOT Gate * NAND Gate * NOR Gate * XOR Gate (Exclusive OR) * XNOR Gate (Exclusive NOR or Equivalence) |
| 1. ***Sequential circuit*** include but not limited to: | * Flip-Flops (e.g., SR, JK, D, T flip-flops) * Latches * Registers * Counters (synchronous and asynchronous) * Finite State Machines (FSMs) * Shift Registers * Memory Units (RAM, ROM in sequential logic contexts) * Control Units in CPUs |
| 1. ***Digital sensing units*** include but not limited to: | * Proximity sensors (e.g., infrared, ultrasonic, capacitive, inductive) * Photoelectric sensors * Temperature sensors with digital output (e.g., DS18B20) * Digital pressure sensors * Motion sensors (e.g., PIR sensors) * Digital accelerometers and gyroscopes (e.g., MPU6050) |
| 1. ***Digital actuating units*** include but not limited to: | * Relays (electromechanical or solid-state, digitally controlled) * Solenoids * Digital servo motors * Stepper motors * DC motors with digital controllers * LEDs and digital displays |
| 1. ***Industrial automation and robotic control systems*** include but not limited to: | * + Programmable Logic Controllers   + Human machine interface   + Sensors   + Actuators   + Robotic arms   + Robotic manipulators   + Robotic end effectors   + Motion control systems   + Safet systems |
| 1. ***PPE*** include but not limited to: | * + Helmet   + Hand gloves   + Safety shoes   + Harness   + Safety goggles |
| 1. ***Safety devices*** include but not limited to: | * Guards * Interlocks * Emergency push buttons |
| 1. ***Industrial automation and robotic monitoring systems*** includes but not limited to: | * Industrial monitoring sensors * Dashboards * Human machine interfaces * Display monitors |
| 1. ***Monitored industrial automation and robotic system technical parameters*** includes but not limited to: | * Temperature * Pressure * Flow rate * Displacement * Speed * Vibration * Load and force * Power consumption * Environmental conditions |

**REQUIRED KNOWLEDGE AND SKILLS**

This section describes the knowledge and skills required for this unit of competency.

**Required knowledge**

The individual needs to apply knowledge of:

* Occupational Health and safety
* Industrial wiring systems
* IEEE regulations
* Electrical and electronic testing and measuring tools
* Electrical workshop practices
* Documentation and records keeping
* Electrical power backup systems
* Interpreting technical documentation
* Process control system

**Required Skills**

The individual needs to apply the following skills:

* Structured industrial wiring
* Electrical and electronic troubleshooting
* Problem solving
* Technical reporting
* Communication skills
* Digital skills
* Time management
* Decision making
* Critical thinking
* Adaptability

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required knowledge, skills and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency | Assessment requires evidence that the candidate:   * 1. Applied digital logic gate concepts as per work requirement   2. Applied sequential circuit concepts as per work requirement   3. Identified digital sensing units as per work requirements   4. Identified digital actuating units as per work requirement   5. ***Identified industrial automation and robotic control systems*** are identified as per installation   6. Performed industrial automation and robotic system start up and shut down according to operating manual   7. Managed industrial automation and robotic system alarms as manufacturer’s manual   8. Utilized industrial automation and robotic system visualization tools as per workplace procedures   9. Recorded monitored industrial automation and robotic system technical parameters as per workplace procedures   10. Loaded industrial automation and robotic system process recipe as per work requirement   11. Configured industrial automation and robotic system process parameters as per work requirement |
| 1. Resource Implications | The following resources should be provided:   * 1. Access to relevant workplace or appropriately simulated environment where assessment can take place   2. Resources appropriate for performance of assessment tasks |
| 1. Methods of Assessment | Competency in this unit may be assessed through:   1. Project 2. Practical 3. Third party report 4. Portfolio of evidence 5. Oral questioning 6. Written tests |
| 1. Context of Assessment | This competency may be assessed in a workplace or in a simulated workplace. |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## MAINTAIN PRODUCT QUALITY

**UNIT CODE: 0714 351 08A**

**UNIT DESCRIPTION**

This unit covers the competencies required by an industrial automation and robotics system operator to maintain quality of products produced through an industrial automated system. These competencies include; conducting product quality checks, adjusting industrial automation and robotics machinery stetting and documenting production quality activities.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**  These describe the key outcomes which make up workplace function | **PERFORMANCE CRITERIA**  These are assessable statements, which specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in the Range*** |
| 1. Conduct product quality checks | * 1. Product visual inspection is carried out as per work place procedures   2. ***Product quality monitoring equipment*** are used as per workplace procedures   3. Nonconforming products are rejected as per workplace procedures |
| 1. Document production quality activities | * 1. Industrial automation and robotics conforming products are recorded as per workplace procedures   2. Industrial automation and robotics nonconforming products are recorded as per workplace procedures   3. Industrial automation and robotics machine setting deviations are recorded as per workplace procedures |
| 1. Adjust industrial automation and robotics machinery settings | * 1. PPE are donned as per work requirement   2. Industrial automation and robotics machine setting deviations are identified as per work requirement   3. Industrial automation and robotics machinery setting adjustment tools and equipment are gathered as per work requirement   4. Industrial automation and robotics machine setting deviations are eliminated as per work requirement |

**RANGE**

This section provides work environment and conditions to which the performance criteria apply. It allows for different work environment and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. ***PPE*** includes but not limited to: | * + Helmet   + Hand gloves   + Safety shoes   + Harness   + Safety goggles |
| 1. ***Product quality monitoring equipment*** includes but not limited to: | * Dimensional measurement systems * Automated cameras * Vision sensors * Surface profilometers * Ultrasonic testing equipment |

**REQUIRED KNOWLEDGE AND SKILLS**

This section describes the knowledge and skills required for this unit of competency.

**Required knowledge**

The individual needs to apply knowledge of:

* Occupational Health and safety
* Hand tools maintenance
* Pressure testing and measuring tools
* Temperature testing and measuring tools
* Displacement measuring tools
* Process control systems
* Workshop practices
* Hydraulics
* Documentation and records keeping
* Pneumatic valves nomenclature
* Interpreting technical documentation
* Sensors and transducers
* Instrumentation systems

The individual needs to apply the following skills:

* Use of hand tools
* Problem solving
* Technical reporting
* Communication skills
* Digital skills
* Time management
* Decision making
* Critical thinking

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required knowledge, skills and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency | Assessment requires evidence that the candidate:   * 1. Donned PPE as per work requirement   2. Carried out product visual inspection as per work place procedures   3. Used product quality monitoring equipment as per workplace procedures   4. Rejected nonconforming products as per workplace procedures   5. Eliminated industrial automation and robotics machine setting deviations as per work requirement   6. Recorded industrial automation and robotics conforming products as per workplace procedures   7. Recorded industrial automation and robotics machine setting deviations as per workplace procedures   8. Eliminated industrial automation and robotics machine setting deviations as per work requirement   9. Recorded industrial automation and robotics conforming products as per workplace procedures   10. Recorded industrial automation and robotics machine setting deviations as per workplace procedures |
| 1. Resource Implications | The following resources should be provided:   * 1. Access to relevant workplace or appropriately simulated environment where assessment can take place   2. Resources appropriate for performance of assessment tasks |
| 1. Methods of Assessment | Competency in this unit may be assessed through:   1. Project 2. Practical 3. Oral questioning 4. Third party report 5. Portfolio of evidence 6. Written tests |
| 1. Context of Assessment | This competency may be assessed in a workplace or in a simulated workplace. |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## MAINTAIN INDUSTRIAL AUTOMATION AND ROBOTIC SYSTEMS

**UNIT CODE:** 0714 351 07A

**UNIT DESCRIPTION**

This unit covers the competencies required by an operator to carry out maintenance of industrial automation and robotic systems. These competencies include; applying workshop safety, performing housekeeping, carrying out industrial automation and robotic system autonomous maintenance, carrying out industrial automation and robotic system troubleshooting and replacing industrial automation and robotic system parts.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**  These describe the key outcomes which make up workplace function | **PERFORMANCE CRITERIA**  These are assessable statements which specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in the Range*** |
| 1. Apply workshop safety | 1. Safe work environment is maintained as per workplace requirements 2. ***Workplace hazards*** and risks are controlled as per workplace requirements 3. ***Workplace accidents*** and incidents are managed as per workplace requirements |
| 1. Perform house keeping | * 1. Safety procedures and practices are observed as per workplace requirements   2. Housekeeping equipment and materials are selected as per the task to be performed   3. Waste sorting and disposal is carried out as per workplace procedure   4. Housekeeping equipment and materials are selected as per the task to be performed   5. Waste sorting and disposal is carried out as per workplace procedure |
| 1. Carry out industrial automation and robotic system autonomous maintenance | * 1. Industrial automation and robotic system autonomous maintenance tasks are identified as per equipment   2. Industrial automation and robotic system autonomous maintenance tools and equipment are assembled as per work requirement.   3. PPE are donned as per work requirement   4. Industrial automation and robotic system autonomous maintenance tasks are carried as per system equipment manuals   5. Industrial automation and robotic system autonomous maintenance checklists are filled as per workplace procedures |
| 1. Carry out industrial automation and robotic system troubleshooting | * 1. PPE are donned as per work requirement   2. Industrial automation and robotic system alerts are identified as per operational manual   3. Industrial automation and robotic system alerts are cleared as per operational manual   4. Industrial automation and robotic system persistent alerts are reported as per workplace procedures |
| 1. Replace industrial automation and robotic system parts | * 1. PPE are donned as per work requirement   2. Consumable industrial automation and robotic system parts are identified as per equipment operational manual   3. Tools, equipment and system parts are assembled as per work requirement   4. Industrial automation and robotic system consumable parts are serviced as per work requirement   5. Industrial automation and robotic system services are recorded as per workplace procedures   6. Industrial automation and robotic system set up housekeeping is carried out as per work place procedures |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

| **Variable** | **Range** |
| --- | --- |
| Workplace hazards may include but not limited to: | * Physical * Biological * Chemical * Ergonomics * Safety |
| Workplace accidents may include but not limited to: | * Cuts and bleeds * Fracture * Fainting * Electric shock |
| Workshop Tools, equipment and materials may include but not limited to: | * Measuring tools * Marking out tools * Cutting tools * Fitting tools * Forging tools * Sheet metal tools * Machining tools |
| Housekeeping equipment and materials may include but not limited to: | * Brooms * Detergents * Waste clothes |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Problem solving
* Creativity
* Innovation
* Communication skills

**Required knowledge**

The individual needs to demonstrate knowledge of:

* Work place hazards
* Hazard measurement and control
* Work place accidents
* Accidents contingency measures
* Engineering materials
* Workshop tools, equipment and machines
* Material preservation methods
* Waste management
* Housekeeping procedures

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required knowledge, skills and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency | Assessment requires evidence that the candidate:   * 1. Maintained tools and equipment as per the workplace procedures   2. Applied preservation method as per work requirement   3. Carried out industrial automation and robotic system autonomous maintenance tasks as per system equipment manuals   4. Filled industrial automation and robotic system autonomous maintenance checklists as per workplace procedures   5. Cleared industrial automation and robotic system alerts as per operational manual   6. Reported persisted industrial automation and robotic system alerts as per workplace procedures   7. Serviced industrial automation and robotic system consumable parts as per work requirement   8. Recorded industrial automation and robotic system services as per workplace procedures   9. Carried out industrial automation and robotic system set up housekeeping as per work place procedures |
| 1. Resource Implications | The following resources should be provided:   * 1. Access to relevant workplace or appropriately simulated environment where assessment can take place   2. Resources appropriate for performance of assessment tasks |
| 1. Methods of Assessment | Competency in this unit may be assessed through:   1. Project 2. Practical 3. Oral questioning 4. Third party report 5. Portfolio of evidence 6. Written tests |
| 1. Context of Assessment | This competency may be assessed in a workplace or in a simulated workplace. |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

**INSTALL AND MAINTAIN INDUSTRIAL AUTOMATION ELECTRICAL SYSTEMS**

**UNIT CODE:** 0714 451 09A

**UNIT DESCRIPTION**

This unit covers the competencies required in installation of an industrial automation and robotics electrical systems according to the system design considerations. It involves conducting industrial automation electrical system site survey, planning industrial automation electrical system installation, installing industrial automation electrical system and maintaining industrial automation electrical system.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**  These describe the key outcomes which make up workplace function | **PERFORMANCE CRITERIA**  These are assessable statements, which specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in the Range*** |
| 1. Conduct industrial automation electrical system site survey | * 1. Industrial automation electrical system ***site survey*** ***aspects*** are identified as per work requirement   2. Electrical system ***site survey*** ***tools and equipment*** are assembled as per work requirement   3. Industrial automation electrical system site survey is carried out as per work requirement   4. Site survey report is generated as per workplace procedures |
| 1. Plan industrial automation electrical system installation | * 1. Industrial automation electrical system installation is designed as per work requirement   2. Industrial automation electrical system installation workplan is prepared as per work requirements   3. Industrial automation ***electrical system supplies*** are assembled as per work requirement |
| 1. Install industrial automation electrical system | * 1. ***PPE*** are donned as per work requirement   2. Industrial automation electrical system structured wiring is carried out as per installation layout   3. Industrial automation ***electrical system accessories*** and ***equipment*** are mounted as per installation layout   4. Industrial automation electrical system wires are terminated as per work requirement   5. Industrial automation ***electrical system tests*** arecarried out as per work requirement   6. Industrial automation electrical system installation housekeeping is caried out as per workplace procedures   7. ***Electrical site waste*** is disposed as per work requirement |
| 1. Maintain industrial automation electrical system | * 1. Industrial automation electrical system maintenance schedule is prepared as per workplace procedures   2. PPE are donned as per work requirement   3. Industrial automation electrical systems ***maintenance*** ***tools, equipment*** and ***spares*** are assembled as per work requirement   4. Industrial automation electrical systems ***maintenance tasks*** are carried out as per work requirement   5. Maintenance reports are prepared as per workplace procedures |

**RANGE**

This section provides work environment and conditions to which the performance criteria apply. It allows for different work environment and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. ***Site survey*** ***aspects*** include but not limited to: | * + Phase requirement analysis   + Voltage requirements   + Power factor needs   + Electrical protection requirements   + Environmental considerations   + Cable routes   + Backup power and redundancy   + Instrumentation systems   + Compatibility with existing systems   + Scalability   + Cost |
| 1. ***Site survey*** ***tools and equipment*** include but not limited to: | * + Tools * Tape measure * Laser meter * Camera * Multimeter * Stationery * Infrared thermometer * Cable tracer * Ladder * Flashlight   + Equipment * Power analyzer * Megohmmeter |
| 1. ***Electrical system supplies*** include but not limited to: | * + Cables   + Protection devices and switchgear   + Distribution board   + Lighting fixtures   + Enclosures   + Earthing rods, clamps   + Electrical tools and equipment   + Connectors and terminals   + Conduits   + Raceways   + Fasteners |
| 1. ***PPE*** includes but not limited to: | * + Helmet   + Hand gloves   + Safety shoes   + Harness   + Safety goggles |
| 1. ***Electrical system accessories*** include but not limited to: | * + Terminal blocks   + Switches   + Sockets   + Push buttons   + Safety interlocks   + Relays |
| 1. ***Electrical system equipment*** includes but not limited to: | * Motors * Drives * Generators * Switchgear * Distribution panel * Control panels |
| 1. ***Electrical system tests*** include but not limited to: | * Functionality test * Continuity * Insulation resistance * Phase sequence * Polarity * Earth loop test |
| 1. ***Electrical site waste*** includes but not limited to: | * Packaging material * Stripped cable insulation * Faulty components and equipment |
| 1. ***maintenance tools, equipment*** and ***spares*** include but not limited to: | * Tools * Multimeters * Clamp meters * Power analyzers * Thermal imaging cameras * Hand tools * Equipment * Cable pulling equipment * Lubricating equipment * Vacuum pump * Megohmmeter * Spares * Circuit breakers * Motors * Controllers * Switches * Lighting fixtures |
| 1. ***maintenance tasks*** include but not limited to: | * Inspection * Testing and measurements * Cleaning * Lubrication * Tightening * Replacing consumables |

**REQUIRED KNOWLEDGE AND SKILLS**

This section describes the knowledge and skills required for this unit of competency.

**Required knowledge**

The individual needs to apply knowledge of:

* Occupational Health and safety
* Electrical wiring systems
* IEEE regulations
* Electrical Testing and measuring tools
* Electrical workshop practices
* Documentation and records keeping
* Electrical power backup systems
* Interpreting technical documentation

**Required Skills**

The individual needs to apply the following skills:

* Structured industrial wiring
* Electrical Troubleshooting
* Problem solving
* Technical reporting
* Communication skills
* Digital skills
* Time management
* Decision making
* Critical thinking
* Adaptability

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required knowledge, skills and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency | Assessment requires evidence that the candidate:   * 1. Carried out industrial automation electrical system site survey as per work requirement   2. Generated site survey report as per workplace procedures   3. Designed industrial automation electrical system as per work requirement   4. Assembled industrial automation electrical system supplies as per work requirement   5. Donned PPE as per work requirement   6. Carried out industrial automation electrical system structured wiring as per installation layout   7. Mounted industrial automation electrical system accessories and equipment as per installation layout   8. Terminated industrial automation electrical system wires as per work requirement   9. Tested industrial automation electrical system as per work requirement   10. Carried out Industrial automation electrical systems maintenance tasks as per work requirement |
| 1. Resource Implications | The following resources should be provided:   * 1. Access to relevant workplace or appropriately simulated environment where assessment can take place   2. Resources appropriate for performance of assessment tasks |
| 1. Methods of Assessment | Competency in this unit may be assessed through:   1. Project 2. Practical 3. Third party report 4. Portfolio of evidence 5. Written tests 6. Oral questioning |
| 1. Context of Assessment | This competency may be assessed in a workplace or in a simulated workplace. |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## INSTALL AND MAINTAIN STAND-ALONE CONTROLLED SYSTEMS

**UNIT CODE: 0714 451 10A**

**UNIT DESCRIPTION**

This unit covers the competencies required in installation and maintenance of stand-alone control system. These competencies include; conducting stand-alone system control site survey, planning stand-alone control system installation, installing stand-alone control system and maintaining stand-alone control system.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**  These describe the key outcomes which make up workplace function | **PERFORMANCE CRITERIA**  These are assessable statements which specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in the Range*** |
| 1. Conduct stand-alone control system site survey | * 1. Stand-alone control system ***site survey aspects*** are identified as per work requirement   2. Stand-alone control system ***site survey tools and equipment*** are assembled as per work requirement   3. Stand-alone control system site survey is carried out as per work requirements   4. Stand-alone control system site survey report is generated as per workplace procedures |
| 1. Plan stand-alone control system installation | * 1. Stand-alone control system installation is designed as per installation layout   2. Stand-alone control system installation workplan is prepared as per work requirements   3. ***Stand-alone control system*** ***supplies*** are assembled as per work requirement |
| 1. Install stand-alone control systems | * 1. ***PPE*** are donned as per work requirement   2. Stand-alone control systems ***structured wiring*** is done as per installation layout   3. ***Stand-alone control system accessories*** and ***equipment*** are mounted as per installation layout   4. Stand-alone control system wires are terminated as per work requirement   5. ***Stand-alone control system tests*** arecarried out as per work requirements   6. Stand-alone controlled processes are calibrated as per work requirement   7. Stand-alone control system installation site housekeeping is caried out as per workplace procedures   8. Stand-alone control system installation ***site waste*** is disposed as per work requirement |
| 1. Maintain stand-alone control systems | * 1. Stand-alone control system maintenance schedule is prepared as per workplace procedures   2. PPE are donned as per work requirement   3. Stand-alone control system ***maintenance tools, equipment*** and ***spares*** are assembled as per work requirement   4. Stand-alone control system ***maintenance tasks*** are carried out as per work requirement   5. Stand-alone control system maintenance reports are prepared as per workplace procedures |

**RANGE**

This section provides work environment and conditions to which the performance criteria apply. It allows for different work environment and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. ***site survey aspects*** include but not limited to: | * + Power requirements   + User requirements   + Environmental considerations   + Cable routes   + Instrumentation systems   + Compatibility with existing systems   + Scalability   + Cost |
| 1. ***site survey tools and equipment*** include but not limited to: | * + Tools * Tape measure * Laser meter * Camera * Multimeter * Stationery * Infrared thermometer * Cable tracer * Ladder * Flashlight   + Equipment * Power analyzer * Megohmmeter * Personal computer |
| 1. ***Stand-alone control supplies*** include but not limited to: | * + Cables   + Protection devices and switchgear   + Distribution board   + Lighting fixtures   + Enclosures   + Earthing rods, clamps   + Installation Tools and equipment   + Connectors and terminals   + Conduits   + Raceways * Fasteners |
| 1. ***PPE*** includes but not limited to: | * + Helmet   + Hand gloves   + Safety shoes   + Harness   + Safety goggles |
| 1. ***structured wiring*** includes but not limited to: | * Cable routing * Cable laying * Cable labelling |
| 1. ***Stand-alone control system accessories*** include but not limited to: | * + Terminal blocks   + Switches   + Sockets   + Push buttons   + Safety interlocks * Relays * Contactors * Sensors |
| 1. ***Stand-alone control equipment*** includes but not limited to: | * Motors * Drives * Generators * Enclosures * Switchgear * Distribution panel * Control panels |
| 1. ***Stand-alone control system tests*** include but not limited to: | * Functionality test * Electrical Continuity * Insulation resistance * Phase sequence * Polarity * Earth loop test |
| 1. ***Site waste*** includes but not limited to: | * Packaging material * Stripped cable insulation * Faulty components and equipment |
| 1. ***Maintenance tools, equipment*** and ***spares*** include but not limited to: | * Tools * Multimeters * Clamp meters * Power analyzers * Thermal imaging cameras * Hand tools * Equipment * Cable pulling equipment * Lubricating equipment * Vacuum pump * Megohmmeter * Spares * Circuit breakers * Motors * Controllers * Switches * Lighting fixtures * Indicator lights |
| 1. ***Maintenance tasks*** include but not limited to: | * Inspection * Testing and measurements * Cleaning * Lubrication * Tightening * Replacing components * Replacing consumables |

**REQUIRED KNOWLEDGE AND SKILLS**

This section describes the knowledge and skills required for this unit of competency.

**Required knowledge**

The individual needs to apply knowledge of:

* Occupational Health and safety
* Electrical wiring systems
* IEC, IEEE regulations
* Electrical Testing and measuring tools
* Electrical workshop practices
* Documentation and records keeping
* Electrical power backup systems
* Interpreting technical documentation
* PLC programming
* Sensors and transducers
* Instrumentation systems

**Required Skills**

The individual needs to apply the following skills:

* Structured industrial wiring
* Electrical Troubleshooting
* Problem solving
* Technical reporting
* Communication skills
* Digital skills
* Time management
* Decision making
* Critical thinking
* Housekeeping
* Adaptability

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required knowledge, skills and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency | Assessment requires evidence that the candidate:   * 1. Carried out stand-alone control system site survey as per work requirement   2. Generated stand-alone control system site survey report as per workplace procedures   3. Designed stand-alone control system as per work requirement   4. Assembled stand-alone control system supplies as per work requirement   5. Donned PPE as per work requirement   6. Did stand-alone control systems structured wiring as per installation layout   7. Mounted stand-alone control system accessories and equipment as per installation layout   8. Terminated stand-alone control system wires as per work requirement   9. Carried out stand-alone control system tests as per work requirements   10. Calibrated stand-alone controlled processes as per work requirement   11. Carried out stand-alone control system maintenance tasks are as per work requirement |
| 1. Resource Implications | The following resources should be provided:   * 1. Access to relevant workplace or appropriately simulated environment where assessment can take place   2. Resources appropriate for performance of assessment tasks |
| 1. Methods of Assessment | Competency in this unit may be assessed through:   1. Project 2. Practical 3. Third party report 4. Portfolio of evidence 5. Written tests 6. Oral questioning |
| 1. Context of Assessment | This competency may be assessed in a workplace or in a simulated workplace. |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

**INSTALL** **AND MAINTAIN PNEUMATIC SYSTEMS**

**UNIT CODE: 0714 451 11A**

**UNIT DESCRIPTION**

This unit covers the competencies required in installation and maintenance of pneumatic systems, . These competencies include; applying knowledge of perfect gases, operating air compressors, conducting pneumatic system site survey, planning pneumatic system installation and installing pneumatic system and maintaining pneumatic systems.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**  These describe the key outcomes which make up workplace function | **PERFORMANCE CRITERIA**  These are assessable statements, which specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in the Range*** |
| 1. Apply knowledge of perfect gases | * 1. ***Laws of Perfect Gases*** are applied as per the task requirements   2. General Gas Equation is derived as per the task requirements   3. Characteristic Equation of Gas is applied as per the task requirements   4. Universal Gas Constant or Molar Constant is determined as per the task requirements   5. Specific ***Heat*** is determinedas per the task requirements |
| 1. Operate air compressors | * 1. Air Compressors are classified as per the task requirements   2. Working of Single Stage Reciprocating Air Compressor is determined as per the task requirements   3. Work-done by a Single Stage Reciprocating Air Compressor without Clearance Volume is determined as per the task requirements   4. Power Required to Drive a Single Stage Reciprocating Air Compressor is determined as per the task requirements   5. Work-done by Reciprocating Air Compressor with Clearance Volume is determined as per the task requirements   6. Multistage Compression is determined as per the task requirements   7. Power Required to Drive a Two-stage Reciprocating Air Compressor is determined as per the task requirements   8. Minimum Work Required for a Two-stage Reciprocating Air Compressor is determined as per the task requirements. |
| 1. Conduct pneumatic system site survey | 1. Pneumatic system site survey aspects are identified as per work requirement 2. Pneumatic system site survey tools and equipment are assembled as per work requirement 3. Pneumatic system site survey is carried out as per work requirement 4. Pneumatic system site survey report is generated as per workplace procedures |
| 1. Plan pneumatic system installation | * 1. Pneumatic system is designed as per work requirement   2. Pneumatic system installation workplan is prepared as per work requirements   3. ***Pneumatic system supplies*** are assembled as per work requirement |
| 1. Install pneumatic system | * 1. ***PPE*** are donned as per work requirement   2. Pneumatic system piping is done as per installation layout   3. ***Pneumatic system accessories*** and ***equipment*** are mounted as per installation layout   4. Pneumatic system fittings are connected as per work requirement   5. ***Pneumatic system tests*** arecarried out as per work requirements   6. Pneumatic controlled process is calibrated as per work requirement   7. Pneumatic system installation site housekeeping is caried out as per workplace procedures   8. Pneumatic system installation ***site waste*** is disposed as per work requirement |
| 1. Maintain pneumatic system | * 1. Pneumatic system maintenance schedule is prepared as per workplace procedures   2. PPE are donned as per work requirement   3. Pneumatic system ***maintenance tools, equipment*** and ***spares*** are assembled as per work requirement   4. ***Pneumatic system*** ***maintenance tasks*** are carried out as per work requirement   5. Pneumatic system maintenance reports are prepared as per workplace procedures |

**RANGE**

This section provides work environment and conditions to which the performance criteria apply. It allows for different work environment and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. Laws of Perfect Gases may include but not limited to: | * Boyle's Law * Charles' Law * Gay-Lussac Law * Joule's Law * Avogadro's Law |
| 1. Air compressor may include but not limited to | * Rotary compressors * Reciprocating compressors * Axial compressors   Centrifugal compressors |
| 1. ***Pneumatic system*** ***site survey aspects*** include but not limited to: | * + User requirements   + System requirements   + Space and layout   + Environmental considerations   + Power sources   + Safety regulations and standards   + Air quality   + Instrumentation systems   + Compatibility with existing systems   + Scalability   + Reliability   + Cost |
| 1. ***Pneumatic system*** ***site survey tools and equipment*** include but not limited to: | * + Tools * Tape measure * Laser distance meter * Camera * Flow meters * Pressure gauges * Stationery * Infrared thermometer * Ladder * Flashlight * Leakage testers * Hand tools   + Equipment * Air analyzers * Ladder |
| 1. ***Pneumatic system supplies*** include but not limited to: | * + Pressure gauges   + Vacuum gauges   + Pressure regulators   + Pipes and tubes   + Connectors   + Air compressors   + Valves   + Enclosures   + Fittings   + Safety valves   + Installation Tools and equipment |
| 1. ***PPE*** includes but not limited to: | * + Helmet   + Hand gloves   + Safety shoes   + Harness   + Safety goggles |
| 1. ***Pneumatic system piping*** includes but not limited to: | * + Tubing   + fittings   + Valves and manifolds   + Filters   + Regulators   + Pressure relief devices   + Supports and brackets |
| 1. ***Pneumatic system accessories*** include but not limited to: | * + Couplers   + Check valves   + Flow meters   + Pressure gauges   + Installation valves |
| 1. ***Pneumatic system equipment*** includes but not limited to: | * Pneumatic valves * Pneumatic cylinders * Compressors * Pneumatic pumps * Positioners |
| 1. ***Pneumatic system tests*** include but not limited to: | * Functionality test * Leakage test * Pressure test * Air quality test * Flow rate test |
| 1. ***Site waste*** includes but not limited to: | * Packaging material * Faulty components and equipment |
| 1. ***Maintenance tools, equipment*** and ***spares*** include but not limited to: | * Tools * Hand tools * Pressure gauge * Equipment * Lifting gear * Air flow meter * Air quality analyzer * Spares * Air filters * Air dryers * Pressure gauges * Seals * Actuators * Air Tubings |
| 1. ***Pneumatic system maintenance tasks*** include but not limited to: | * Inspection * Testing and measurements * Air quality check * Pressure check * Cleaning * Tightening * Replacing components * Replacing consumables |

**REQUIRED KNOWLEDGE AND SKILLS**

This section describes the knowledge and skills required for this unit of competency.

**Required knowledge**

The individual needs to apply knowledge of:

* Occupational Health and safety
* Principles of compressed air
* Pressure Testing and measuring tools
* Workshop practices
* Air compressors
* Documentation and records keeping
* Pneumatic valves nomenclature
* Interpreting technical documentation
* Sensors and transducers
* Instrumentation systems
* Programmable logic controllers

**Required Skills**

The individual needs to apply the following skills:

* Pneumatic piping
* Problem solving
* Technical reporting
* Communication skills
* Digital skills
* Time management
* Decision making
* Critical thinking

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required knowledge, skills and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency | Assessment requires evidence that the candidate:   * 1. Applied air compressor as per work requirements   2. Carried out pneumatic system site survey is carried out as per work requirement   3. Generated pneumatic system site survey report as per workplace procedures   4. Designed pneumatic system as per work requirement   5. Assembled pneumatic system supplies as per work requirement   6. Donned PPE per work requirement   7. Did pneumatic system piping as per installation layout   8. Mounted pneumatic system accessories and equipment as per installation layout   9. Connected pneumatic system fittings as per work requirement   10. Carried out pneumatic system tests as per work requirements   11. Calibrated pneumatic controlled process as per work requirement   12. Carried out pneumatic system maintenance tasks as per work requirement |
| 1. Resource Implications | The following resources should be provided:   * 1. Access to relevant workplace or appropriately simulated environment where assessment can take place   2. Resources appropriate for performance of assessment tasks |
| 1. Methods of Assessment | Competency in this unit may be assessed through:   1. Project 2. Practical 3. Third party report 4. Portfolio of evidence 5. Written tests 6. Oral questioning |
| 1. Context of Assessment | This competency may be assessed in a workplace or in a simulated workplace. |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## INSTALL AND MAINTAIN HYDRAULIC SYSTEMS

**UNIT CODE: 0714 451 12A**

**UNIT DESCRIPTION**

This unit covers the competencies required in installation and maintenance of hydraulic systems according to the design considerations and installation standards. These competencies include; conducting hydraulic system site survey, planning hydraulic system installation, installing hydraulic system and maintaining hydraulic systems.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**  These describe the key outcomes which make up workplace function | **PERFORMANCE CRITERIA**  These are assessable statements, which specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in the Range*** |
| 1. Apply heat transfer and heat exchangers in fluid | 1. ***Heat transfer media*** is selected as per work requirements. 2. *Heat exchangers* are applied as per task requirement 3. Heat transfer is regulated as per task requirement |
| 1. Apply knowledge of flow of fluids | 1. **Losses of energy in pipes** are determine as per the task requirements 2. **The hydraulic gradient and total energy lines of the flowing fluids are determined as per the task requirements** 3. **Power Transmission of the flowing fluid Through Pipes are determine** as per the task’s requirements |
| 1. Apply knowledge of viscous flow of fluids | 1. ***Flow of Viscous Fluid*** are determined as per task requirements 2. ***Kinetic energy correction and momentum are determined as per task requirements*** 3. ***Power* absorbed in viscous flow** is determined as per the task requirements |
| 1. Operate fluid pumps | 1. The parts of ***Fluid pumps*** are identified as per task requirement 2. Worked done and power by the Fluid pumps are determined as per task requirement 3. Specific speed of the centrifugal pump is determined as per the task requirements 4. Variation of Velocity and Acceleration in the Suction and Delivery Pipes Due to Acceleration of the Piston in reciprocating pump is determined as per the task requirements |
| 1. Conduct hydraulic system site survey | 1. ***Hydraulic system site survey*** ***aspects*** are identified as per work requirement 2. ***Hydraulic system site survey tools and equipment*** are assembled as per work requirement 3. Hydraulic system site survey is carried out as per work requirement 4. Hydraulic system site survey report is generated as per workplace procedures |
| 1. Plan hydraulic system installation | 1. Hydraulic system installation is designed as per work requirement. 2. Hydraulic system installation workplan is prepared as per work requirements 3. ***Hydraulic system supplies*** are assembled as per work requirement |
| 1. Install hydraulic system | * 1. ***PPE*** are donned as per work requirement   2. ***Hydraulic system piping is done as per installation layout***   3. ***Hydraulic system accessories and equipment are mounted as per installation layout***   4. ***Hydraulic system fittings are connected as per work requirement***   5. ***Hydraulic system tests are carried out as per work requirements***   6. ***Hydraulic controlled process is calibrated as per work requirement***   7. ***Hydraulic system installation site housekeeping is caried out as per workplace procedures***   8. ***Hydraulic system installation site waste is disposed as per work*** requirement |
| 1. Maintain hydraulic system | * 1. Hydraulic system maintenance schedule is prepared as per workplace procedures   2. PPE are donned as per work requirement   3. Hydraulic system maintenance tools, equipment and spares are assembled as per work requirement   4. Hydraulic system maintenance tasks are carried out as per work requirement   5. Hydraulic system maintenance reports are prepared as per workplace procedures |

**RANGE**

This section provides work environment and conditions to which the performance criteria apply. It allows for different work environment and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. Heat transfer media may include but not limited to | * Composite wall * Slab * Thick Cylinder * Thick Sphere |
| 1. Heat exchangers may include but not limited to | * Double pipe heat exchanger * Shell and tube heat exchanger * Plate heat exchanger * Condenser and boiler heat exchanger |
| 1. Fluid pump may include but not limited to: | * Reciprocating pump * Centrifugal pump |
| 1. Flow of Viscous Fluid may include but not limited to: | * Circular pipe * Between Two Parallel Plates |
| 1. Power absorbed in viscous flow may include but not limited to: | * Viscous Resistance of Journal Bearings * Viscous Resistance of Foot-step Bearing * Viscous Resistance of Collar Bearing * Loss of Head Due to Friction in Viscous Flow |
| 1. Hydraulic system site survey aspects include but not limited to: | * + User requirements   + System requirements   + Space and layout   + Environmental considerations   + Power sources   + Safety regulations and standards   + Instrumentation systems   + Status of existing systems   + Scalability   + Reliability   + Cost |
| 1. Hydraulic system site survey tools and equipment include but not limited to: | * + Tools * Tape measure * Laser distance meter * Camera * Flow meters * Pressure gauges * Stationery * Thermometer * Ladder * Flashlight * Leakage testers * Hand tools   + Equipment * Leakage testers * Hydraulic fluid analysis kit * Hydraulic pressure testing kit * Ladder |
| 1. Hydraulic system Supplies include but not limited to: | * + Pressure gauges   + Vacuum gauges   + Pressure regulators   + Pipes   + Connectors   + Air compressors   + Hydraulic Valves   + Enclosures   + Hydraulic cylinders and pumps   + Fluid reservoirs   + Hydraulic fluid   + Sealing and fasteners   + Mounting hardware   + Installation Tools and equipment   + Electrical supplies   + Safety equipment |
| 1. PPE includes but not limited to: | * + Helmet   + Hand gloves   + Safety shoes   + Harness   + Safety goggles |
| 1. Hydraulic system piping includes but not limited to: | * + Hydraulic tubing   + Hydraulic hoses   + Hydraulic fittings   + Flanges   + Couplers   + Manifolds   + Filters   + Check valves   + Pressure relief valves   + Supports and brackets   + Flow control valves |
| 1. Hydraulic system accessories include but not limited to: | * + Breathers and filters   + Pressure gauges   + Temperature gauges   + Level gauges   + Sight glasses   + Pressure switches   + Coolers and heat exchangers   + Accumulators   + Valves |
| 1. Hydraulic system equipment includes but not limited to: | * Hydraulic Pumps * Hydraulic Cylinders * Hydraulic Motors * Hydraulic reservoirs * Hydraulic power units * Hydraulic control systems |
| 1. Hydraulic system tests include but not limited to: | * Functionality test * Leakage test * Pressure test * Temperature test * Flow rate test * Noise and vibration test |
| 1. site waste includes but not limited to: | * Packaging material * Faulty components and equipment |
| 1. maintenance tools, equipment and spares include but not limited to: | * Tools * Hand tools * Pressure gauge * Equipment * Lifting gear * Hydraulic press * Hydraulic flushing unit * Hydraulic test bench * Hydraulic hose crimping machine * Spares * Hydraulic hoses * Hydraulic fittings * Hydraulic fluid * Hydraulic filters * Hydraulic valves * Hydraulic cylinders * Hydraulic pump seals |
| 1. Hydraulic system maintenance tasks include but not limited to: | * Inspection * Testing and measurements * Fluid level check * Fluid condition check * Cleaning * Tightening * Lubrication * Pressure check * Replacing components * Replacing consumables |

**REQUIRED KNOWLEDGE AND SKILLS**

This section describes the knowledge and skills required for this unit of competency.

**Required knowledge**

The individual needs to apply knowledge of:

* Occupational Health and safety
* Fluid mechanics
* Pressure Testing and measuring tools
* Workshop practices
* Documentation and records keeping
* Hydraulic valves
* Interpreting technical documentation
* Instrumentation systems
* Programmable logic controllers

**Required Skills**

The individual needs to apply the following skills:

* Hydraulic piping
* Problem solving
* Technical reporting
* Communication skills
* Digital skills
* Time management
* Decision making
* Critical thinking

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required knowledge, skills and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency | Assessment requires evidence that the candidate:   * 1. Applied heat exchangers as per task requirement   2. Applied fluid pump as per work requirements   3. Carried out hydraulic system site survey as per work requirement   4. Generated hydraulic system site survey report as per workplace procedures   5. Designed hydraulic system as per work requirement   6. Assembled hydraulic system supplies are assembled as per work requirement   7. Donned PPE as per work requirement   8. Did hydraulic system piping as per installation layout   9. Mounted hydraulic system accessories and equipment as per installation layout   10. Connected hydraulic system fittings as per work requirement   11. Carried out hydraulic system tests as per work requirements   12. Calibrated hydraulic controlled process as per work requirement   13. Carried out hydraulic system maintenance tasks as per work requirement |
| 1. Resource Implications | The following resources should be provided:   * 1. Access to relevant workplace or appropriately simulated environment where assessment can take place   2. Resources appropriate for performance of assessment tasks |
| 1. Methods of Assessment | Competency in this unit may be assessed through:   1. Project 2. Practical 3. Third party report 4. Portfolio of evidence 5. Written tests 6. Oral questioning |
| 1. Context of Assessment | This competency may be assessed in a workplace or in a simulated workplace. |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

# 