

**REPUBLIC OF KENYA**

**NATIONAL OCCUPATIONAL STANDARDS**

**FOR**

**INDUSTRIAL AUTOMATION AND ROBOTICS OPERATOR**

**KNQF LEVEL 4**

**OCCUPATIONAL STANDARD ISCED CODE: 0714 354A**

# FOREWORD

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

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

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

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

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

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# 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 Act CAP. 210A and Sessional Paper No. 4 of 2016 on Reforming Education and Training in Kenya, emphasized the need to reform curriculum development, assessment and certification. This called for a shift to CBET in order to address the mismatch between skills acquired through training and skills needed by industry as well as increase the global competitiveness of Kenyan labour force.

Incumbent Industrial Automation and Robotics industry experts in conjunction with expert subject trainers and other related stakeholders have developed these Occupational Standards for Industrial Automation and Robotics Level 4. These standards will be the basis for development of competency-based curriculum for Industrial Automation and Robotics KNQF Level 4.

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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# ABBREVIATIONS AND ACRONYMS

|  |  |
| --- | --- |
| ISCED | International Standard Classification of Education |
| CV | Curriculum Vitae |
| CPU | Central Programming Unit |
| RAM | Random Access Memory |
| ROM | Read Only Memory |
| CD | Compact Disc |
| DVD | Digital Video Disc |
| HDMI | High-Definition Multimedia Interface |
| DVI | Digital Visual Interface |
| VGA | Video Graphics Array |
| USB | Universal Serial Bus |
| OS | Operating System |
| ICT | Information Computer Technology |
| PPE | Personal Protective Equipment |
| DC | Direct Current |
| AC | Alternating Current |
| DCS | Distributed Control System |

# KEY TO UNIT CODE

**Sector / Industry**

**Sub Sector**

**Occupational Area**

**Version Control**

**Unit of Competence Number**

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

xx

x

xxx

x

x

x

# OVERVIEW

The industrial automation and robotics operator occupational standard serves as framework defining the key skills, knowledge and competencies required by individuals engaged in the field of industrial automation and robotics. The standard is divided into three sections as summarized in the table below. The core competency standards include operating of industrial automation and robotics systems, maintaining industrial automation and robotics systems and maintaining product quality.

**SUMMARY OF UNITS OF COMPETENCY**

|  |  |
| --- | --- |
| **UNIT CODE** | **UNIT TITLE** |
| **CORE UNITS OF COMPETENCY** | |
| 0714 351 01A | OPERATE INDUSTRIAL AUTOMATION AND ROBOTIC SYSTEMS |
| 0714 351 02A | MAINTAIN INDUSTRIAL AUTOMATION AND ROBOTIC SYSTEMS |
| 0714 351 03A | MAINTAIN PRODUCT QUALITY |
|  |  |

CORE UNITS OF COMPETENCY

## OPERATE INDUSTRIAL AUTOMATION AND ROBOTIC SYSTEMS

**UNIT CODE: 0714 351 01A**

**UNIT DESCRIPTION**

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

**ELEMENTS AND PERFORMANCE CRITERIA**

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

**RANGE**

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

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

**REQUIRED KNOWLEDGE AND SKILLS**

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

**Required knowledge**

The individual needs to apply knowledge of:

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

**Required Skills**

The individual needs to apply the following skills:

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

**EVIDENCE GUIDE**

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

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

## MAINTAIN PRODUCT QUALITY

**UNIT CODE: 0714 351 03A**

**UNIT DESCRIPTION**

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

**ELEMENTS AND PERFORMANCE CRITERIA**

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

**RANGE**

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

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

**REQUIRED KNOWLEDGE AND SKILLS**

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

**Required knowledge**

The individual needs to apply knowledge of:

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

The individual needs to apply the following skills:

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

**EVIDENCE GUIDE**

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

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

## MAINTAIN INDUSTRIAL AUTOMATION AND ROBOTIC SYSTEMS

**UNIT CODE:** 0714 351 02A

**UNIT DESCRIPTION**

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

**ELEMENTS AND PERFORMANCE CRITERIA**

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

**RANGE**

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

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

**REQUIRED SKILLS AND KNOWLEDGE**

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

**Required Skills**

The individual needs to demonstrate the following skills:

* Problem solving
* Creativity
* Innovation
* Communication skills

**Required knowledge**

The individual needs to demonstrate knowledge of:

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

**EVIDENCE GUIDE**

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

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

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