

**THE REPUBLIC OF KENYA**

**NATIONAL OCCUPATIONAL STANDARDS**

**FOR**

**INDUSTRIAL MECHATRONICS TECHNICIAN**

**LEVEL 6**

**PROGRAMME CODE: 0715 554 A**

**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 Automotive Engineering 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.

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Principal Secretary,

State Department for Technical and Vocational Education and Training,

**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 engineering industry experts in conjunction with expert subject trainers and other related stakeholders have developed these Occupational Standards for Industrial Mechatronics Technician Level 6. These standards will be the basis for development of competency-based curriculum for Industrial Mechatronics Technician Level 6

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.

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Cabinet Secretary,

Ministry of Education, Science & Technology

**KEY TO UNIT CODE**



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**ACRONYMS**

AC Alternating Current

ANSYS Analysis System

BC Basic Competency

CAD Computer Aided Design

CNC Computer Numerical Control

CPU Central Processing Unit

CR Core Competency

DC Direct Current

HDMI High-Definition Multimedia Interface

I/O Input/ Output

ICT Information Communication Technology

IEEE Institute of Electrical and Electronics Engineers

IM Industrial Mechatronics

LAN Local Access Network

MATLAB Matrix Laboratory

MSDS Material Safety Data Sheets

NEMA National Environment Management Authority.

PID Proportional Integral Derivative

PLC Programmable Logic Controller

PPE Personal Protective Equipment

QHSE Quality Health, Safety and Environment Management

RTD Resistance Temperature Nature.

SCADA Supervisory Control and Data Acquisition

SSAC Sector Skill Advisory Committee

TVET Technical and Vocational Education and Training

USB Universal Serial Bus

**OVERVIEW**

Industrial Mechatronics Technician level 6 qualification consists of competencies that an individual must achieve which entails designing electromechanical systems, installing electromechanical systems, maintaining electromechanical systems, designing hydraulic and pneumatic systems, installing hydraulic and pneumatic systems, maintaining hydraulic and pneumatic systems, installing robotic systems, maintaining robotic systems, managing industrial resources, programming PLC systems, maintaining PLC systems, maintaining SCADA systems and operating fabrication machinery.

Its qualification includes the following: Basic, Common and Core competencies:

**SUMMARY OF UNITS OF COMPETENCY**

**BASIC UNITS OF COMPETENCY**

|  |  |
| --- | --- |
| **UNIT CODE** | **UNIT TITLE** |
| **BASIC UNITS OF COMPETENCE** | |
| 0611 541 01A | APPLY DIGITAL LITERACY |
| 0031 541 02A | APPLY COMMUNICATION SKILLS |
| 0417 541 03A | APPLY WORK ETHICS AND PRACTICES |
| 0413 541 04A | APPLY ENTREPRENEURIAL SKILLS |
| **COMMON UNITS OF COMPETENCE** | |
| 0541 541 05A | APPLY ENGINEERING MATHEMATICS |
| 0715 541 06A | APPLY THERMODYNAMICS AND FLUID MECHANICS |
| 0715 541 07A | APPLY ENGINEERING MECHANICS |
| 0713 541 08A | APPLY ELECTRICAL AND ELECTRONICS PRINCIPLES |
| 0732 551 09A | PERFORM COMPUTER AIDED DRAWING |
| **CORE UNITS OF COMPETENCY** | |
| 0715 551 10A | DESIGN ELECTROMECHANICAL SYSTEMS |
| 0715 551 11A | INSTALL AND MAINTAIN ELECTROMECHANICAL SYSTEM |
| 0715 551 12A | INSTALL AND MAINTAIN HYDRAULIC AND PNEUMATIC SYSTEMS |
| 0715 551 13A | INSTALL AND MAINTAIN STAND-ALONE CONTROLLERS |
| 0715 551 14A | INSTALL AND MAINTAIN PLC SYSTEM |
| 0715 551 15A | INSTALL AND MAINTAIN ROBOTIC SYSTEM |
| 0715 551 16A | INSTALL AND MAINTAIN SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) SYSTEMS |
| 0715 551 17A | INSTALL ELECTRICAL MACHINES AND MECHANICAL DRIVES |
| 0715 551 18A | OPERATE FABRICATION MACHINERY |

# BASIC UNITS OF COMPETENCY

## APPLY DIGITAL LITERACY

**UNIT CODE:** 0611 541 01A

**UNIT DESCRIPTION:**

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

**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. Operate computer devices | * 1. C***omputer device*** usage is determined as per workplace requirements.   2. ***Computer hardware*** is identified according to job requirements.   3. ***Computer software*** is identified according to workplace requirements.   4. Computer devices are turned on or off as per the correct workplace procedure.   5. ***Mouse techniques*** are applied in solving tasks as per workplace requirements.   6. Keyboardtechniques are applied in solving tasks as per workplace requirements.   7. Computer files and folders are created and managed as per workplace requirements.   8. ***Internet connection option***s are identified and applied in connecting computer devices to the Internet.   9. ***External devices*** are identified and connected to the computer devices as per the job requirement. |
| 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: | * Remotask * Data annotation.tech * Cloudworker * 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. Operated computer devices as per workplace policies and regulations.   2. Solved tasks using the office suite as per workplace policies and regulations.   3. Manage data and information as per workplace policies and regulations.   4. Performed online communication and collaboration as per workplace policies and regulations.   5. Applied cybersecurity skills in accordance with workplace policies and regulations.   6. Executed online tasks according to the job requirements.   7. Searched for job opportunity based on competencies.   8. Prepared job requirement documentations based on job opportunity.   9. 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 541 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 | * 1. Existing non-verbal communication techniques are identified and applied based on organization policy.   2. Non-verbal communication techniques are articulated to enhance inclusivity according to workplace requirements.   3. Non-verbal communication techniques are modeled to enhance inclusivity according to workplace requirements. |
| 1. Apply oral communication skills | * 1. Types of oral communication are identified and established as per organization policy.   2. Pathways of oral communication are identified and established as per organization policy.   3. Pathways of oral communication are reviewed according to organization procedures.   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 541 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 | 1. ***Teams*** are formed to enhance productivity based on organization’s objectives 2. ***Duties are assigned to teams under the organization policy.*** 3. ***Team activities are managed and coordinated as per set objectives.*** 4. ***Team performance is evaluated based on set targets as per workplace policy.*** 5. ***Conflicts are resolved between team members in line with organization policy.*** 6. ***Gender and diversity-related issues are identified and mainstreamed in accordance with workplace policy.*** 7. ***Healthy relationships are developed and maintained in line with the workplace.*** 8. ***Adaptability*** and flexibility are applied in dealing with team members as per workplace policies |
| 1. Maintain professional and personal development | * 1. ***Personal growth and development*** needs are identified and assessed in line with the requirements of the job.   2. ***Training and career opportunities*** are identified and utilized based on job requirements.   3. ***Resources*** for training are mobilized and allocated based on organizations and individual skills needs.   4. Licenses and certifications relevant to the job and career are obtained and renewed as per policy.   5. Recognitions are sought as proof of career advancement in line with professional requirements.   6. Work priorities and personal commitments are balanced and managed based on the requirements of the job and personal objectives.   7. Dynamism and on-the-job learning are embraced in line with the organization’s goals and objectives. |
| 1. Apply Problem solving skills | * 1. ***Creative, innovative*** and practical solutions are developed based on the problem   2. ***Independence and initiative*** in identifying and solving problems are demonstrated based on the requirements of the job***.***   3. ***Team problems*** are solved as per the workplace guidelines Problem-solving strategies are applied as per the workplace guidelines   4. ***Problems*** are analyzed and assumptions tested as per the context of data and circumstances |
| 1. Promote Customer Care | * 1. Customers' needs are identified based on their characteristics   2. Customer ***feedback*** is allowed and facilitated in line with organization policies.   3. Customer concerns and complaints are analyzed and resolved in line with the set organizational culture.   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 541 05A

**Unit Description**

This unit describes the competences required in order to apply engineering mathematics. It enables the learner to; apply algebra, apply trigonometry and hyperbolic functions, apply complex numbers, perform coordinates geometry, carry out binomial expansion, apply calculus, carry out mensuration, apply statistics, apply vector theorem and apply matrices.

**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 italicised terms are elaborated in the Range)*** |
| --- | --- |
| 1. Apply algebra | * 1. Indices calculations are performed as per laws of indices   2. Logarithms calculations are performed as per laws of logarithms   3. Simultaneous equations are performed as per job requirement   4. Quadratic equations are solved as per job requirement |
| 1. Apply trigonometry and hyperbolic functions | * 1. Calculations are performed as per trigonometric rules   2. Calculations are performed according to ***hyperbolic functions*** rules   3. Trigonometric identities are applied as per job requirement |
| 1. Apply complex numbers | * 1. Complex numbers are represented on Argand diagrams as per job requirement   2. ***Operations*** involving complex numbers are performed as per job requirement   3. De Moivre’s theorem is applied as per as per job requirement |
| 1. Perform coordinates geometry | * 1. Polar equations are solved as per job requirement   2. Polar equations graphs are drawn as per job requirement   3. Normal and tangents are determined as per job requirement |
| 1. Carry out binomial expansion | * 1. Binomial series is determined as per as per job requirement   2. Roots of numbers are determined as per job requirement   3. Errors of small changes are determined as per job requirement |
| 1. Apply calculus | 1. Derivatives of functions are determined as per job requirement 2. Differentiation is applied as per job requiremen 3. Integrals of functions are determined as per job requirement 4. Integration is applied as per job requirement |
| 1. Carry out mensuration | * 1. Perimeter and areas of regular figures are obtained as per job requirement   2. Volume and surface area of solids are obtained as per job requirement   3. Area of irregular figures is obtained as per job requirement |
| 1. Apply statistics and probability | * 1. ***Measures of central tendency*** are obtained as per job requirement   2. ***Measures of dispersion*** are obtainedas per job requirement   3. Laws of probability are applied as per job requirement   4. ***Probability distribution*** methods are applied as per job requirement   5. Sampling distribution methods are applied as per job requirement |
| 1. Apply vector theorem | * 1. Vectors and scalar quantities are defined as per job requirement   2. ***Operations*** on vectors are performed as per job requirement   3. Position vectors are determined as per as per job requirement   4. Resolution of vectors is performed as per job requirement   5. Vector and scalar products are obtained as per job requirement |
| 1. Apply matrices | * 1. Matrices operations are performed as per job requirement   2. Inverse of matrices are obtained as per job requirement   3. Simultaneous equations are solved using matrices as per job 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. Operations may include but not limited to: | * 1. Addition   2. Subtraction   3. Multiplication   4. Division |
| 1. Hyperbolic functions may include but not limited to: | * 1. Sinh x   2. Cosh x   3. Cosech x   4. Tanh x   5. Sech x |
| 1. Measures of central tendency may include but not limited to: | 1. Mean 2. Median 3. Mode |
| 1. Measures of dispersion may include but not limited to | * 1. Co-efficient of Range.   2. Co-efficient of Variation.   3. Co-efficient of Standard Deviation.   4. Co-efficient of Quartile Deviation.   5. Co-efficient of Mean Deviation |
| 1. Probability distributions may include but not limited to: | * 1. Binomial distribution   2. Poisson distribution   3. Normal distribution |

**REQUIRED KNOWLEDGE AND UNDERSTANDING**

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
* Applying statistics
* Drawing graphs
* Using different measuring tools

**Required Knowledge**

The individual needs to demonstrate knowledge and understanding of:

* Algebra
* Linear algebra
* Basic calculus
* Geometry
* 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
* Vector operations
* Matrix operations

**EVIDENCE GUIDE**

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

|  |  |
| --- | --- |
| 1. Critical aspects of competency | Assessment requires evidence that the candidate:   1. Applied algebra as per job requirement 2. Applied trigonometry and hyperbolic functions as per job requirement 3. Applied complex numbers as per job requirement 4. Applied coordinates geometry as per job requirement 5. Applied calculus as per job requirement 6. Carried out binomial expansion as per job requirement 7. Carried out mensuration as per job requirement 8. Applied statistics as per job requirement 9. Applied vector as per job requirement 10. Applied matrices as per job requirement |
| 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 carrying out the tasks required |
| 1. Methods of assessment | Competency may be assessed through:   * 1. Written tests   2. Third party report   3. Portfolio of evidence |
| 1. Context of assessment | Competency may be assessed:   * 1. At the workplace   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 THERMODYNAMICS AND FLUID MECHANICS

**UNIT CODE:** 0715 541 06A

**Unit Description**

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

**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 Thermodynamic Processes | 1. Apply knowledge of basic thermodynamics 2. The ***Laws of Thermodynamics*** to a Non-flow Process and Steady Flow Process are applied as per the task requirements 3. ***Thermodynamic Processes*** are applied as per the task requirements 4. ***Thermodynamics systems*** are applied as per task requirement 5. Applying heating and expansions of gases and Work done During a Non-flow Process as per the task requirements 6. General Laws for Expansion and Compression are applied as per the task requirements 7. Application of Steady Flow Energy Equation to Engineering Systems as per the task requirements |
| 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. Apply knowledge of steam cycle | 1. Thermodynamics ***steam cycles*** are applied as per task requirements 2. Steam systems are controlled and determined as per task requirement 3. Energy balance is carried out in steam cycles as per work requirements. 4. Thermodynamics ***steam turbines*** are applied as per task requirements |
| 1. Apply knowledge of fuel combustion | * 1. Elements and Compounds of fuel are determined as per the task requirement   2. Combustion Equations of Fuels is applied as per the task requirement   3. ***Conversion analysis*** of fuels is determined as per the task requirement   4. Mass of Carbon in Flue Gases and Mass of Flue Gases per kg of Fuel Burnt is determined as per the task requirement   5. Excess Air Supplied is determined as per the task requirement   6. Flue Gas Analysis by Ors at Apparatus is determined as per the task requirement |
| 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. 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. Apply knowledge of flow of fluids | 1. **Losses of energy in pipes** are determined 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. Apply dimensional and models analysis fluids | * 1. **Derived quantities** and dimensional homogeneity are determined as per task requirements   2. ***Methods of dimensional analysis*** are determined as per the task requirements   3. ***Model Analysis*** is applied as per the task requirements   4. ***Model Laws*** are applied 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 |

**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. Laws of Thermodynamicsmay include but not limited to: | * First law of thermodynamics * Second law of thermodynamics * Zeroth law of thermodynamics |
| 1. Thermodynamic Processes may include but not limited to: | * Non-flow Process. * Constant Volume Process * Constant Pressure Process * Hyperbolic Process. * Constant Temperature Process * Adiabatic Process * Polytropic Process. |
| 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. Specific Heat may include but not limited to: | * Constant Volume * Constant Pressure |
| 1. Steam cycles may include but not limited to: | * Rankine * Carnot * reheat * regenerative |
| 1. Steam turbines may include but not limited to: | * Impulse Turbines * Reaction turbines |
| 1. Conversion analysis may include but not limited to: | * Mass to volume * Volume to mass |
| 1. Thermodynamics systems may include but not limited to: | * Boundary and surrounding * Closed systems * Open systems * Isolated systems * Adiabatic system * Homogeneous systems * Heterogeneous systems |
| 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. Air compressor may include but not limited to | * Rotary compressors * Reciprocating compressors * Axial compressors * Centrifugal compressors |
| 1. Fluid pump may include but not limited to: | * Reciprocating pump * Centrifugal pump |
| 1. Model Analysismay include but not limited to: | * Similitude-Types of Similarities * Types of Forces Acting in Moving Fluid * Dimensionless Numbers * Reynold’s Number (Re) * Froude’s Number (Fe) * Euler’s Number (Eu) * Weber’s Number (We) * Mach’s Number (M) |
| 1. losses of energy in pipesmay include but not limited to: | * Loss of Energy (or head) Due to Friction * Loss of Head Due to Sudden Enlargement * Loss of Head Due to Sudden Contraction * Loss of Head at the Entrance of a Pipe * Loss of Head at the Exit of Pipe * Loss of Head Due to an Obstruction in a Pipe * Loss of Head Due to Bend in Pipe * Loss of Head in Various Pipe Fittings |
| 1. Flow of Viscous Fluidmay include but not limited to: | * Circular pipe * Between Two Parallel Plates |
| 1. Power absorbed in viscous flowmay 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. Model Lawsmay include but not limited to: | * Reynold’s Model Law * Froude Model Law * Euler’s Model Law * Weber Model Law * Mach Model Law * Model Testing of Partially Sub-merged Bodies |
| 1. Methods of dimensional analysis may include but not limited to: | * Rayleigh’s method * Buckingham’s pi-theorem. |
| 1. Derived quantities may include but not limited to: | * Fundamental * Geometric * Kinematic Quantities * Dynamic Quantities |

**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 and innovation
* Use of tools and equipment
* Communication skills

**Required knowledge**

The individual needs to demonstrate knowledge of:

* Thermodynamics cycles
* Thermodynamics systems
* Steady flow energy equations
* Laws of thermodynamics
* Perfect gas laws
* Compression and expansion of gases
* Power cycles
  + Rankine cycle
  + Regenerative cycle
  + Reheat cycle
  + Binary cycle
* Types of fuels
* Combustion equations
* Calorific values of fuels
* Combustion analysis
* Principles of heat transfer
* Heat transfer media
* Heat exchangers
* Types of compressors
* Types of fluid pumps
* Dimensional analysis

**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. Applied thermodynamics cycles and systems as per task requirement 2. Applied steady flow energy equations as per laws of thermodynamics. 3. Applied steam systems as per task requirement 4. Controlled fuel combustion as per task requirement 5. Applied heat exchangers as per task requiremen 6. Applied air compressor as per work requirements 7. Applied fluid pump as per work requirements 8. Controlled fluid flow discharge losses as per as per task requirement |
| 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 carrying out the tasks required |
| 1. Methods of assessment | Competency may be assessed through:   1. Practical 2. Written tests 3. Third party report 4. Portfolio of Evidence |
| 1. Context of assessment | Competency may be assessed:   * 1. At the workplace   2. In a simulated work environment |
| 1. Guidance information for assessment | * 1. Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## APPLY ENGINEERING MECHANICS

**UNIT CODE:** 0715 541 07A

**UNIT DESCRIPTION**

This unit of competency describes the competences required in order to apply engineering mechanics principles. This includes applying forces and moments, apply friction principles, apply kinematics of motion, apply mechanical work-energy theorem, apply kinetics of motion, apply law of machines, determine loading conditions, apply simple mechanisms, design belts, ropes and chain drives, design toothed gears and gear trains, design mechanical rotor dynamic machines, apply stress and strain concepts, apply simple bending theory and apply torsion theory in mechanical 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 forces and moments in a mechanical system | * 1. Beams and shafts are designed as per job requirement   2. Beams and shafts are selected as per job requirement   3. Rotating mechanical parts are designed as per job requirement |
| 1. Apply friction principles in mechanical systems | * 1. Lubrication of moving parts is done as per job requirement   2. Moving objects are designed as per job requirement   3. Coolants and cutting fluids are selected as per job requirement |
| 1. Apply kinematics of motion in mechanical systems | * 1. Moving objects are designed as per job requirement   2. Structural supports are designed as per job requirement   3. Structural supports are selected as per job requirement   4. Displacement-time graphs are generated as per job requirement |
| 1. Apply mechanical work-energy theorem | * 1. Mechanical work is determined as per job requirement   2. Energy requirements are obtained as per job requirement   3. Mechanical power is determined as per job requirement |
| 1. Apply kinetics of motion in mechanical systems | * 1. Moving objects are designed as per job requirement   2. Structural supports are selected as per job requirement   3. Kinematic linkages are selected as per job requirement |
| 1. Apply law of machines | * 1. ***Simple machines*** are designed as per job requirement   2. Simple machines are selected as per job requirement   3. Machine speeds are adjusted as per job requirement |
| 1. Determine loading conditions in mechanical systems | * 1. Structures are designed as per job requirement   2. Beams and shafts are selected as per job requirement   3. Machine components are designed as per job requirement |
| 1. Apply simple mechanisms | * 1. Mechanisms are designed as per job requirement   2. Mechanisms are selected as per job requirement   3. Linkages are designed as per job requirement |
| 1. Design belts, ropes and chain drives | * 1. Belt drives are designed as per job requirement   2. Rope drives are designed as per job requirement   3. Chain drives are designed as job requirement |
| 1. Design toothed gears and gear trains | * 1. ***Toothed gears*** are designed as per job requirement   2. Toothed gears are selected as per job requirement   3. Gears are serviced as per job requirement |
| 1. Design mechanical rotor dynamic machines | * 1. Pumps are designed as per job requirement   2. Pumps are selected as per job requirement   3. Rotary compressors are designed as per job requirement   4. Fans and vanes are designed as per job requirement |
| 1. Apply stress and strain concepts in mechanical systems | * 1. Common engineering materials are selected as job requirement   2. ***Engineering components*** are designed as job requirement   3. ***Engineering components*** are selected as per job requirement |
| 1. Apply simple bending theory in mechanical systems | * 1. Beams are designed as per job requirement   2. Beams are selected as per job requirement   3. Shafts are designed as per job requirement   4. Shafts are selected as per job requirement |
| 1. Apply torsion theory in mechanical systems | * 1. Torque of components is obtained as per job requirement   2. Shafts are designed as per job requirement   3. Shafts are designed as per job requirement   4. Angle of twist of components is obtained as per job 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**  ***May include but not limited to:*** |
| 1. Simple machines | * 1. Pulley   2. Wedge   3. Inclined plane   4. Pulley   5. Wheel and axle   6. Screw jack |
| 1. Toothed gears | * 1. Bevel gears   2. Spur gears   3. Worm gears   4. Spiral bevel gears   5. Helical gears |
| 1. Engineering components | * 1. Beams   2. Thin cylinders   3. Thin shells |

**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:

* Arithmetic skills
* Mechanical machine operation
* Critical thinking
* Analytical skills

**Required knowledge**

The individual needs to demonstrate knowledge of:

* General Physics
* Engineering Mathematics
* Measurements

**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. Designed beams and shafts as per job requirement   2. Designed moving objects as per job requirement   3. Generated displacement-time graphs as per job requirement   4. Determined mechanical power as per job requirement   5. Selected kinematic linkages as per job requirement   6. Designed simple machines as per job requirement   7. Selected beams and shafts as per job requirement   8. Designed belt drives as per laws of tension   9. Selected toothed gears as per job requirement   10. Designedengineering components as per job requirement   11. Designed shafts as per job requirement   12. Obtained torque of components as per job requirement |
| 2. 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 |
| 3. Methods of Assessment | Competency in this unit may be assessed through:   * 1. Project   2. Practical   3. Written tests   4. Portfolio of evidence |
| 1. 4. Context of Assessment | Competency may be assessed in a workplace or simulated workplace |
| 1. 5. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## APPLY ELECTRICAL AND ELECTRONICS PRINCIPLES

**UNIT CODE:** 0713 541 08A

**UNIT DESCRIPTION**

This unit describes the competences required in order to apply electrical and electronics principles. This includes applying safety requirements for electricity, apply basic electrical quantities and principles, apply D.C and A.C circuits in electrical installation, Apply magnetism and electromagnetism, perform single and three phase power supply, Apply sensors and transducers principles, Apply principles of analogue electronics, Apply principles of digital electronics and Design Electronic circuits.

**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 safety requirements for electricity | 1. Usage of personal protective equipment is demonstrated as per job requirement 2. ***Electrical hazards*** are controlled as per job requirement 3. Methods of ***electric hazard prevention*** are applied as per job requirement |
| * + - 1. Apply basic electrical quantities and principles | * 1. Basic ***SI unit***s in electrical are applied as per job requirement   2. Conductors and insulators are applied as per job requirement   3. ***Quantities*** of charge, force, work and power are applied as per job requirement   4. Calculations involving Ohm’s law are performed as per job requirement |
| * + - 1. Apply D.C and A.C circuits in electrical installation | * 1. Connections involving parallel and series circuits are performed as per job requirement   2. Measurement of voltages and current in AC and DC is carried out as per job requirement |
| * + - 1. Apply magnetism and electromagnetism | * 1. Magnetic and non-magnetic materials are identified as per job requirement   2. Concepts of magnetic fields and magnetic field distribution are applied as per job requirement   3. ***Laws of electromagnetic*** induction are applied as per job requirement   4. Concepts of electromagnetism are applied as per job requirement   5. Self and mutual induction is applied as per job requirement |
| * + - 1. Perform single and three phase power supply | * 1. Single and three phase concept is applied in as per job requirement   2. Connections of single and three phase power supply are performed as per job requirement   3. Measurement of single and three phase power is performed as per job requirement |
| * + - 1. Apply sensors and transducers principles | * 1. Types of ***sensors and transducer*** are identified as per job requirement   2. Sensors and transducers mode of action are determined as per job requirement   3. Sensors and transducers components are applied as per job requirement |
| * + - 1. Apply principles of analogue electronics | * 1. Analogue ***electronic components*** are identified according to design specifications   2. Analogue ***electronics passive circuit components*** are connected according to design specifications   3. Analogue ***electronics active circuit components*** are connected according to design specifications |
| * + - 1. Apply principles of digital electronics | * 1. Digital electronics ***number system*** is applied as per job requirement.   2. Digital electronics ***logic gates*** are identified as per design specification.   3. Digital electronics logic gates are applied as per design specification.   4. Digital electronics circuits are constructed as per job requirement |
| * + - 1. Design Electronic circuits | * 1. Electronic circuit schematic diagram is drawn as per design specification.   2. Electronic circuits components are identified as per design specification.   3. Electronic circuit schematic diagram is drawn as per design specification.   4. Electronic circuit schematic diagram is simulated as per design specification.   5. Electronic circuit components are soldered as per design specification   6. Electronic circuit is tested as per design specification |

**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. SI units include but not limited to: | * Power – Watts (W) * Current – Amperes (A) * Resistance – Ohms(Ω) * Voltage – Volts (V) |
| 1. Quantities includes but not limited to: | * Charge * Force * Work * Power |
| 1. Electric hazard includes but not limited to: | * Shocks * Explosions * Electrocution * Burns * Fires * Electric arc |
| 1. Electrical hazard protection includes but not limited to: | * Head protection * Insulating gloves * LOTTO * Eye protection |
| 1. Electronic components include but not limited to: | * Diodes * Capacitor * Resistors * Transistors * Fuse |
| 1. Laws of electromagnetic induction may include but not limited to: | * Coulomb’ law * Faraday’s laws * Amperes law * Lenz’ law |
| 1. Sensors and transducermay include but not limited to: | * Temperature * Level * Displacement and proximity * Viscosity * Moisture * Humidity * Pressure |
| 1. Passive circuit components may include but not limited to: | * Resistances * Capacitors * Coils (also called inductors) |
| 1. Active circuit components may include but not limited to: | * Diodes * Integrated Circuits * MOSFETs * JFETs * Optoelectronics * Oscillators * Transistors |
| 1. Number system may include but not limited to: | * Decimal * Hexadecimal * Octal * Binary |
| 1. Logic gates may include but not limited to: | * AND gate * OR gate * NOT gate * NAND gate * NOR gate * XOR gate * XNOR gate |

**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:

* Apply basic Electrical formulas
* Use of basic Electrical instruments
* Perform various unit conversions of Electrical quantities
* Power factor correction
* Logical thinking
* Problem solving
* Applying statistics
* Drawing graphs
* Using different measuring tools

**Required knowledge**

The individual needs to demonstrate knowledge of:

* Electrical power calculations
* Various laws in Electrical engineering
* Electrical formulas
* Power triangle
* SI units of various electrical parameters
* Lightening arrestor testing
* Selecting the correct type of electrical machines for various uses
* Types and purpose of measuring instruments
* Units of measurement and abbreviations

**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. Performed calculations involving Ohm’s law as per job requirement   2. Performed basic electrical and electronic measurements as per job requirement   3. Performed connections involving parallel and series circuits as per job requirement   4. Carried out measurement of voltages and current in AC and DC as per job requirement   5. Controlled ***electrical hazards*** as per job requirement   6. Applied electronic components in electrical circuits as per job requirement   7. Applied concepts of magnetism and electromagnetism as per job requirement   8. Applied single and three phase concept as per job requirement   9. Applied sensors and transducers components as per job requirement   10. Connected analogue electronics passive circuit components according to design specifications   11. Connected analogue electronics active circuit components according to design specifications   12. Connected analogue sensors according to design specifications   13. Applied digital electronics logic gates as per design specification.   14. Constructed digital electronic circuits as per job 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. Project   2. Practical   3. Written tests   4. Oral Questioning   5. Portfolio of evidence |
| 1. Context of Assessment | Competency may be assessed in a workplace or simulated workplace |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## PERFORM COMPUTER AIDED DRAWING

**UNIT CODE:** 0732 551 09A

**Unit Description**

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

**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. Navigate CAD software | 1. Computing equipment and software are identified according to task requirement 2. Drawing ***CAD software*** is applied as per work requirements 3. CAD Software templates are identified as per drawing requirement 4. ***CAD Files*** are imported into working space as per drawing requirements 5. Symbols, codes and standards to be applied are identified according to software functionality 6. ***Drawing elements*** are applied according to task requirement 7. ***Editing tools*** are applied according to task requirement |
| 1. Produce geometric drawings | * 1. ***Drawing lines*** are identified according to standard drawing conventions   2. ***Geometrical forms*** are constructed according to standard drawing conventions   3. ***Types of angles*** are constructed according to principles of trigonometry   4. ***Geometric drawings*** are developed in accordance with standard conventions |
| 1. Produce pictorial drawings | * 1. Drawing symbols and abbreviations are applied according to standard drawing conventions   2. ***Pictorial drawings*** are produced as per work requirements   3. Pictorial drawings are saved as per work requirements |
| 1. Produce orthographic drawings. | 1. First angle orthographic drawings are developed as per standard conventions of orthographic drawings 2. Third angle orthographic drawings are developed as per standard conventions of orthographic drawings 3. Orthographic drawings are saved as per work requirements |
| 1. Produce assembly drawings | 1. Orthographic views are exploded according to standard conventions of orthographic drawings 2. Pictorial views are exploded according to standard conventions of pictorial drawings 3. Orthographic and pictorial views are assembled as per drawing specifications 4. Sectional views are produced according to standard conventions of drawing 5. Parts list is developed according to drawing schematic |
| 1. Design mechanical components | 1. Mechanical components are designed as per work requirements 2. Computer aided engineering (CAE) is applied in simulation as per work requirements 3. Improvements to increase efficiency is determined according to design analysis results 4. Manufacturing database is created according to manufacturing process 5. Improvements on designed document is achieved according the manufacturing design |

**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. CAD software may include but not limited to: | * + AutoCAD   + Inventor   + SolidWorks |
| 1. CAD Files may include but not limited to | * DWG * STL * DXF * STEP |
| 1. Drawing elements may include but not limited to: | * Points * Line angles * Circles and arcs * Planes (horizontal, vertical) * Figures and solids * Shapes |
| 1. Editing tools may include but not limited to: | * Delete, undo and redo commands * Fillet and chamfer commands * Trim, extend and break commands * Zoom and pan commands * Move, copy, and paste commands * Rotate and mirror commands * Object snapping and grouping commands * Dimension and scaling commands |
| 1. types of lines may include but not limited to: | * Dimension lines * Hidden detail lines * Extension lines * Section lines * Break lines * Chain |
| 1. types of geometric forms may include but not limited to: | * Circle * Rectangle * Triangle * Polygon |
| 1. Types of angles may include but not limited to | * Acute * Obtuse * Right |
| 1. Geometrical drawings may include but not limited to | * 2-Dimensional * 3-Dimensional * Orthographic * Isometric |
| 1. Pictorial drawings may include but not limited to | * Isometric * Oblique * Cabinet * Cavalier |
| 1. Different types of geometric forms may include but not limited to: | * Circle * Rectangle * Triangle * Polygon |
| 1. Different types of angles may include but not limited to: | * Acute * Obtuse * Right |

**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:

* Critical thinking
* Numerical skills
* Image interpretation
* Drawing synthesis
* Communication
* Computer skills
* Software navigation (manipulates drawing entities, modify dimension styles, create and use layers, manipulate the drawing origin, define and utilize symbol libraries, etc.)

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Organizational policies and procedures relevant to creating CAD drawings
* Various CAD programs their capabilities, functions and processes
* Drawing outcomes (orthographic, isometric, perspective,2D, 3D)
* Drawing elements (points, line angles, circles, arcs, planes, solids and figures, dimensions and hatchings shapes, etc.)
* Solid modeling, developing sectioned models, etc.
* Geometric constructions
* Measurement and scaling
* Engineering calculations (clearance and tolerance)
* Engineering drawing symbols
* Awareness of copyright and intellectual property issues and legislation in relation to drawing

**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. Applied drawing CAD software as per work requirements. 2. ImportedCAD Filesinto working space as per drawing requirements. 3. Used editing tools to manipulate drawing according to customer specification 4. Developed geometric drawings according to standard drawing conventions 5. Produced pictorial drawings as per work requirements. 6. Saved Orthographic drawings as per work requirements Produced geometric drawings. 7. Assembled Orthographic and pictorial views as per drawing specifications. 8. Computer aided engineering (CAE) is applied in simulation as per work requirements. |
| 1. Resource Implications | The following resources should be provided:   1. Appropriately simulated environment where assessment can take place 2. Access to relevant work place 3. Resources relevant to the proposed activity or task. |
| 1. Methods of Assessment | Competency in this unit may be assessed through:   1. Practical assessments 2. Project 3. Third party report 4. Written examinations 5. Portfolio of Evidence |
| 1. Context of Assessment | Competency may be assessed in a work place or a simulated workplace |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended |

# CORE UNITS OF COMPETENCY

## DESIGN ELECTROMECHANICAL SYSTEMS

**UNIT CODE:** 0715 551 10A

**Unit Description**

This unit covers the competencies required by an industrial mechatronic technician to design electromechanical systems. It prepares the technician to perform need analysis, develop conceptual design, build electromechanical system prototype, and test electromechanical system prototype.

**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 italicised terms are elaborated in the Range)*** |
| --- | --- |
| 1. Perform electromechanical system need analysis | * 1. Electromechanical system problem is defined according to work requirement   2. ***Electromechanical System*** specifications are identified as per work requirement   3. Electromechanical Systems need analysis report is generated as per work requirement |
| 1. Develop Electromechanical Systems conceptual design | * 1. Electromechanical system design optimization is carried out as per work requirement   2. Electromechanical system design concepts are formulated according to work requirement   3. Electromechanical system design concepts are simulated as per work requirement   4. ***Electromechanical system design concepts feasibility test*** is carried out according to work requirement   5. Electromechanical System design concept is selected as per work description |
| 1. Build electromechanical system prototype | * 1. ***Health and safety procedures*** are applied as per Work requirement   2. ***Electromechanical system Prototype components*** ***specifications*** are determined as per design specifications   3. Electromechanical system prototype tools, equipment and materials are acquired as per design specifications   4. ***Electromechanical system prototype components*** are assembled as per design requirement   5. Electromechanical system Prototype circuitry is laid out as per design   6. ***Electromechanical control system*** is configured as per design requirement |
| 1. Test Electromechanical system prototype | * 1. Health and safety procedures are applied as per work requirement.   2. ***Electromechanical system prototype tests*** are carried out as per work requirement   3. Electromechanical system prototype troubleshooting is carried out according to work requirement.   4. Electromechanical system prototype is redesigned as per work requirement.   5. Electromechanical system prototype is optimized according to work requirement.   6. Electromechanical system design is documented as per work place 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** |
| --- | --- |
| Electromechanical system specifications may include but not limited to: | * Electromechanical design function * Electromechanical design output * Project name * Customer’s name * Project scope * Project objective |
| Health and safety procedures may include but not limited to: | * PPEs * Work permits * Waste management * Electrical wiring colour coding * Danger warning signage * Barricades * High voltage signage * Health policy |
| Electromechanical system Prototype components specifications may include but not limited to: | * Rated voltage and current * Rated power * Motor speed * Motor torque * Bearing type |
| Electromechanical system prototype tests may include but not limited to: | * Electrical * Mechanical * Functionality * Safety |
| Electromechanical system prototype components may include but not limited to: | * Circuit board * Variable frequency drive * Programmable logic controller * 2 bar linkage * 3 bar linkage * Bearings (ball bearing, rolling-element bearing etc.) * Electric motors (AC, DC, Stepper, Servo, Linear etc.) * Pulleys (fixed, block and tackle, movable etc.) * Chain drive * Clamp lever * Spring * Damper * Mechanical seal |
| Electromechanical control system may include but not limited to: | * Distributed control systems * SCADA * Stand alone controllers (PID, microprocessors, microcontrollers etc * Relay * PLC |
| Electromechanical system design concepts feasibility test may include but not limited to: | * Design ergonomics * Architecture * Design cost * Design context * Design Speed |

**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 skills
* Critical thinking skills
* Enthusiasm for learning
* Communication skills
* Organizational skills
* Numerical skills
* Creative thinking skills
* Work ethics
* Design skills
* Mechanical fabrication
* PCB fabrication

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Computer aided design (SOLIDWORKS, Inventor, fusion 360 etc)
* Engineering mechanics
* Electrical and electronic principles
* Health and Safety Standards
* Simulation software (ANSYS, MATLAB, FluidSim, etc)
* Flow diagrams
* SCADA
* PLC system
* PID control system
* Microcontrollers

**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. Defined electromechanical system problem according to work requirement   2. Identifiedelectromechanical system specifications as per work requirement   3. Formulated electromechanical system design concepts according to work requirement   4. Simulated electromechanical system design concepts are as per work requirement   5. Carried out electromechanical system design concepts feasibility test according to work requirement   6. Applied health and safety procedures as per work requirement   7. Determined electromechanical system prototype components specifications as per design specifications   8. Assembled electromechanical system prototype components as per design requirement   9. Laid out electromechanical system prototype circuitry as per design   10. Configured electromechanical control system as per design requirement |
| 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. Workplace or simulated workplace. |
| 1. Guidance information for assessment | * 1. Holistic assessment with other units relevant to the industry sector and workplace work role is recommended. |

## INSTALL AND MAINTAIN ELECTROMECHANICAL SYSTEM

**UNIT CODE:** 0715 551 11A

**Unit Description**

This unit describes the competencies required by an industrial mechatronic technician to prepare electromechanical system installation site, mount electromechanical system components, and maintain electromechanical 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 italicised terms are elaborated in the Range)*** |
| --- | --- |
| 1. Prepare electromechanical system installation site | * 1. ***Health and safety procedures*** are applied as per work requirement.   2. Electromechanical system installation site survey is conducted as per work requirement.   3. Electromechanical system installation schedule is developed as per the manufacturer’s requirement.   4. Electromechanical system installation area is set up as per the manufacturer’s requirement |
| 1. Mount electromechanical system components | * 1. Health and safety procedures are applied as per work requirement   2. ***Electromechanical system components*** are assembled according to manufacturer’s specifications.   3. ***Electromechanical control systems*** are configured as per manufacturer’s specifications.   4. ***Electromechanical system tests*** are carried out according to work requirement.   5. Electromechanical system installation report is prepared as per workplace procedures. |
| 1. Maintain electromechanical system | * 1. Health and safety procedures are applied as per work requirement   2. Electromechanical system maintenance schedule is developed as per work requirement.   3. Electromechanical system maintenance is carried out as per manufacturer’s requirement.   4. Electromechanical system is troubleshooted as per manufacturer’s requirement.   5. Electromechanical system maintenance report is generated 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** |
| --- | --- |
| Health and safety procedures may include but not limited to: | * PPEs * Work permits * Waste management * Electrical wiring colour coding * Danger warning signage * Barricades * High voltage signage * Health policy |
| Electromechanical system tests may include but not limited to: | * Electrical * Mechanical * Functionality * Safety |
| Electromechanical system components include but not limited to: | * Circuit board * Variable frequency drive * Programmable logic controller * 2 bar linkage * 3 bar linkage * Bearings (ball bearing, rolling-element bearing etc.) * Electric motors (AC, DC, Stepper, Servo, Linear etc.) * Pulleys (fixed, block and tackle, movable etc.) * Chain drive * Clamp lever * Spring * Damper * Mechanical seal |
| Electromechanical control systems may include but not limited to: | * Distributed control systems * SCADA * Stand-alone controllers (PID, microprocessors, microcontrollers etc * Relay * PLC |

**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 skills
* Critical thinking skills
* Communication skills
* Organizational skills
* Numerical skills
* Creative thinking skills
* Programming skills
* Mechanical fabrication
* PCB fabrication

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Computer aided design (SOLIDWORKS, Inventor, fusion 360 etc.)
* Health and Safety Standards
* Electrical circuit design
* Flow diagrams
* SCADA
* Stand-alone controllers
* Electrical and mechanical design
* PLC
* Sensors and transducers

**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. Applied health and safety procedures as per work requirement.   2. Conducted electromechanical system installation site survey as per work requirement.   3. Developed electromechanical system installation schedule as per the manufacturer’s requirement.   4. Assembled electromechanical system components according to manufacturer’s specifications.   5. Configured electromechanical control systems as per manufacturer’s specifications.   6. Carried out electromechanical system tests according to work requirement.   7. Prepared electromechanical system installation report as per workplace procedures.   8. Developed electromechanical system maintenance schedule as per work requirement.   9. Carried out electromechanical system maintenance as per manufacturer’s requirement.   10. Troubleshooted electromechanical system as per manufacturer’s requirement. |
| 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. Workplace or simulated workplace. |
| 1. Guidance information for assessment | * 1. Holistic assessment with other units relevant to the industry sector and workplace work role is recommended. |

## INSTALL AND MAINTAIN HYDRAULIC AND PNEUMATIC SYSTEMS

**UNIT CODE: 0715 551 12A**

**Unit Description**

This unit covers the competencies required by an industrial mechatronic technician to prepare hydraulic and pneumatic systems installation site, mount hydraulic and pneumatic system components, and maintain hydraulic and pneumatic 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 italicised terms are elaborated in the Range)*** |
| --- | --- |
| 1. Prepare hydraulic and pneumatic system installation site | * 1. ***Health and safety procedures*** are applied as per work requirement.   2. Hydraulic and pneumatic system installation site survey is conducted as per work requirement.   3. Hydraulic and pneumatic system installation schedule is developed as per the manufacturer’s requirement.   4. Hydraulic and pneumatic system installation area is set up as per the manufacturer’s requirement. |
| 1. Mount hydraulic and pneumatic system components | * 1. Health and safety procedures are applied as per work requirement.   2. ***Hydraulic and pneumatic components*** are assembled according to manufacturer’s specifications.   3. ***Hydraulic and pneumatic controllers*** are configured as per manufacturer’s specifications.   4. ***Hydraulic and pneumatic system tests*** are performed as per work requirement.   5. Hydraulic and pneumatic system installation report is prepared as per workplace procedures. |
| 1. Maintain hydraulic and pneumatic system | * 1. Health and safety procedures are applied as per work requirement   2. Hydraulic and pneumatic system maintenance schedule is developed as per work requirement.   3. Hydraulic and pneumatic system maintenance is carried out as per manufacturer’s requirement.   4. Hydraulic and pneumatic system is troubleshooted as per manufacturer’s requirement.   5. Hydraulic and pneumatic System maintenance report is generated 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** |
| --- | --- |
| Health and safety procedures may include but not limited to: | * PPEs * Work permits * Waste management * Electrical wiring colour coding * Danger warning signage * Barricades * High voltage signage * Health policy |
| Hydraulic and pneumatic components may include but not limited to: | * Reservoirs, tanks and accumulators * Pumps (centrifugal, submersible, diaphragm, gear, peristaltic, piston etc.) * Motors (AC, DC, linear, servo, stepper etc.) * Actuators * Pipes and hoses (fixed, flexible) * Valves (pressure relief, pressure reducing etc.) * Switches (mechanical, electronic etc.) * Gauges (limit, pressure etc.) * Filters (pressure, oil, air etc.) * Cylinders * DCV |
| Hydraulic and pneumatic controllers may include but not limited to: | * Distributed control systems * SCADA * Stand-alone controllers (PID, microprocessors, microcontrollers etc * Relay * PLC |
| Hydraulic and pneumatic system tests may include but not limited to: | * Electrical * Mechanical * Functionality * Safety |

**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 skills
* Critical thinking skills
* Communication skills
* Organizational skills
* Numerical skills
* Creative thinking skills
* Programming skills
* Mechanical fabrication
* PCB fabrication
* Work planning

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Computer aided design (SOLIDWORKS, Inventor, fusion 360 etc.)
* Health and Safety Standards
* Electrical circuit design
* Flow diagrams
* SCADA
* Stand-alone controllers
* Mechanical design
* PLC
* Hydraulic and pneumatic components, parts and accessories
* Interpretation of installation manuals – hydraulic and pneumatic
* Report writing
* Properties of materials
* Sensors and transducers
* Hydraulic & pneumatic system control
* Measurement and instrumentation devices and operation

**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. Applied health and safety procedures as per work requirement.   2. Conducted hydraulic and pneumatic system installation site survey as per work requirement.   3. Developed hydraulic and pneumatic system installation schedule as per the manufacturer’s requirement.   4. Assembled hydraulic and pneumatic components according to manufacturer’s specifications.   5. Configured hydraulic and pneumatic controllers as per manufacturer’s specifications.   6. Performed hydraulic and pneumatic system tests as per work requirement.   7. Developed hydraulic and pneumatic system maintenance schedule as per work requirement.   8. Carried out hydraulic and pneumatic system maintenance as per manufacturer’s requirement.   9. Troubleshooted hydraulic and pneumatic system as per manufacturer’s requirement. |
| 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. Workplace or simulated workplace. |
| 1. Guidance information for assessment | * 1. Holistic assessment with other units relevant to the industry sector and workplace work role is recommended. |

## INSTALL AND MAINTAIN STAND-ALONE CONTROLLERS

**UNIT CODE:** 0715 551 13A

**Unit Description**

This unit covers the competencies required by an industrial mechatronic technician to mount stand-alone controller hardware, interface stand-alone controller I/O modules, program stand-alone controller, and maintain stand-alone controller.

**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 italicised terms are elaborated in the Range)*** |
| --- | --- |
| 1. Mount Stand-alone controller hardware | * 1. ***Health and safety procedures*** are applied as per work requirement   2. ***Stand-alone controller*** installation toolsare selected as per work requirement   3. Stand-alone controller installation cabinet is prepared as per manufacturer’s specifications   4. Stand-alone controllersare fitted in the cabinet according to drawings   5. Stand-alone control system wiring is carried out as per IEEE regulations |
| 1. Interface Stand-alone controller I/O | * 1. Stand-alone controller I/Oare identified as per OEM manual.   2. Stand-alone controller I/O are mounted as per work requirement   3. Stand-alone controller I/O cables are selected as per work IEEE regulations.   4. Stand-alone controller I/O cables are laid out as per IEEE regulations   5. Stand-alone controller I/O cables are terminated as per IEEE regulations   6. Stand-alone controller I/O are tested as per work requirement. |
| 1. Program Stand-alone controller | * 1. ***Stand-alone programming software*** is installed as per manufacturer’s specifications   2. Stand-alone controller is programed as per work requirement   3. Stand-alone controller program is compiled according to programming software requirement   4. Stand-alone controller program is uploaded as per software specification   5. Stand-alone controller program is tested according to work requirement |
| 1. Maintain Stand-alone controller | * 1. Stand-alone controller performance is monitored as per work requirement.   2. Stand-alone controller program is backed-up as per software requirement.   3. Stand-alone controller is troubleshooted as per OEM manual   4. Stand-alone controller program is restored as per software requirement.   5. Stand-alone controller system is tagged as per manufacturer’s specifications.   6. Stand-alone controller modules are tested as per OEM manual.   7. Stand-alone controller system is cleaned according to OEM manual.   8. Stand-alone controller system maintenance is documented 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** |
| --- | --- |
| Health and safety procedures may include but not limited to: | * PPEs * Work permits * Waste management * Electrical wiring colour coding * Danger warning signage * Barricades * High voltage signage * Health policy |
| Stand-alone controller may include but not limited to: | * [Programmable Logic Controllers (PLCs)](https://www.electricaltechnology.org/2015/10/what-is-plc-programmable-logic-controller-industrial-control.html) * Supervisory Control and Data Acquisition (SCADA) * [Distributed Control System (DCS)](https://www.electricaltechnology.org/2016/08/distributed-control-system-dcs.html). * PIDs * Microcontroller * Digital signal processors * Motor controllers * Power inverters |
| Stand-alone programming software may include but not limited to; | * Arduino IDE * Raspberry Pi IDE * Gx works * Rs Logix * Step 7 * TIA Portal |

**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:

* Communication skills
* Problem solving skills
* Decision making skills
* Presentation skills
* Organizational skills
* Time management
* Data collection and analysis
* Use of tools and equipment
* Technical presentation
* Technical drawing
* Troubleshooting skills
* Programming

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Computer aided design (SOLIDWORKS, Inventor, fusion 360 etc.)
* Health and Safety Standards
* Electrical circuit design
* Flow diagrams
* SCADA
* Electrical and mechanical design
* PLC
* Microcontroller
* Digital signal processing
* Report writing

**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. Applied health and safety procedures as per work requirement   2. Selected stand-alone controller installation tools as per work requirement   3. Carried out stand-alone control system wiring as per IEEE regulations   4. Identified stand-alone controllers I/O as per OEM manual.   5. Mounted stand-alone controller I/O as per work requirement   6. Selected stand-alone controller I/O cables as per work IEEE regulations.   7. Tested stand-alone controller I/O interface as per work requirement.   8. Installed stand-alone programming software as per manufacturer’s specifications   9. Tested stand-alone controller program as per work requirement   10. Monitored stand-alone controller performance as per work requirement.   11. Troubleshooted stand-alone controller as per OEM manual   12. Documented stand-alone controller system maintenance as per work requirement. |
| 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. Workplace or simulated workplace. |
| 1. Guidance information for assessment | * 1. Holistic assessment with other units relevant to the industry sector and workplace work role is recommended. |

## INSTALL AND MAINTAIN PLC SYSTEM

**UNIT CODE:** 0715 551 14A

**Unit Description**

This unit covers the competencies required by an industrial mechatronic technician to mount PLC hardware, interface PLC I/O modules, program PLC, and maintain PLC 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 italicised terms are elaborated in the Range)*** |
| --- | --- |
| 1. Mount PLC hardware | * 1. ***Health and safety procedures*** are applied as per work requirement   2. Installationtoolsare selected as per work requirement.   3. Installation cabinet is prepared according to manufacturer’s specifications   4. ***PLC Hardware*** is fitted in the cabinet as per work requirement   5. Wiring is carried out according to IEEE regulations. |
| 1. Interface PLC I/O modules | * 1. ***PLC Network cables*** are selected according to work requirement   2. PLC network cables are laid out as per work requirement   3. PLC Network cables are terminated according to IEEE regulations   4. I/O cables are terminated according to IEEE regulations.   5. PLC Network cables are tested according to work requirement |
| 1. Program PLC | * 1. ***PLC programming software*** is installed according to manufacturer’s specifications   2. PLC is programed as per work requirement   3. PLC program is simulated according to work requirement   4. PLC program is downloaded as per software specification   5. PLC program is tested according to work requirement |
| 1. Maintain PLC Systems | * 1. PLC performance is monitored as per work requirement.   2. PLC program is backed-up as per software requirement.   3. PLC system is troubleshooted as per OEM manual.   4. PLC program is restored as per software requirement.   5. PLC system is tagged as per manufacturer’s specifications.   6. ***PLC Modules*** are identified as per OEM manual.   7. PLC modules are tested as per OEM manual.   8. PLC system is cleaned according to OEM manual. |

**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** |
| --- | --- |
| Health and Safety Procedures may include but not limited to | * Operator safety * PPEs * Work permits * Waste management * Electrical wiring colour coding * Danger warning signage * Barricades * High voltage signage * Health policy |
| PLC Hardware may include but not limited to: | * Power supply * Input module * Output module * Processor (CPU) * Rack or mounting assembly * Indicator lights |
| PLC Network cables may include but not limited to: | * Ethernet cable * USB Cable * Serial Cable * Profinet cables * Profibus cables * Coaxial cables * Fiber optic cables |
| PLC programming software may include but not limited to: | * Automation builder * RS Logix * Logosoft * Gx works * Step 5- Micro wins * Step 7- Simatic Manager * TIA portal * CX-One * Twido Suite * Automation suit * Codesys * Bosch R exroth |
| PLC Modules may include but not limited to: | * Power Supply Module (PS) * CPU * Interface Module (IM) * Signal Modules (SM) * Function Module (FM) * Communication Processor (CP) |

**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 skills
* Change management skills
* Communication skills
* Writing a program
* Ability to work under pressure
* Multitasking skills
* Termination
* Industrial networking
* Critical thinking
* Monitoring and assessing
* Active learning
* Equipment maintenance
* Decision making
* Fault diagnosis/ troubleshooting
* System evaluation
* Technology design
* Logical reasoning
* Documentation
* Interpreting working drawing
* Hardware configuration
* Software configuration
* Analytical thinking
* Proper use of wire cutter and crimping tool

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* PID and control process
* PLC program structure
* PLC program faults
* Indirect addressing and arrays
* HMI and/or SCADA design
* PLC programming
* PLC device communication protocols and channels
* Interface Mediums (RS232, RS485, etc.)
* Field wiring
* Memory and addressing
* Arrays and pointers
* Ladder logic
* Functional block diagrams
* Sequential flow chart
* Siemens PLC software
* Hitachi PLC software
* Mitsubishi PLC software
* Schneider PLC software
* Electrical wiring standards, codes and procedures
* IEEE standards
* HMI’s
* Address priority and symbol priority
* Network ports
* BUS network
* Electrical tools and equipment
* Personal Protective Equipment
* Electrical Health and Safety 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. Applied health and safety procedures as per work requirement   2. Fitted PLC Hardware in the cabinet as per work requirement   3. Terminated PLC Network cables according to IEEE regulations   4. Tested PLC Network cables according to work requirement   5. Installed PLC programming software according to manufacturer’s specifications   6. Tested PLC program according to work requirement   7. Backed-up PLC program as per software requirement.   8. Identified PLC Modules as per OEM manual.   9. Tested PLC modules as per OEM manual. |
| 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. Workplace or simulated workplace. |
| 1. Guidance information for assessment | * 1. Holistic assessment with other units relevant to the industry sector and workplace work role is recommended. |

## INSTALL AND MAINTAIN ROBOTIC SYSTEM

**UNIT CODE:** 0715 551 15A

**Unit Description**

This unit covers the competencies required by an industrial mechatronic technician to prepare robotic systems installation site, assemble robotic system components, program robotic system, and maintain robotic 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 italicised terms are elaborated in the Range)*** |
| --- | --- |
| 1. Prepare robotic systems installation site | * 1. ***Health and safety procedures*** are applied as per work requirement.   2. Robotic system installation site survey is conducted as per work requirement.   3. Robotic system installation schedule is developed as per the manufacturer’s requirement.   4. Robotic system installation area is set up as per the manufacturer’s requirement.   5. Robotic system site preparation report is documented as per work place procedure. |
| 1. Assemble   robotic system components | * 1. Health and safety procedures are applied as per work requirement.   2. ***Robotic system types*** are identified as per work requirement.   3. ***Robotic system components*** are mounted according to manufacturer’s manuals.   4. Robotic system components are connected according to ***manufacturer’s manuals***.   5. ***Robotic system tests*** are carried out according to work requirement |
| 1. Program robotic system | * 1. ***Robotic system programming software*** is installed according to manufacturer’s specifications.   2. Robotic system is programed as per work requirement.   3. Robotic system program is simulated according to work requirement.   4. Robotic system program is downloaded as per software specification.   5. Robotic system is tested according to work requirement.   6. Robotic system programming report is prepared as per workplace procedures. |
| 1. Maintain robotic system | * 1. Health and safety procedures are applied as per work requirement.   2. Robotic system maintenance schedule is developed as per work requirement.   3. Robotic system maintenance is carried out as per manufacturer’s requirement.   4. Robotic system is troubleshooted as per manufacturer’s requirement.   5. Robotic system maintenance report is documented 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** |
| --- | --- |
| Health and safety procedures may include but not limited to: | * PPEs * Work permits * Waste management * Electrical wiring colour coding * Danger warning signage * Barricades * High voltage signage * Health policy |
| Robotic system types may include but not limited to: | * Cartesian robot * Polar robot * Articulated robot |
| Robotic system components may include but not limited to: | * Manipulator * Controller unit * Sensors * Actuators * Encoders * Gears * Motors (servo motors, stepper motors, linear motors, etc) |
| Robotic system tests may include but not limited to: | * Electrical * Mechanical * Functionality * Safety |
| Robotic system programming software may include but not limited to: | * TIA Portal * STEP 7 * GX Works * TWINCAT * Micro-Logix * C, C++ (Arduino, Raspberry Pi, STM32 etc) |
| Manufacturer’s manuals may include but not limited to: | * System installation manuals * System operation manuals * Software manuals * Maintenance manuals |

**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:

* Programming
* Safety and Health Standards (OSHA)
* System networking
* Time management
* Inspection and testing skills
* Report writing
* Problem solving
* Critical thinking
* Decision making
* Communication skills
* Troubleshooting

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Working principles of robot
* Geometry (Kinematics)
* Industrial networking
* CAM/CIM principles
* Robotic system architecture
* Computer aided design
* Instrumentation
* Control theory
* Sensors and actuators
* Health and safety standards
* Planar and spatial mechanisms

**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. Applied health and safety procedures as per work requirement.   2. Conducted robotic system installation site survey as per work requirement.   3. Developed robotic system installation schedule as per the manufacturer’s requirement.   4. Set up robotic system installation area as per the manufacturer’s requirement.   5. Identified robotic system types as per work requirement.   6. Connected robotic system components according to manufacturer’s manuals.   7. Carried out robotic system tests according to work requirement.   8. Programmed robotic system as per work requirement.   9. Tested robotic system according to work requirement.   10. Developed robotic system maintenance schedule as per work requirement.   11. Carried out robotic system maintenance as per manufacturer’s requirement.   12. Troubleshooted robotic system as per manufacturer’s requirement. |
| 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. Workplace or simulated workplace. |
| 1. Guidance information for assessment | * 1. Holistic assessment with other units relevant to the industry sector and workplace work role is recommended. |

## INSTALL AND MAINTAIN SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) SYSTEMS

**UNIT CODE:** 0715 551 16A

**Unit Description**

This unit covers the competencies required by an industrial mechatronic technician to Maintain SCADA systems. It enables the learner to: prepare SCADA System installation site, mount SCADA System Components, Program SCADA System and maintain SCADA 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 italicised terms are elaborated in the Range)*** |
| --- | --- |
| 1. Prepare SCADA System installation site | * 1. SCADA system installation site survey is conducted as per work requirement.   2. SCADA system installation schedule is developed as per work place requirement.   3. SCADA installation site is set up as per work requirement.   4. SCADA system installation site survey report is prepared as per work place requirement. |
| 1. Mount SCADA System Components | * 1. ***Health and safety procedures*** are applied as per work requirement   2. SCADA system installation tools are selected according to work requirement   3. SCADA system installation cabinets are prepared according to manufacturer’s specifications   4. ***SCADA components*** are fitted according to work requirement   5. SCADA system wiring is carried out according to IEEE regulations |
| 1. Program SCADA System | * 1. ***SCADA programming software*** is installed according to manufacturer’s specifications   2. SCADA program is written as per work requirement   3. SCADA program is simulated according to work requirement   4. SCADA program is downloaded as per software specification   5. SCADA program is tested according to work requirement. |
| 1. Maintain SCADA system | * 1. ***SCADA system*** performance is monitored as per work requirement.   2. SCADA program is backed-up as per software requirement.   3. SCADA system is troubleshooted as per OEM manual.   4. SCADA program is restored as per software requirement.   5. SCADA system is tagged as per manufacturer’s specifications.   6. SCADA components are identified as per OEM manual.   7. SCADA components are tested as per OEM manual.   8. SCADA components are cleaned according to OEM manual. |

**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** |
| --- | --- |
| Health and safety proceduresmay include but not limited to: | * PPEs * Work permits * Waste management * Electrical wiring colour coding * Danger warning signage * Barricades * High voltage signage |
| SCADA Components may include but not limited to: | * Data input devices such as sensors * Data processing devices, such as a PLC or RTU * Data output devices such as an HMI or monitor, relays * Communication devices |
| SCADA Programming software may include but not limited to: | * WinTr * Siemens * MC Works64 * Easy SCADA |
| SCADA system may include but not limited to: | * SCADA software * Firewalls * Security updates * Firmware updates * PLCs |

**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:

* Communication skills
* Problem solving
* Decision making
* Presentation
* Organizing
* Time management
* Report writing
* Creativity and innovation
* Data collection and analysis
* Use of tools and equipment
* Technical presentation
* Technical drawing
* Installation and dismantle of faulty parts
* Repair or replace faulty parts
* Perform tests and run the machine
* Service and maintenance
* Perform system diagnostics

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* SCADA system communication
* SCADA program extraction
* SCADA software operation
* SCADA program restoration
* SCADA program back-up
* SCADA system connection
* Online diagnosis
* Remote terminal unit fault identification
* Network faults identification
* Report writing

**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 | * 1. Applied health and safety procedures as per work requirement   2. FittedSCADA components according to work requirement   3. Carried out SCADA system wiring according to IEEE regulations   4. Wrote SCADA program as per work requirement   5. Tested SCADA program according to work requirement   6. Monitored SCADA system performance as per work requirement.   7. Backed-up SCADA program as per software requirement.   8. Troubleshooted SCADA system as per OEM manual.   9. Restored SCADA program as per software requirement.   10. Tested SCADA components as per OEM manual. |
| 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. Workplace or simulated workplace. |
| 1. Guidance information for assessment | * 1. Holistic assessment with other units relevant to the industry sector and workplace work role is recommended. |

## INSTALL ELECTRICAL MACHINES AND MECHANICAL DRIVES

**UNIT CODE:** 0715 551 17A

**UNIT DESCRIPTION**

This unit covers the competencies required in installation and maintenance of electrical machines and mechanical drives. The competencies covered include: analyzing electrical machines, installing electrical machines, maintaining electrical machines, analyzing mechanical drives, assembling mechanical drives, and maintaining mechanical drives.

**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. Analyze electrical machines | * 1. ***Electrical principles*** is applied as per work requirement   2. ***Electrical machines*** are identified as per work requirement.   3. Electrical machine sizing is carried out as per load requirements   4. Power requirements are identified as per electrical machine   5. Electrical machine analysis report is prepared as per work place procedures |
| 1. Install electrical machines | * 1. PPE are donned as per work requirement   2. Electrical machines ***installation*** ***tools*** and ***equipment*** are assembled as per work requirement   3. Electrical machines are mounted as per ***design specifications***   4. Electrical machines are ***terminated and connected*** as per work requirement   5. ***Electrical machines tests*** are carried out as per work requirement |
| 1. Maintain electrical machines | * 1. Electrical machines maintenance schedule is prepared as per workplace procedures   2. PPE are donned as per work requirement   3. Electrical machines maintenancetools, equipment and ***spares*** are assembled as per work requirement   4. Electrical machines ***maintenance tasks*** are carried out as per work requirement   5. Electrical machines Maintenance reports are prepared as per workplace procedures |
| 1. Analyze mechanical drives | * 1. ***Mechanical drives*** are identified as per work requirement.   2. Mechanical drives sizing is carried out as per work requirement   3. Mechanical drives analysis report is prepared as per work place procedures |
| 1. Assemble mechanical drives | * 1. PPE are donned as per work requirement   2. Mechanical drives assembling tools and equipment are assembled as per work requirement   3. Mechanical drives are assembled as per ***design specifications***   4. ***Mechanical drives tests*** are carried out as per work requirement |
| 1. Maintain mechanical drives | * 1. Mechanical drives maintenance schedule is prepared as per workplace procedures   2. PPE are donned as per work requirement   3. Mechanical drives maintenancetools, equipment and ***spares*** are assembled as per work requirement   4. Mechanical drives ***maintenance tasks*** are carried out as per work requirement   5. Mechanical drives 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** |
| Electrical principle includes but not limited to: | * + Ohms law   + Kirchhoff’s law   + Electromagnetism   + Electrostatics |
| Electrical machines include but not limited to: | * + AC motors   + DC motors   + Special motors   + Transformers   + AC Generators   + DC Generators |
| Installation tools include but not limited to: | * + Hand tools   + Pliers   + Hammer   + Spanners   + Wire stripper   + Crimping tool   + Allen keys   + Screw drivers   + Multimeters |
| Installation equipment includes but not limited to: | * + Lifting gear   + Scaffold   + PPE   + Safety Harness   + Motors   + Transformers   + Generators   + Compressors   + Pumps |
| Design specifications include but not limited to: | * + Installation manual   + Installation layout   + Operation manual |
| Terminated and connected includes but not limited to: | * + Wire termination   + Component coupling |
| Electrical machines tests include but not limited to: | * + Functionality tests   + Electrical tests   + Endurance tests   + Speed tests |
| Electrical machines maintenance tools, equipment and spares include but not limited to: | * Tools   + Pliers   + Hammer   + Spanners   + Wire stripper   + Crimping tool   + Allen keys   + Screw drivers   + Multimeters * Equipment   + Lifting gear   + PPE * Spares   + Motors   + Motor parts   + Bearings   + Generators   + Cables |
| Electrical machines maintenance tasks include but not limited to: | * Inspection * Testing and measurements * Cleaning * Lubrication * Tightening * Replacing consumables |
| Mechanical drives include but not limited to: | * Pulleys * Gears * Belts * Chains * Conveyers |
| Mechanical drives tests | * Alignment * Functionality test * Load test and Vibration tests |
| Mechanical drives maintenance tools, equipment and spares include but not limited to: | * Tools * Hand tools * Alignment lase * Cleaning tools * Equipment * Pullers * Lifting gear * Climbing gear * Spares * Chains * Sprocket * Belts * Fasteners * Gears * Pulleys |

**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
* Material science
* Electrical machines
* Mechanical science

**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

**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. Identified Electrical machines as per work requirement.   2. Sized electrical machine as per load requirements   3. Donned PPE as per work requirement   4. Mounted electrical machines as per design specifications   5. Terminated and connected Electrical machines as per work requirement   6. Carried out electrical machines tests as per work requirement   7. Carried out electrical machine maintenance tasks as per work requirement   8. Identified mechanical drives as per work requirement.   9. Sized mechanical drives as per work requirement   10. Assembled mechanical drives as per design specifications   11. Carried out mechanical drives tests as per work requirement   12. Carried out mechanical drives 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 | * 1. This competency may be assessed in a workplace or in a simulated workplace. |
| 1. Guidance information for assessment | * 1. Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## OPERATE FABRICATION MACHINERY

**UNIT CODE:** 0715 551 18A

**Unit Description**

This unit describes the competencies required by an industrial mechatronics technician to operate a fabrication machinery and produce a part within the required safety rules and standards. In the context of the standard, the technician is to demonstrate ability to: create part designs, perform machine configuration, and perform machining processes.

**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 italicised 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. Apply material science principles | 1. Safety procedures and practices are observed as per workplace requirements 2. Safe handling of materials is carried out as per job requirements 3. ***Engineering materials*** are selected as per job requirement 4. Engineering materials are classified as per job requirement |
| 1. Apply Workshop tools and equipment | * 1. Safety procedures and practices are observed as per workplace requirements   2. Technical Drawing are interpreted as per job requirements   3. ***Workshop Tools, equipment*** are selected as per task requirements   4. Workshop tools and equipment are calibrated as per manufacture’s manual   5. Workshop tools are used as per work requirement   6. Tools and equipment are maintained as per workplace procedure |
| 1. Carry out metal joining processes | * 1. Safety procedures and practices are observed as per workplace requirements   2. Tools and equipment are identified as per task requirement   3. ***Material preparations*** is carried out as per task requirement   4. ***Joinery methods*** are applied as per task requirement   5. ***Metal finishing******processes*** are carried out as per task requirement |
| 1. Apply workshop organisation techniques | * 1. Waste sorting and disposal is carried out as per workplace procedure   2. Workshop layout is applied as per workplace requirement   3. Management inventory is prepared as per work requirement   4. Maintenance schedules are prepared as per workplace procedure   5. Housekeeping is carried out as per work requirement |
| 1. Create part designs | * 1. ***Health and safety procedures*** are applied as per work requirement   2. Fabrication machinery part design drawing is obtained as per work requirement   3. Fabrication machinery operation sequence plan is developed as per the ***design specifications***.   4. Fabrication machinery part design is created in reference to design specification   5. Fabrication machinery precision is performed as per design specification |
| 1. Perform machine configuration | * 1. Health and safety procedures are applied as per work requirement   2. Fabrication machinery tooling is set on the machinery as per work requirement.   3. Fabrication machinery materials are set as per work requirement.   4. Fabrication machine configuration is performed as per work requirement. |
| 1. Perform machining processes | * 1. Health and safety procedures are applied as per work requirement   2. ***Fabrication***machining operations are performed as per work requirement.   3. Fabrication machinery part inspection is carried out as per design requirement.   4. Fabrication machinery documentation is carried out 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** |
| --- | --- |
| Health and safety procedures include but not limited to: | * PPEs * Work permits * Waste management * Electrical wiring colour coding * Danger warning signage * Barricades * High voltage signage |
| Design specifications | * Dimensions * Geometry * Surface finish |
| Fabrication machining operations include but not limited to: | * CNC machining * Drilling * Turning * Milling * Grinding * Screw cutting |

**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:

* Interpreting working drawing
* Creating designs
* Configuring machines
* Fabrication methods
* Product inspection
* Report writing
* Communication skills
* Use of tools and equipment
* Technical presentation
* Technical drawing
* Team workability
* Innovative, creative, self-driven and quality control skills

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Workplace procedures and OSHA
* Proper usage, maintenance and storage of tools
* Interpreting technical drawing
* Developing an operation plan
* Work scheduling
* Tag out/Lock out procedures
* Material selection criteria
* Understanding of work piece composition and quality
* CNC machining principles
* Inspection techniques
* Waste management
* Report writing
* Record keeping
* Workshop organization
* Fundamental programming and automation.
* CAD techniques
* Mechanics
* Electronics

**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. Applied health and safety procedures as per work requirement   2. Controlled workplace hazards and risks per workplace requirements   3. Managed workplace accidents and incidents as per workplace requirements   4. Classified engineering materials as per job requirement   5. Calibrated workshop tools and equipment as per manufactures manual   6. Maintained tools and equipment as per the workplace procedures   7. Carried out materials preparation as per task requirement   8. Applied joinery methods as per task requirement   9. Applied preservation method as per work requirement   10. Applied workshop layout as per workplace requirement   11. Prepared management inventory as per work requirement   12. Prepared maintenance schedules as per workplace procedure   13. Obtained fabrication machinery part design drawing as per work requirement.   14. Created fabrication machinery part design in reference to design specification   15. Determined fabrication machinery precision as per design specification.   16. Performed fabrication machining as per work requirement.   17. Inspected fabrication machinery part as per design requirement. |
| 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. Workplace or simulated workplace. |
| 1. Guidance information for assessment | * 1. Holistic assessment with other units relevant to the industry sector and workplace work role is recommended. |