National Competency Standards Level 5 for Mechatronics Technology

National Vocational and Technical Training Commission (NAVTTC),
Government of Pakistan

ACKNOWLEDGEMENTS

National Vocational and Technical Training Commission (NAVTTC) extends its gratitude and appreciation to many representatives of business, industry, academia, government agencies, Provincial TEVTAs, Sector Skill Councils and trade associations who speared their time and expertise to the development and validation of these National Vocational Qualifications (Competency Standards, Curricula, Assessments Packs and related material). This work would not have been possible without the financial and technical support of the TVET Sector Support Programme co-funded by European Union, Germans and Norwegian and German Governments implemented by GIZ Pakistan. NAVTTC is especially indebted to *Dr. Muqeem ul Islam,* who lead the project from the front. The core team was comprised on:

- *Dr. Muqeem ul Islam,* Director General (Skills Standards and Curricula) NAVTTC
- *Mr. Muhammad Naeem Akhtar*, Senior Technical Advisor TSSP-GIZ,
- *Mr. Muhammad Yasir*, Deputy Director (SS&C Wing) NAVTTC
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- *Mr. Muhammad Fayaz Soomro,* Deputy Director (SS&C Wing) NAVTTC

NAVTTC team under the leadership of Dr. Muqeem ul Islam initiated development of CBT & A based qualifications of diploma level-5 as a reform project of TVET sector in November 2018 and completed 27 NVQF diplomas of Level-5 in September, 2019. It seems worth highlighting that during this endeavor apart from developing competency standards/curricula in conventional trades new dimensions containing high-tech trades in TVET sector in the context of generation IR 4.0 trades have also been developed which inter alia includes Robotics, Mechatronics, artificial intelligence, industrial automation, instrumentation and process control. Moreover, trades like entrepreneurship, green/environmental skills and variety of soft/digital skill have also been developed to equipped the Pakistani youth with skills set as per requirement of the global trends. These skills have been made integral part of all the 27 diplomas.

Nobody has been more important in the pursuit of this project than Dr. Nasir Khan, Executive Director, NAVTTC, whose patronage and support remain there throughout the development process and lastly to thanks specially to Syed Javed Hassan Chairman NAVTTC and Raja Saad Khan, Deputy Team Lead TSSP-GIZ who made it happened in this challenging time.

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1. Introduction

Mechatronics is an interdisciplinary field that combines elements of engineering, machining, information technology, robotics, and electronics. It synchronize these diverse fields for the purpose of designing, fabrication and field testing of the production lines and manufacturing processes in order to optimize their performance and efficiencies. In this field several mechanical systems such as hydraulic, pneumatic, camera, electric motor and engines are interface, configure and combine in order to peform the tasks with increase efficiency and performance. Since several differenct mechanical, electrical and optical systems are inference, the continual operational maintenance, confirgation and upgradation is required which need trained main power in the field of mechantronics in order to run the industrial processes and machines with any system failure or breakdown.

Typically, a mechatronics technologist need to perform several task such as stand alone operation / testing of the mechanical and electronics systems in order to diagnose the faulty parts. These task may attribute to the checking, installation and configuration of electronics curcuits, motor drives, hydraulic / pneumatic moving system. The industry is lacking the expert technologist who has sound knowledge and command over all mechanical and electronics systems especially when these are interface and working in the close loop environment.

Mechatronics technologists can work in several fields, but they are commonly found in the manufacturing and automation sector. Several industrial process and production lines can be optimize by implementing fine mechanical precision in environmental conditions that may be dangerous or inefficient for human hands and can be perform optimally by adding mechanrtonic solutions.Mechatronics has had a measurable impact both on the speed with which new products can be assembled.

The professionals that are skilled in this area of mechantronics are in high demand on production lines that range from projects as large as automotive vehicle manufacturing to the smallest microelectronic products. For instance, blood pressure monitoring device has pneumatic pump, a sensor to sense the blood pressure and electronics / microprocessor based circuit to measure the blood pressure. Similarly, several home appliances such as washing machines, ovens and refrigerators are now equipped with sophisticated mechatronics systems in order to optimized their products in terms of performance and electricitical power consumption. Therfore, to repair and maintain such home appliances, the traditional technician are fail to work because of their training explicitly in the field of mechanical, electrical or electronics. Being conscious of these facts , National Vocational & Technical Training Commission (NAVTTC) developed competency standards for

Mechatronics Technology under National Vocational Qualifications Framework (NVQF). Followings are the competency standards which are developed by the Qualifications Development Committee (QDC) and validated by the Qualifications Validation Committee (QVC) having representation from the leading Mechatronics industries from public and private sector, Engineering Universities and Technical Education of the country.

2. Purpose of the Qualification

The purpose of this qualification is to set the high professional standards for the Mechatronics technological sector. The specific objectives of developing these qualifications are as under:

- Improve the professional competence of the trainees
- Provide opportunities for recognition of the skills attained through formal or informal pathways
- Improve the quality and effectiveness of the training and assessment for Mechatronics Technological sector
- Enabling / helping / facilitating the existing workforce to indulge themselves in new technologies and methods

3. Core competencies of the Qualification

The Mechatronics Technology qualification of level 5 consists of the 40% of theory and 60% of the practical. The Core competencies of the qualification are as follows:

Competency Standards	Level
Health and Safety	
Maintain Occupational Health and Safety	2
Adopt Safety Regulations, Labor Protection Laws, Environmental Protection Laws at Workplace	2
Total	
Basic Machining	
Perform Metal/Bench Work	2
Perform general machining	2
Perform cutting on Metal Circular/Power Heck Saw	2

Perform tool sharpening	2
Perform Basic Lathe Machine Operations	3
Perform Drilling Machine Operations	2
Perform Shaper, Planar and Slotter Machining Operations	3
Perform Milling Operations	3
Electrical Essentials & Networks	
Operate Measuring Instruments	3
Verify Ohm's & Kirchhoff's Laws by Implementing Series/Parallel Circuits	3
Measure Electrical Power, Energy, Power Factor & Determine Phase Sequence	3
Construct Electromagnet to See Various Effects & Verify Faradays Law	3
Verify Law of Combination of Capacitor & Determine Break Down Voltage of Capacitor	3
Maintain Tools & Equipment	3
Make Cable/Wire Joints	2
Prepare and Install Distribution Boards	2
Carryout Basic Electrical Installations	2
Install Single Phase Electrical Wiring	2
Perform Testing of Electrical Wiring	2
Operate Single Phase Transformer	5
Perform Tests on Single Phase Transformer	5
-	
Digital Skills	

Install Computer Operating Systems And Hardware	3
Operate Word-Processing Applications	3
Operate Spreadsheet Applications	3
Operate Presentation Packages	3
Perform Writing And Editing Tasks	3
Perform Computer Operations	3
Use Computer Applications	3
Create User Documentation	3
Create Technical Documentation	3
Create Basic Databases	3
Operate Digital Media Technology	3
Use Social Media Tools For Collaboration And Engagement	3
E-Commerce	3
Use Digital Devices	3
Metrology	
Take measurements with graduated tools	3
Take measurements with combination set	3
Perform ling	3
Take measurements with gauges	3
Perform measurements through Micrometer	3
Measure dimensions with Vernier tools	3
Measure angles with angle measuring Instruments	3

Measure Threads and Gears	3
Basic Engineering Drawing	
Perform Basic Manual Drawing	3
Construct different Engineering Curves	3
Construct multi-view drawings	3
Install CAD Software	3
Develop 2D CAD drawings	3
Develop 3D CAD drawings	3
Welding - I	
Interpret Parts and Assembly Drawing	2
Evaluate the Use of Hand and Power Tools	2
Perform Pre-Welding Operations	2
Perform Oxy Acetylene Welding	3
Cut Metal by Oxy-Acetylene / Oxy-Fuel Flame/Grinding (Manually and Auto Cutting)	3
Perform Gas Welding On Mild Steel Plates (1F, 2F, 3F)	3
Gas Metal Arc Welding (GMAW) in Flat (1F, 1G), Horizontal (2F, 2G), Vertical (3F, 3G) and Overhead (4F, 4G) Positions	4
Gas Tungsten Arc Welding (GTAW) in Flat (1F, 1G), Horizontal (2F, 2G), Vertical (3F, 3G) and Overhead (4F, 4G) Positions	4
Shielded Metal Arc Welding (SMAW) in Flat (1F, 1G), Horizontal (2F, 2G), Vertical (3F, 3G) and Overhead (4F, 4G) Positions	4
Flux Cored Arc Welding (FCAW)	4
Perform Soldering and Brazing Operations	3

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Microprocessor & Microcontrollers	
Design Microprocessor applications	4
Identify Microcontroller Types and its Architecture	4
Interface Microcontroller with system	4
Carryout various Microcontroller Applications.	4
Apply Microcontroller to build Control System.	4
Total	
Analogue Electronics	
Identify the Semiconductor Devices	*4*
Construct The RF & AF Amplifiers	*4*
Design the Oscillators	*4*
Analyze operational Amplifier circuits	*4*
Design the Multi-Vibrators	*4*
Construct Ramp Generator circuits	*4*
Design Function Generator & Comparator circuits	*4*
Total	
Soft Skills	
Develop workplace policy and procedures for sustainability	4
Manage meetings	4

Manage recruitment selection and induction processes	4
Manage personal work priorities and professional development	4
Manage workforce planning	4
Undertake project work	4
Identify and communicate trends in career development	4
Apply specialist interpersonal and counseling interview skills	4
Work safely in an office environment	4
Develop workplace documents	4
Prepare and implement negotiation	4
Maintain professionalism in the workplace	4
Organize schedules	4
Computer Programming	
Installation of C++, IDE for Arduino and Python	4
Carryout Basic C++ Programming	4
Carryout Basic Programming using python	4
Perform basic programming using microcontrollers	4
Total	
Computer Integrated Manufacturing (CIM)	
Perform CNC Machine Operations	4
Perform CNC Lathe Operations	4
Perform CNC Milling Operations	4

Machines and Mechanism	
Demonstrate Simple Mechanisms	4
Perform Kinematic Analysis of Simple Mechanisms	5
Demonstrate Mechanical Power Transmission Elements	4
Perform Kinematic Analysis of Mechanical Power Transmission Elements	5
Total	
AC and DC Machines	
Verify Basic Laws of Electrical Machines	4
Analyze an Alternator	4
Analyze Single Phase Motors	4
Analyze Special Purpose Motors	4
Analyze Three Phase Motors	4
Analyze Dc Generators	4
Perform Tests on DC Generators	4
Analyze Dc Motors.	4
Perform Tests On DC Motors.	4
Total	
Digital Electronics	
Verify Truth Tables of Digital Gates	3
Construct & Verify Combinational Logic Circuit	4
Construct and Verify Function of Flip Flops	4
Construct Multi vibrator with 555 IC	4

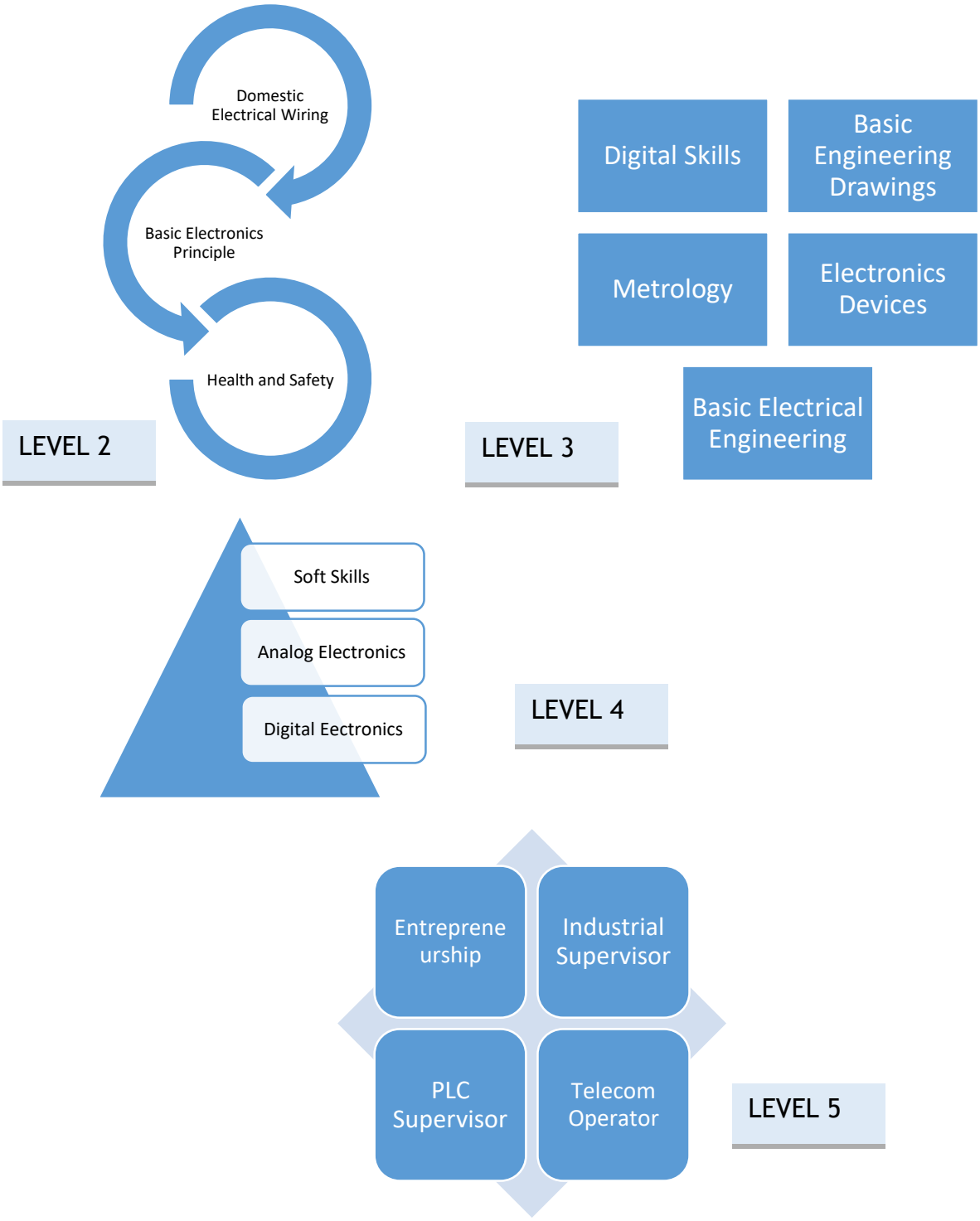
Construct Shift Registers and Counters with the Help of Flip Flops	4
Total	
Sensors and Actuators	
Test Sensors and Transducers	4
Calibrate Sensors and Transducers	4
Interface the Sensor & Transducers	4
Test Actuators	4
Interface and control Actuator with sensors	4
Total	
-	
Programmable Logic Controllers (PLC) (5)	
Install PLC software and Simulator	5
Interface PLC with system	5
Program PLC using Ladder Logic	5
Design and Test the PLC	5
Carry out Industrial Automation on PLC	5
Design of Machine Members (5)	
Calculate Stresses in Machine Parts	5
Calculator diameter of cylinder for hoop and longitudinal stresses	5
Calculate thickness and diameter of spherical shell for circumferential stresses	5

Design welded joints for transverse and parallel fillet under static and fatigue loading	5
Calculate stresses due to initial tightening and external load on screws	5
Design dimension of square and rectangular keys	5
Design shaft subjected to twisting moment only	5
Design flange coupling for specific torque	5
Total	
Industrial Instrumentation (5)	
Design & Implement a process control	5
Install Transducer & Transmitters in Industrial Applications	5
Install the process Regulators	5
Install the Variable Frequency Drive (VFD)	5
Install Pneumatic & Hydraulic systems	5
Total	
Robotics(5)	
Identify Various Parts of Robots	3
Identify Various Parts of Robot Arm	3
Develop Robot program	5
Develop robotic arm structure	5
Test the Robot	5
Total	
Mechatronic Projects	
Access Control System using RFID Reader RC522	5
Finger print Sensor Based Biometric Attendance System	5

Humidity and Temperature Monitoring System.	5
Smart Stick for Blinds	5
Perform Line Following Robot	5
Perform Smart Phone Control Robot Using Bluetooth	5
Perform IoT Controlled based home automation system	5
Perform Smart Phone Control Door Lock System	5
Perform Security System Using Motion Detection	5
Perform Water- Detection in Tank	5
Perform Mini CNC 2D Plotter	5
Perform Voice Controlled Robot	5
Total	
Hydraulics and Pneummatics 5	
Operate Hydraulic Bench and Its Functions	5
Calibrate Bourdon Tube and Diaphragm Pressure Gauge	5
Operate Hydraulic Press	4
Verify Bernoulli's Equation	5
Analyse the performance of Pumps	5
Construct circuit for Double Acting Hydraulic Cylinder	4
Setup a Pressure Device and Hold Specific Load on a Double Acting Cylinder	5
Construct Circuit of Double Acting Hydraulic Cylinder for Mechanical Interlocking	5
Set Speed and Direction of Hydraulic Motor	5
Operate Pressure Measuring Instruments	5
Operate Flow Regulating Devices	5

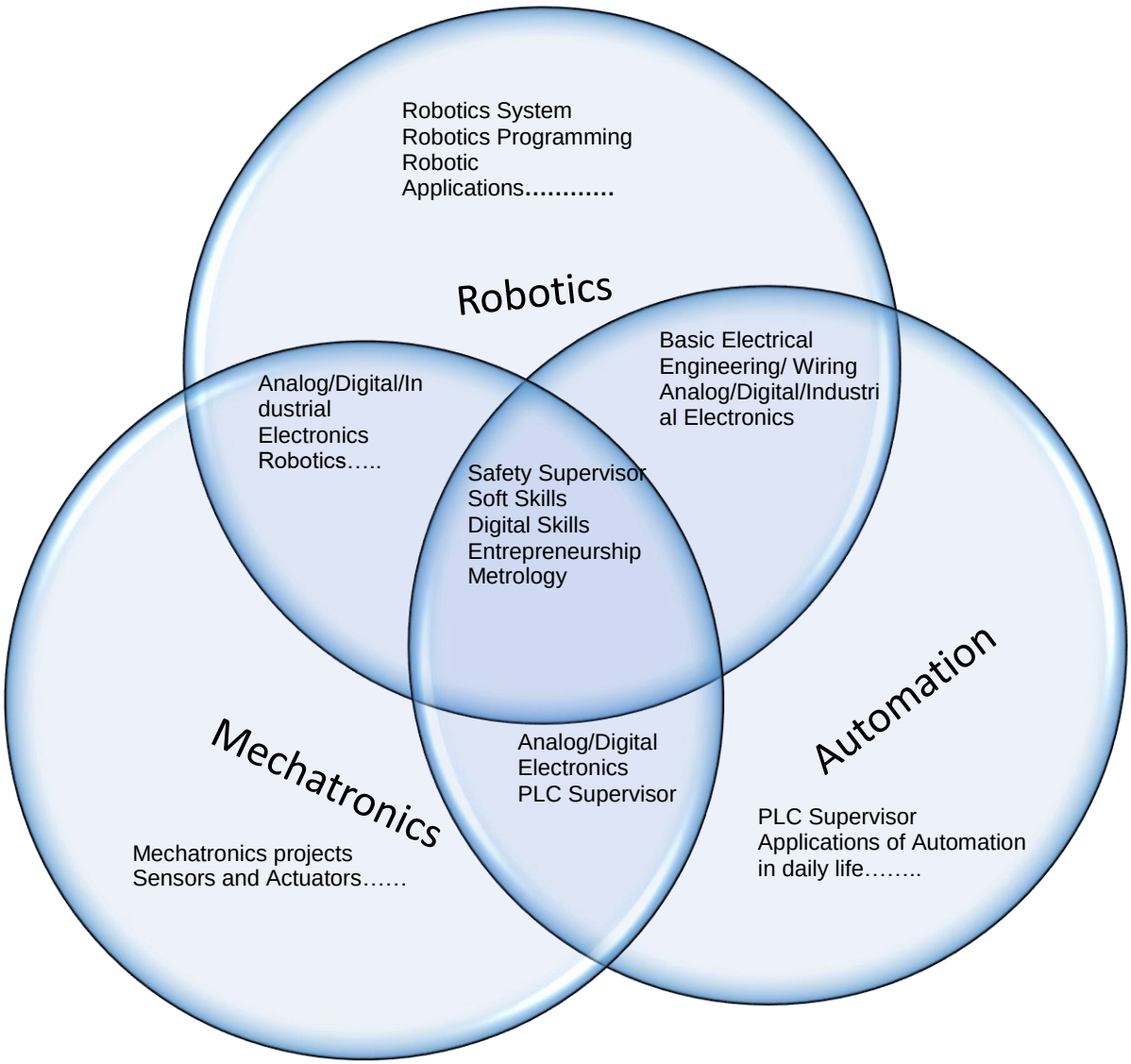
Entrepreneurial Skill (5)	
Develop Entrepreneurial Skills	5
Apply project information management and communications techniques	5
Apply project human resources management approaches	5
Direct human resources management of a project program	5
Develop a project management plan	5
Maintain business resources	5
Develop a sales plan	5
Plan and implement business-to-business marketing	5
Address customer needs	5
Manage personal finances	5
Solve problems which jeopardize safety and security	5
Coordinate a work team	5
Lead small teams	5
Plan and organize work	5
Develop teams and individuals	5
Apply problem solving techniques in the workplace using critical thinking	5
Manage human resource services	5
Total	

4. Common Courses with respective levels



5. Mapping of the Qualification

Mapping of the Qualifications



6. Date of Validation

The level 5 of National DAE qualification on Mechanical Technology has been validated by the Qualifications Validation Committee (QVC) members on 22-24 August, 2019 and will remain valid till 24 Aug, 2029

7. Date of Review

The level 5 of National DAE qualification on Mechanical Technology shall be reviewed after three years of the validation i.e. 25 Aug, 2022

8. Codes of Qualifications

The International Standard Classification of Education (ISCED) is a framework for assembling, compiling and analyzing cross-nationally comparable statistics on education and training. ISCED codes for these qualifications are assigned as follows:

ISCED Classification for DAE Mechanical Technology level-5	
Code	**Description**
0714E&A(1)	1st Level National Certificate of level-5, in " Mechatronics Technology"
0714E&A(2)	2nd Level National Certificate of level-5, in "Mechatronics Technology"
0714E&A(3)	3rd Level National Certificate of level-5, in "Mechatronics Technology"
0714E&A(4)	4th Level National Certificate of level-5, in "Mechatronics Technology"
0714E&A(5)	5th Level National Certificate of level-5, in "Mechatronics Technology"

9. Members of Qualification Development Committee

The following members participated in the qualifications development and validation of this qualification:

S#	Name	Designation	Organization
1	Engr. Javed Rehman Larik	Assistant Professor	MUET Jmashoro
2	Dr. Saifullah Samo	Assistant Professor	MUET Jamshoro
3	Muhammad Sohaib	Assistant Manager	Lucky feed processing plant
4	Engr Sajid Ali	Instructor	Mehran university

5	Mr.Usman Ali	Assistant Manager(Lining)	Orient Automotive Industry (Pvt) Ltd
6	Mr.Ahmad Ali	Instructor	Aman Tech Karachi
7	Mr. Atif Rehman	Sr.Instructor	MITI, Karachi
8	Mr. Mehboob	Sr.Instructor	SOS, Karachi
9	Engr. Aijaz Ahmed Zia	D&A Engineer	INTECH Process Automation
10	Engr. Inayat Ur Rehman	DACUM Facilitator,	Ex. KPK TVETA
11	Muhammad Ishaq	Dy. Director	NAVTTC Islamabad

10. Qualification Validation Committee

S#	Name	Designation	Organization
1	Engr. Javed Rehman Larik	Assistant Professor	MUET Jmashoro
2	Dr. Saifullah Samo	Assistant Professor	MUET Jamshoro
3	Engr. Fazal-ur-Rehman	Associate Professor	KP- TEVTA
4	Engr. Touseef Asghar	Instructor	P - TEVTA
8	Engr. Inayat Ur Rehman	DACUM Facilitator,	Ex. KPK TEVTA
9	Fayaz Ahmed Soomro	Dy. Director	NAVTTC Islamabad

11. Entry Requirements

The entry for D.A. E National Certificate level 5, in Mechatronics Technology are

1. A person having National Vocational Certificate level 4, in Mechatronics Technology.
2. A person having Matric certificate with Science subjects

12. Categorization and Levelling of the Competency Standards

Competency Standard		Category	Contact hr.			Cr. Hr.
			Th.	Pr.	Total	
Health and Safety						
Maintain Occupational Health and Safety	2	Generic	10	30	40	4
Adopt Safety Regulations, Labor Protection Laws, Environmental Protection Laws at Workplace	2	Generic	10	30	40	4
Total			20	60	80	8
Basic Machining						
Perform Metal/Bench Work	2	Technical	6	9	15	1.5
Perform general machining	2	Technical	3	5	8	0.8

Perform cutting on Metal Circular/Power Heck Saw	2	Technical	2	3	5	0.5
Perform tool sharpening	2	Technical	2	3	5	0.5
Perform Basic Lathe Machine Operations	3	Technical	9	14	23	2.3
Perform Drilling Machine Operations	2	Technical	2	3	5	0.5
Perform Shaper, Planar and Slotter Machining Operations	3	Technical	6	8	14	1.4
Perform Milling Operations	3	Technical	10	15	25	7
			40	60	100	10
Electrical Essentials & Networks						
Operate Measuring Instruments	3	Technical	6	18	24	2.4
Verify Ohm's & Kirchhoff's Laws by Implementing Series/Parallel Circuits	3	Technical	6	18	24	2.4
Measure Electrical Power, Energy, Power Factor & Determine Phase Sequence	3	Technical	6	18	24	2.4
Construct Electromagnet to See Various Effects & Verify Faradays Law	3	Technical	6	18	24	2.4
Verify Law of Combination of Capacitor & Determine Break Down Voltage of Capacitor	3	Technical	6	18	24	2.4
Maintain Tools & Equipment	3	Technical	6	18	24	2.4
Make Cable/Wire Joints	2	Technical	9	21	30	3
Prepare and Install Distribution Boards	2	Technical	9	21	30	3
Carryout Basic Electrical Installations	2	Technical	9	21	30	3
Install Single Phase Electrical Wiring	2	Technical	9	21	30	3
Perform Testing of Electrical Wiring	2	Technical	9	21	30	3
Operate Single Phase Transformer	5	Technical	9	21	30	3
Perform Tests on Single Phase Transformer	5	Technical	9	21	30	3
			99	255	354	35.4
-						

Digital Skills						
Install Computer Operating Systems And Hardware	3	Generic	6	24	30	3
Operate Word-Processing Applications	3	Generic	6	24	30	3
Operate Spreadsheet Applications	3	Generic	6	24	30	3
Operate Presentation Packages	3	Generic	6	24	30	3
Perform Writing And Editing Tasks	3	Generic	6	24	30	3
Perform Computer Operations	3	Generic	6	24	30	3
Use Computer Applications	3	Generic	6	15	21	2.1
Create User Documentation	3	Generic	6	15	21	2.1
Create Technical Documentation	3	Generic	6	24	30	3
Create Basic Databases	3	Generic	6	24	30	3
Operate Digital Media Technology	3	Generic	6	24	30	3
Use Social Media Tools For Collaboration And Engagement	3	Generic	6	24	30	3
E-Commerce	3	Generic	6	24	30	3
Use Digital Devices	3	Generic	6	24	30	3
			84	318	402	40.2
Metrology						
Take measurements with graduated tools	3	Technical	6	18	24	2.4
Take measurements with combination set	3	Technical	6	18	24	2.4
Perform ling	3	Technical	6	18	24	2.4
Take measurements with gauges	3	Technical	6	18	24	2.4
Perform measurements through Micrometer	3	Technical	6	18	24	2.4
Measure dimensions with Vernier tools	3	Technical	6	18	24	2.4

Measure angles with angle measuring Instruments	3	Technical	6	18	24	2.4
Measure Threads and Gears	3	Technical	6	18	24	2.4
			48	144	192	19.2
Basic Engineering Drawing						
Perform Basic Manual Drawing	3	Technical	6	18	14	1.4
Construct different Engineering Curves	3	Technical	6	18	17	1.7
Construct multi-view drawings	3	Technical	9	27	25	2.5
Install CAD Software	3	Technical	6	18	17	1.7
Develop 2D CAD drawings	3	Technical	9	27	25	2.5
Develop 3D CAD drawings	3	Technical	9	27	19	1.9
			45	135	117	11.7
Welding - I						
Interpret Parts and Assembly Drawing	2	Technical	3	3	6	0.6
Evaluate the Use of Hand and Power Tools	2	Technical	2	3	5	0.5
Perform Pre-Welding Operations	2	Technical	6	10	16	1.6
Perform Oxy Acetylene Welding	3	Technical	12	24	15	1.5
Cut Metal by Oxy-Acetylene / Oxy-Fuel Flame/Grinding (Manually and Auto Cutting)	3	Technical	12	24	17	1.7
Perform Gas Welding On Mild Steel Plates (1F, 2F, 3F)	3	Technical	12	24	11	1.1
Gas Metal Arc Welding (GMAW) in Flat (1F, 1G), Horizontal (2F, 2G), Vertical (3F, 3G) and Overhead (4F, 4G) Positions	4	Technical	12	24	30	3
Gas Tungsten Arc Welding (GTAW) in Flat (1F, 1G), Horizontal (2F, 2G), Vertical (3F, 3G) and Overhead (4F, 4G) Positions	4	Technical	12	24	30	3
Shielded Metal Arc Welding (SMAW) in Flat (1F, 1G), Horizontal (2F, 2G), Vertical (3F, 3G) and Overhead (4F, 4G) Positions	4	Technical	12	24	24	2.4
Flux Cored Arc Welding (FCAW)	4	Technical	12	24	30	3

Perform Soldering and Brazing Operations	3	Technical	9	21	16	1.6
			104	205	200	20
Microprocessors & Microcontrollers						
Design Microprocessor applications	4	Technical	4	12	16	1.6
Identify Microcontroller Types and its Architecture	4	Technical	8	15	23	2.3
Interface Microcontroller with system	4	Technical	5	21	26	2.6
Carryout various Microcontroller Applications.	4	Technical	4	20	24	2.4
Apply Microcontroller to build Control System.	4	Technical	3	24	27	2.7
Total			24	92	116	11.6
Analogue Electronics						
Identify the Semiconductor Devices	4	Technical	9	21	30	3
Construct The RF & AF Amplifiers	4	Technical	9	21	30	3
Design the Oscillators	4	Technical	9	21	30	3
Analyze operational Amplifier circuits	4	Technical	9	21	30	3
Design the Multi-Vibrators	4	Technical	9	21	30	3
Construct Ramp Generator circuits	4	Technical	9	21	30	3
Design Function Generator & Comparator circuits	4	Technical	9	21	30	3
Total			63	147	210	21
Soft Skills						
Develop workplace policy and procedures for sustainability	4	Generic	6	24	30	3

Manage meetings	4	Generic	6	24	30	3
Manage recruitment selection and induction processes	4	Generic	6	24	30	3
Manage personal work priorities and professional development	4	Generic	6	24	30	3
Manage workforce planning	4	Generic	6	24	30	3
Undertake project work	4	Generic	6	24	30	3
Identify and communicate trends in career development	4	Generic	6	24	30	3
Apply specialist interpersonal and counseling interview skills	4	Generic	6	24	30	3
Work safely in an office environment	4	Generic	6	24	30	3
Develop workplace documents	4	Generic	6	24	30	3
Prepare and implement negotiation	4	Generic	6	24	30	3
Maintain professionalism in the workplace	4	Generic	6	24	30	3
Organize schedules	4	Generic	6	24	30	3
			78	312	390	39
Computer Programming						
Installation of C++, IDE for Arduino and Python	4	Functional	2	9	11	1.1
Carryout Basic C++ Programming	4	Functional	3	12	15	1.5
Carryout Basic Programming using python	4	Functional	3	9	12	1.2
Perform basic programming using microcontrollers	4	Functional	1	11	12	1.2
Total			11	40	50	5
Computer Integrated Manufacturing (CIM)						
Perform CNC Machine Operations	4	Technical	20	30	50	5
Perform CNC Lathe Operations	4	Technical	20	30	50	5

Perform CNC Milling Operations	4	Technical	20	30	50	5
			60	90	150	15
Machines and Mechanism						
Demonstrate Simple Mechanisms	4	Technical	11	12	23	2.3
Perform Kinematic Analysis of Simple Mechanisms	5	Technical	9	12	21	2.1
Demonstrate Mechanical Power Transmission Elements	4	Technical	11	18	29	2.9
Perform Kinematic Analysis of Mechanical Power Transmission Elements	5	Technical	9	18	27	2.7
Total			40	60	100	10
AC & DC Machines						
Verify Basic Laws of Electrical Machines	4	Technical	6	24	30	3
Analyze an Alternator	4	Technical	6	24	30	3
Analyze Single Phase Motors	4	Technical	6	24	30	3
Analyze Special Purpose Motors	4	Technical	6	24	30	3
Analyze Three Phase Motors	4	Technical	6	24	30	3
Analyze Dc Generators	4	Technical	6	24	30	3
Perform Tests on DC Generators	4	Technical	6	24	30	3
Analyze Dc Motors.	4	Technical	6	24	30	3
Perform Tests On DC Motors.	4	Technical	6	24	30	3
Total			54	216	270	27
Digital Electronics						
Verify Truth Tables of Digital Gates	3	Technical	9	21	30	3
Construct & Verify Combinational Logic Circuit	4	Technical	9	21	30	3
Construct and Verify Function of Flip Flops	4	Technical	9	21	30	3

Construct Multi vibrator with 555 IC	4	Technical	9	21	30	3
Construct Shift Registers and Counters with the Help of Flip Flops	4	Technical	9	21	30	3
Total			45	105	150	15
Sensors and Actuators						
Test Sensors and Transducers	4	Technical	12	18	30	3
Calibrate Sensors and Transducers	4	Technical	10	18	28	2.8
Interface the Sensor & Transducers	4	Technical	12	18	30	3
Test Actuators	4	Technical	12	18	30	3
Interface and control Actuator with sensors	4	Technical	11	21	32	3.2
Total			57	93	150	15
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Programmable Logic Controllers (PLC) (5)						
Install PLC software and Simulator	5	Technical	12	30	42	4.2
Interface PLC with system	5	Technical	12	30	42	4.2
Program PLC using Ladder Logic	5	Technical	12	30	42	4.2
Design and Test the PLC	5	Technical	12	30	42	4.2
Carry out Industrial Automation on PLC	5	Technical	12	30	42	4.2
			60	150	210	21
Design of Machine Members (5)						
Calculate Stresses in Machine Parts	5	Technical	10	12	22	2.2
Calculator diameter of cylinder for hoop and longitudinal stresses	5	Technical	8	12	20	2

Calculate thickness and diameter of spherical shell for circumferential stresses	5	Technical	8	9	17	1.7
Design welded joints for transverse and parallel fillet under static and fatigue loading	5	Technical	8	15	23	2.3
Calculate stresses due to initial tightening and external load on screws	5	Technical	8	12	20	2
Design dimension of square and rectangular keys	5	Technical	8	12	20	2
Design shaft subjected to twisting moment only	5	Technical	6	9	15	1.5
Design flange coupling for specific torque	5	Technical	4	9	13	1.3
Total			60	90	150	15
Industrial Instrumentation (5)						
Design & Implement a process control	5	Technical	9	21	30	3
Install Transducer & Transmitters in Industrial Applications	5	Technical	9	21	30	3
Install the process Regulators	5	Technical	9	21	30	3
Install the Variable Frequency Drive (VFD)	5	Technical	9	21	30	3
Install Pneumatic & Hydraulic systems	5	Technical	9	21	30	3
Total			45	105	150	15
Robotics(5)						
Identify Various Parts of Robots	3	Technical	8	18	26	2.6
Identify Various Parts of Robot Arm	3	Technical	6	24	30	3
Develop Robot program	5	Technical	9	15	24	2.4
Develop robotic arm structure	5	Technical	8	18	26	2.6
Test the Robot	5	Technical	8	15	23	2.3
Total			39	90	129	12.9
Mechatronic Projects						
Access Control System using RFID Reader RC522	5	Technical	9	30	30	3

Finger print Sensor Based Biometric Attendance System	5	Technical	9	30	30	3
Humidity and Temperature Monitoring System.	5	Technical	9	27	27	2.7
Smart Stick for Blinds	5	Technical	9	30	30	3
Perform Line Following Robot	5	Technical	9	33	33	3.3
Perform Smart Phone Control Robot Using Bluetooth	5	Technical	9	36	36	3.6
Perform IoT Controlled based home automation system	5	Technical	9	40	40	4
Perform Smart Phone Control Door Lock System	5	Technical	9	36	36	3.6
Perform Security System Using Motion Detection	5	Technical	9	36	36	3.6
Perform Water- Detection in Tank	5	Technical	9	33	33	3.3
Perform Mini CNC 2D Plotter	5	Technical	9	33	33	3.3
Perform Voice Controlled Robot	5	Technical	9	36	36	3.6
Total			108	400	400	40
Hydraulics and Pneummatics 5						
Operate Hydraulic Bench and Its Functions	5	Technical	3	3	6	0.6
Calibrate Bourdon Tube and Diaphragm Pressure Gauge	5	Technical	3	6	9	0.9
Operate Hydraulic Press	4	Technical	3	10	13	1.3
Verify Bernoulli's Equation	5	Technical	5	9	14	1.4
Analyse the performance of Pumps	5	Technical	5	9	14	1.4
Construct circuit for Double Acting Hydraulic Cylinder	4	Technical	3	5	8	0.8
Setup a Pressure Device and Hold Specific Load on a Double Acting Cylinder	5	Technical	3	7	10	1
Construct Circuit of Double Acting Hydraulic Cylinder for Mechanical Interlocking	5	Technical	8	11	19	1.9
Set Speed and Direction of Hydraulic Motor	5	Technical	3	5	8	0.8
Operate Pressure Measuring Instruments	5	Technical	12	16	28	2.8

Operate Flow Regulating Devices	5	Technical	7	14	21	2.1
			55	95	150	15
Entrepreneurial Skill (5)						
Develop Entrepreneurial Skills	5	Generic	6	18	24	2.4
Apply project information management and communications techniques	5	Generic	9	15	24	2.4
Apply project human resources management approaches	5	Generic	9	15	24	2.4
Direct human resources management of a project program	5	Generic	9	15	24	2.4
Develop a project management plan	5	Generic	6	15	21	2.1
Maintain business resources	5	Generic	6	15	21	2.1
Develop a sales plan	5	Generic	6	24	30	3
Plan and implement business-to-business marketing	5	Generic	6	24	30	3
Address customer needs	5	Generic	9	21	30	3
Manage personal finances	5	Generic	9	15	24	2.4
Solve problems which jeopardize safety and security	5	Generic	6	24	30	3
Coordinate a work team	5	Generic	6	24	30	3
Lead small teams	5	Generic	6	24	30	3
Plan and organize work	5	Generic	6	24	30	3
Develop teams and individuals	5	Generic	6	24	30	3
Apply problem solving techniques in the workplace using critical thinking	5	Generic	6	24	30	3
Manage human resource services	5	Generic	6	24	30	3
Total			117	345	462	46.2

NOTE:- The semester project may please be allotted to the students by the concerned teacher in relevant technology, while the final semester project is already laid down in the curriculum.

13. Detail of Qualifications and its Competency Standards

Health and Safety

0714E&A1. Maintain Health and Safety

Overview: This competency standard covers the skills and knowledge required to ensure safety of machine, knowledge of safety alarm in working area, personal protective equipment (PPE), Maintain First-aid Box, Maintain Fire protection and Machines safety.

Competency Unit	Performance Criteria
CU1. Ensure safeguarding devices Off condition	**P-1.** Check the alarm or indicator or devices which represent the Human Presence in the working area. **P-2.** Check and test the working of mechanical limits and working area. **P-3.** Check and test the interlock barrier and guards during off load. **P-4.** Analyze and interpret the data. **P-5.** Report the results.
CU2. Ensure Safeguarding devices in on condition	**P-1.** Locate and distinguish the various types' areas, i.e. Supervisor area, operator area, user area and restricted area for area labelling. **P-2.** Check and observe the absence of human presence in the restricted area with the naked eye and verify with the Human presence sensor output. **P-3.** Check and test the starting parameter for starting Robot, i.e. input power, frequency, lubrication, etc. **P-4.** Check and test working of the Emergency braking mechanism, while emergency power stop is not recommended. **P-5.** Analyse and interpret the data. **P-6.** Report the results.
CU3. Ensure safety devices during ON load condition	**P-1.** Check and test the ON load sensing devices, interlocks, ON/OFF load torque and feedback mechanism. **P-2.** Compare the on load and offload data. **P-3.** Analyze and interpret data. **P-4.** Report the results.
CU4.Ensure Personal	**P-1.** Arrange personal protective equipment as per

Protective Equipment (PPE).	requirements **P-2.** Wear correct personal protective equipment **P-3.** Store PPE at appropriate place after use.
CU5. Maintain First-aid Box	**P-1.** Ensure availability of first aid box **P-2.** Check first aid box for requisite emergency **P-3.** Check expiry of medicines **P-4.** Perform first aid treatment against electric shocks **P-5.** Perform first aid treatment/bandages against minor injuries.
CU6. Maintain Fire Extinguisher	**P-1.** Check expiry of fire extinguisher. **P-2.** Operate fire extinguisher. **P-3.** Replace fire extinguisher. **P-4.** Ensure that the fire brigade is at stand by(for major emergency).
CU7. Ensure Safeguard of Machines	**P-1.** Maintain radiator shield **P-2.** Maintain alternator fan shield **P-3.** Maintain heat resister material on silencer **P-4.** Cover main circuit breaker **P-5.** Lock canopy doors

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- Define Hazards and its types.
- Define Guarding methods.
- Differentiate between physical, chemical and electrical hazards
- Describe treatments of various hazards
- Describe Use of personal protective equipment (PPE).
- Describe occupational health & safety regulations.
- Define safe manual handling techniques.
- Describe typical worksite hazards
- Describe factors affecting health & safety in the workplace.
- Describe First-Aid-Box

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Define the alarm devices indicators
- Explain various type's areas, supervisor area, operator area, user area and restricted area
- Identify Health and safety signs and precautions
- Prepare the list of PPEs.
- Demonstrate the use of PPEs while performing job at least one.
- Perform first aid treatment against electric shock/minor injury.
- Explain safety procedure at workplace
- Differentiate between safe and unsafe tools.

Tools and Equipment

The tools and equipment required for this competency standard are given below:

S. No.	Items
1.	Safety Shoes
2.	Bump cap (Hard hat) / Helmet
3.	Safety gloves
4.	Appropriate safety glasses
5.	High visibility vest
6.	Safety clothes (Overall)
7.	Hearing protection Ear Plugs/Ear Mufflers
8.	Breathing apparatus
9.	Fall protection
10.	Site emergency response plan
11.	Fire extinguishers
12.	Fire blankets
13.	Respirators/ masks
14.	First aid kits
15.	Stretchers
16.	WHMIS book
17.	First Aid Kit
18.	*ANSI/RIA R15.06-2012*

0714E&A2. Perform safety practices at work place

Overview: This competency standard covers the skills and knowledge required to ensure safety of machine, knowledge of company policies, prepare for emergencies and able to respond emergencies.

Competency Unit	Performance Criteria
CU1. Adopt company policies and procedures	**P1.** Ensure company's safety policy. **P2.** Adopt company safety procedure. **P3.** Advocate worker with company safety policy. **P4.** Implement Safety sign board as per standard.
CU2. Attain health & safety training	**P1.** Take required health and safety training. **P2.** Implement work hazardous material information system (WHMIS). **P3.** Adopt first aid cardio respiratory, resuscitation and CPR.
CU3. Prepare for emergencies	**P1.** Check Take emergency response training. **P2.** Ensure practice of emergency exercises. **P3.** Check the emergency alarms. **P4.** Ensure regular practice of gathering the workers in assembly area during the emergency.
CU4. Respond to emergencies	**P1.** Arrange Follow emergency plan **P2.** Communicate instructions to co workers **P3.** Assess risk and determine course of action **P4.** Operate emergency equipment and supplies **P5.** Ensure that the ambulance is at stand by (for emergency)
CU5. Maintain First-aid Box	**P-1.** Ensure availability of first aid box **P-2.** Check first aid box for requisite emergency **P-3.** Check expiry of medicines **P-4.** Perform first aid treatment against electric shocks **P-5.** Perform first aid treatment/bandages against minor injuries.
CU6. Maintain Fire Extinguisher	**P-1.** Check expiry of fire extinguisher. **P-2.** Operate fire extinguisher. **P-3.** Replace fire extinguisher. **P-4.** Ensure that the fire brigade is at stand by(for major emergency).

CU7. Ensure Safeguard of Machines	**P-1.**	Maintain radiator shield
	P-2.	Maintain alternator fan shield
	P-3.	Maintain heat resister material on silencer
	P-4.	Cover main circuit breaker
	P-5.	Lock canopy doors

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

Types of Accidents
Robotic incidents can be grouped into four categories: a robotic arm or controlled tool causes the accident, places an individual in a risk circumstance, an accessory of the robot's mechanical parts fails, or the power supplies to the robot are uncontrolled.

- Impact or collision accidents
- Crushing and trapping accidents
- Other accidents

Sources of Hazards:

- Human
- Control errors
- Unauthorized access
- Mechanical failures
- Power systems
- Improper installation

Guarding Methods:

- Interlocked Barrier Guard
- Fixed Barrier Guard
- Awareness Barrier Device
- Presence Sensing Devices
- Emergency Robot Braking

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Perform safety reporting procedures and documentation
- Describe fire-fighting methods
- Demonstrate use of appropriate Personal Protective Equipment (PPE) for the assigned job
- Demonstrate removal and disposal of PPE.

Tools and Equipment

The tools and equipment required for this competency standard are given below:

S. No.	Items
1.	Safety Shoes
2.	Bump cap (Hard hat) / Helmet
3.	Safety gloves
4.	Appropriate safety glasses
5.	High visibility vest
6.	Safety clothes (Overall)
7.	Hearing protection Ear Plugs/Ear Mufflers
8.	Breathing apparatus
9.	Fall protection
10.	Site emergency response plan
11.	Fire extinguishers
12.	Fire blankets
13.	Respirators/ masks
14.	First aid kits
15.	Stretchers
16.	WHMIS book
17.	First Aid Kit
18.	*ANSI/RIA R15.06-2012*

0714E&A3. Develop Professionalism

Overview:

This competency standard covers the skills and knowledge required to Demonstrate work ethic, Aware of factors affecting personal health, Resolve problems or disagreements with others, participate in professional development, Work with others, Work independently, Speak and listen effectively, interpret documentation, communicate using signals, and communicate Using electronic equipment.

Critical Evidence	Performance Criteria
CU1. Demonstrate work ethic	P1. Follow principles of work ethics in all situations P2. Adopt professional behavior
CU2. Select factors affecting personal health	P1. Follow factors affecting personal health P2. Aware about the situations/conditions that cause stress in professional and personal life
CU3. Resolve problems or disagreements with others	**P1.** Communicate effectively **P2.** Adopt peaceful approach **P3.** Regulate cause of problem or disagreement **P4.** Resolve issues
CU4. Participate in professional development	P1. Assess own knowledge and skills P2. Acquire information about training opportunities P3. Adopt to Learn through various methods, such as on job training, reading, courses and co-workers
CU5. Work with others	P1. Work as a team member to achieve common goals P2. Keep mind open. P3. Participate in work place meetings P4. Communicate accurately and clearly P5. Co-ordinate job related activities P6. Cooperate with others
CU6. Work independently	P1. Confirm and clarify assignment P2. Take initiative, anticipate and prepare for next steps in job P3. Identify and resolve potential and actual problems P4. Communicate with other site personnel P5. Complete assignment
CU7. Speak and listen effectively	P1. Listen carefully to what is said P2. Confirm understanding, such as repeat instructions

	P3. Communicate message clearly and accurately to others P4. Exchange information with others, such as supervisor, signaler, general public, inspectors, other operators and trade people
CU8. Interpret documentation	P1. Access and maintain documents P2. Provide complete, legible and accurate information in documents P3. Interpret equipment inspection documentation from previous shifts before conducting pre-operational inspection
CU9. Communicate with signals	P1. Identify and work with signals P2. Communicate with audible signals, such as back-up alarm, and site emergency horn P3. Communicate with hand signals
CU10. Communicate with electronic equipment	P1. Check communication devices to verify operating condition, such as complete radio checks P2. Deliver and receive messages using communication equipment P3. Follow communication protocol

Knowledge & Understanding

- Explain Principles of work ethic and expectations.
- Describe Factors/situations/conditions that cause stress in professional and personal life
- Explain working conditions on construction site
  What is the impact of fatigue on job performance?
- What are Conflict resolution techniques?
- What is the importance of effective communication?
- Define roles of individuals on job site, such as supervisor, inspector, other trades people
- Knowledge of types of documentation required, such as log books, safety reports, maintenance reports, inspection reports, time cards
- What are Audible and warning signals used on job site
- Explain the types of communication equipment used on job site

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard**:**

- Handle and set Lightening for Current affair program Own current mental, emotional, and physical state.
- Working conditions on construction site.
- Effective communication.
- Maintain log books, safety reports, maintenance reports, inspection reports, time cards
- Signalers on job site
- Audible and warning signals used on job site
- Communication equipment used on job site

Basic Machining

0714E&A4. Perform Metal / Bench Work

Overview: Overview: This competency standard covers the skills and knowledge required to Develop Name Plate manually, Carry out Sawing, Prepare Inside Calliper, Prepare Bottle Opener, Prepare Dovetail Joint, Prepare Tri Square (small size), ,Cut Threads on Work Piece, Prepare Funnel, Prepare Drawer Handle, Cut Pipe Threads and Prepare spanner (small size).

Critical Evidence	Performance Criteria
CU1. Develop Name Plate manually	**P1.** Select the marking tools **P2.** Hold the sheet in vice. **P3.** Cut the sheet as per given drawing **P4.** Perform surface finishing with file **P5.** Level the surface with tri-square **P6.** Mark the plate as per name requirements **P7.** Punch the marked area **P8.** Perform finishing with sand paper
CU2. Prepare Dovetail Joint	**P1**. Select marking tools **P2**. Cut sheet as per drawing **P3**. Perform surface finishing with file **P4**. Level the surface of both work pieces with tri-square **P5**. Mark both work pieces according to drawing **P6**. Create outer notch on work piece using flat file and hacksaw **P7**. Create inner notch using hacksaw and chisel **P8**. Compare both pieces by inserting outer notch into inner notch **P9.** Perform the finishing with the sand paper
CU3. Prepare Bottle Opener	**P1**. Select marking tools **P2**. Cut sheet as per drawing **P3**. Perform surface finishing with file **P4**. Level the surface with tri-square **P5**. Mark radius as per drawing **P6**. Develop radius as per drawing **P7**. Make the notch with round file **P8**. . Perform finishing with sand paper

CU4. Cut Threads on Work Piece with tap and die	**P1**.Identify different kind of taps & die according to requirement **P2**. Identify the work piece clamping method. **P3**. Apply the tap and die alignment. **P4**. Apply the lubricants while threading. **P5**. Avoid the unwanted engraving and slips. **P6**. Identify the proper threading procedure
CU5. Cut Pipe Threads	**P1**.Select marking tools **P2**. Cut pipe as per drawing **P3**. Select die as per pipe size **P5**. Set die into die holder **P6**. Select relevant vice for pipe clamping **P7**. Perform pipe threading using appropriate method **P8**. Perform finishing with sand paper
CU6. Prepare spanner (small size)	**P1**.Select marking tools **P2**. Cut sheet as per drawing **P3**. Perform surface finishing with file **P4**. Level the surface with tri-square **P5**. Mark radius as per drawing **P6**. Develop radius as per drawing **P7**. Make the notch with round file **P8**. Perform finishing with sand paper
CU7. Prepare Funnel	**P1**. Select marking tools **P2**. Cut sheet as per drawing **P3**. Perform surface finishing with file **P5**. Mark the sheet according to drawing **P6**. Cut the sheet with hand shear **P7**. Create radius of funnel using appropriate tools **P8**. Perform flat lock seam bend using bench vice **P9.**Perform finishing with sand paper.

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

K1. Define basic measurement
K2. Describe basic measuring / Marking / cutting tools
K3. Describe clamping / holding methods.

K4. Describe the types of chisels
K5. Understanding of chiseling process
K6. Understanding of types of fits.
K7. Knowledge of radius gauge
K8. Describe use of round file
K9. Knowledge of different kind of taps & die according to requirement
K10. Knowledge of calculation for drill size for internal threading
K11. Knowledge about clamping of work piece.
K12. Knowledge about threading by die and taps
K13. Knowledge of standard bolts
K14. Understanding proper use of hand shear
K15. knowledge of flat lock seam end in metal sheet working

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Make threads in a hole with tap and die.
- Make threads on a pipe
- Make a funnel of given size

Tool & Equipment

- Work bench
- Bench vices
- Hammer
- Tri-square
- Hand hacksaw
- Scriber
- Vernier caliper
- Flat File
- Number/alphabet punch
- Round file
- Metal working chisel
- Punching tools
- Tap set
- Tap handle
- Pipe vice

0714E&A5 Perform general machining

Overview: This competency standard covers the skills and knowledge required to determine job requirements and sequence of operations, Select and mount tools, perform machining operations and Measure components, Adjust and maintain machine

Critical Evidence	Performance Criteria
CU1. Determine job requirements and sequence of operations	P1. Interpret and understand drawings, instructions and specifications. P2. Determine sequence of operations including job specifications and set-up for maximum efficiency P3. Select appropriate material and establish datum as required
CU2. Select and mount tools	P1. Select a proper tools for the job, P2. Check the sharpeness. P3. Mount the tool in the machine P4. Check the position of tools
CU3. Prepare for machining operations	P1. Mark the work piece P2. Set the parameters for the job P3. Check the requirements for the maximum tool life. P4. Clamped the work piece correctly. P5. Prevent the workpiece from the damage P6. Take product safety requirements. P7. Take personel safety requirements. P8. Perform the Machining
CU4. Measure components, Adjust and maintain machine	P1. Use appropriate instruments or gauges to check components are compliant with measurement requirements and specifications. P2. Carry out routine maintenance and adjustments as required including slide and collar adjustment, cleaning and lubrication

Knowledge & Understanding

- **K1.** Describe basic measurement
- **K2.** Describe basic measuring /Marking /cutting tools
- **K3.** Describe clamping / holding methods
- **K4.** Define Machine shop tool their working and safety procedure during work.
- **K5.** Define Marking tools.
- **K6.** Describe the safety procedure using marking tools.
- **K7.** Describe different type of measuring tools.
- **K8.** Describe Proper Usage of Measuring Tools

K9. Describe different type of measuring tools.

K10. Describe machine types according to their work and rotation.

K11. Describe maintenance and its types.

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Prepare the machine for job.
- Take the dimensions of work piece for job.

Tool & Equipment

- Measuring tools
- Marking tools
- Work holding devices
- Cutting tools
- Machine tools
- Gauges
- Set of spanners
- Set of Allen keys

0714E&A6 Perform cutting on Metal Circular/Power Heck Saw

Overview: This competency standard covers the skills and knowledge required to Carry out Sawing and Carry out Sawing at different angles

Critical Evidence	Performance Criteria
CU1. **Carry out Sawing**	**P1**. Mark the job according to given drawing **P2**. Select appropriate blade according to job requirement **P3**. Set blade in frame of hacksaw as per procedure **P4**. Ensure the work piece is clamped firmly and properly **P5**. Adopt methods and techniques for sawing that is appropriate to job requirement **P6**. Follow marked line during sawing to ensure accuracy.
CU2. **Carry out Sawing at differet angles**	**P1.** Mark the job according to given drawing **P2.** Select appropriate blade according to job requirement **P3.** Set blade in frame of metal circular saw as per procedure. **P4.** Ensure the blade tightness and rotating side. **P5.** Ensure the work piece is clamped firmly and properly **P6.** Adopt the methods and techniques for sawing that is appropriate to job requirement **P7.** Follow marked line during sawing to ensure accuracy.

Knowledge & Understanding

K1. Describe basic measurement
K2. Describe types of hacksaw frames
K3. Describe basic measuring / Marking / cutting tools
K4. Describe clamping / holding methods
K5. Define methods and techniques of sawing.
K6. Describe basic measurement
K7. Describe types of hacksaw frames
K8. Describe basic measuring / Marking /cutting tools
K9. Describe clamping / holding methods.
K10. Define methods and techniques of sawing.

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Cut the work piece with sawing linearly.
- Cut the work piece with sawing at angle.

Tool & Equipment

- Work bench
- Bench vice
- Tri-square
- Hand hacksaw with blade
- Scriber
- Flat File
- Vernier caliper
- Punching tools
- Work bench
- Bench vice
- Tri-square
- Hand hacksaw with blade
- Scriber
- Flat File
- Vernier caliper
- Punching tools

0714E&A7 Perform tool sharpening

Overview: This competency standard covers the skills and knowledge required to perform off-hand grinding and Sharp single point cutting tool on grinding

Critical Evidence	Performance Criteria
CU1 Perform off-hand grinding	P1. Select the proper size and shape of grinding wheel. P2. Observe personal and workplace safety. P3. Hold the work piece firmly against the rotating wheel by placing it on the tool rest. P4. Avoid over heating of the job P5. Adopt technique and methods which are safe. P6. Produce component according to work operations.
CU2 Sharp single point cutting tool on grinding	P1. Select the proper size and shape of grinding wheel. P2. Observe the personal and workplace safety. P3. Hold the work piece firmly against the rotating wheel by placing it on the tool rest. P4. Use the coolant at intervals to avoid over heating of the job. P5. Adopt technique and methods which are safe. P6. Sharp the tool according to work requirements.

Knowledge & Understanding

K1. Types of different grinding machines.

K2. Type, size and shape of wheels and abrasive.

K3. Technique of holding work piece against rotating wheel.

K4. Importance of using coolant.

K5. Methods and techniques for off-hand grinding.

K6. Selecting correct standing position during grinding.

K7. Specific safety precautions and guidelines.

K8. Types of different grinding machines.

K9. Type, size and shape of wheels and abrasive.

K10. Technique of holding work piece against rotating wheel.

K11. Importance of using coolant.

K12. Methods and techniques for off-hand grinding.

K13. Selecting correct standing position during grinding.

K14. Specific safety precautions and guidelines.

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Sharp the work piece.

Tool &Equipment

- D-type bevel protector
- Grinding Machine
- Personal Protective Equipment
- Coolant
- Wheel Dresser stand
- Dresser

0714E&A8 Perform Basic Lathe Machine Operations

Overview: This competency standard covers the skills and knowledge required to Perform cantering operations, Perform facing Operations, Perform turning operations, Perform drilling or boring operations, Perform step turning operations, Perform knurling Operations, Taper turning by tail stock off-set method, Taper turning by plain taper turning attachment, Taper turning by telescopic taper turning attachment and Perform Internal and External threading Operations

Critical Evidence	Performance Criteria
CU1. Perform centering operations	P1. Select the facing tools according to the job requirement. P2. Mount and set the required work-holding devices, work piece and cutting tools. P3. Follow the correct specifications for the part or component to be produced. P4. Select the safe procedures and tools to accomplish the work. P5. Adjust the operating parameters (e.g. speed and feed) of machine tool for centering the job. P6. Ensure all safety mechanisms are in followed .
CU2. Perform facing Operations	P1. Select the facing tools according to job requirement. P2. Mount and set the required work ? ?-holding devices, work piece and cutting tools. P3. Follow the correct specifications for the jop / part or component to be produced. P4. Select safe procedures and tools to accomplish the work. P5. Adjust the operating parameters (e.g. speed and feed) of machine tool to achieve the work specification. P6. Ensure all safety mechanisms are followed .
CU3. Perform turning operations	P1. Obtain and follow the work specifications, drawings or sketches to accomplish the work. P2. Set up and adjust the machine as per work specifications and procedures. P3. Ensure the components produced have the required quality and specified dimensional accuracy. P4. Shut down the machine and equipment on What you want to say ?
CU4. Perform drilling or boring operations	P1. Select the drilling or boring tools according to the drawings. P2. Mount and set the required work (holding devices, work piece and

	cutting tools) P3. Adjust the RPM of machine according to the cutting speed. P4. Perform the boring operation according to the drawing. P5. Check quality of the component produced at different intervals. P6. Observe the personal and workplace safety.
CU5. Perform step turning operations	P1. Mount and set the required work-holding devices, work piece and cutting tools. P2. Select and adjust the appropriate speeds and feeds of turning machine. P3. Produce a component which matches the work specifications using appropriate methods and techniques. P4. Check the quality of the component produced at various intervals. P5. Follow the safety precautions to ensure safe work and to avoid any injury.
CU6. Perform knurling Operations	P1. Select the knurling tool according to drawing. P2. Set the tool and work piece in the machine according to the procedure. P3. Adopt the methods and techniques in order to produce proper knurling on the work piece. P4. Select and adjust an appropriate speeds and feeds of the lathe machine. P5. Use the coolants during knurling to achieve a smooth impression on the work piece. P6. Observe the personal and workplace safety.
CU7. Taper turning by tail stock off-set method	P1. Loosen the tailstock clamp out. P2. Offset tailstock required amount. P3. Centre the cutting tool. P4. Setup the cutting tool for a parallel turning. P5. Check the taper for an accuracy using the taper ring gauge. P6. Finish and turn the taper according to the required size in order to fit
CU8. Taper turning by plain taper turning attachment	P1. Remove the binding screw that cross the slide to cross the feed screw and nut. P2. Tighten the lock screw and set the cutting tool in the center. P3. Set the workpiece in the lathe machine and mark the length of taper.

	P4. Use the binding screw in order to connect the sliding block and side of taper's attachment. P5. Select the depth of a feed cut by the compound rest and feed handle. P6. Take a light cut and recheck the taper fit. P7. Finish the turn and fit the taper to a gauge.
CU0714E&A Taper turning by telescopic taper turning attachment	P1. Clean and oil the guide bar. P2. Loose lock screws and offset end of guide bar, P3. Set the bar to required taper in degrees. P4. Tighten the lock screw and set cutting tool on center. P5. Set the workpiece in lathe and mark the length of a taper and tighten the connecting screw on a sliding block. P6. Move the carriage until the center of attachment is opposite to the length of taper. P7. Lock the anchor and bracket to the lathe bed. P8. Take a cut and select the depth of a cut. P9. Readjust the taper attachment, Take a light cut and recheck the taper fit. P10. Finish the turn and fit the taper to a gauge.
CU10. Perform Internal and External threading Operations	P1. Mount and set the required work-holding devices, work piece and cutting tools. P2. Select and adjust the appropriate speeds and feeds of the turning machine. P3. Produce a component which matches the work specifications using an appropriate methods and techniques. P4. Check the quality of a component produced at the various t intervals. P3.Use the Proper cutting tool with a required dimensions. P5. Follow the safety precautions in order to ensure safe working environment to avoid accidents and injuries.

Knowledge & Understanding

K1. Safety precautions involved in the work.

K2. Methods and techniques of the mounting and setting of a work-piece.

K3. Methods and techniques for the adjustment of operating parameters of the machines and tools. .

K4. Procedure for the adjustment of speed and feed.

K5. Calculation of the speed and feed.

K6. Use of the holding and cutting tools

K7. Reading, understanding and interpretation of the work's specifications, drawings and sketches.

K8. Method and technique of the setting up and adjusting the machine.

K9. Techniques to check the quality of component produced.

K10. Procedure of the shutting down of machine and equipment after closure of activities.

K11. Safety precautions and procedures need to be observed the during work.

K12. Types of the drilling or boring tools and their function.

K13. Procedure of mounting and setting up of work-holding devices, work pieces and cutting tools.

K14. Method and technique of the adjusting RPM of a lathe machine.

K15. Safe boring procedures.

K16. Techniques of checking quality of components.

K17. Calculation of RPM.

K18. Kinds of tapers.

K19. Types of taper turning methods.

K20. Calculation of tapers.

K21. Methods and techniques of adjusting speeds and feeds of turning machine.

K22. Types of knurling tools.

K23. Types of knurling.

K24. Procedure of setting tools and work piece in the machine.

K25. Methods of knurling.

K26. Procedure of adjusting speeds and feeds of a lathe machine. Importance of using a coolants during a knurling.

K27. Knowledge of a lathe operations

K28. Use of a dial indicator

K29. Types of a threading tool.

K30. Types of a threading.

K31. Procedure of setting tools and work piece in the machine.

K32. Methods of threading.

K33. Procedure of adjusting speeds and feeds of a lathe machine. Importance of using the coolants during the knurling.

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Make a knurl on shaft
- Drill and Bore the shaft
- Perform turning operations.

Tool & Equipment

- Lathe Machine
- Cutting Tools
- Measuring Tools
- Personal Protective Equipment
- Files
- Vernier Caliper
- Checking gauges
- Knurling Tools
- Threading Tools

0714E&A9 Perform Drilling Machine Operations

Overview: This competency standard covers the skills and knowledge required to produce holes using drilling machine, Perform counter boring and counter sinking and perform machine reaming

Critical Evidence	Performance Criteria
CU1. Produce holes using drilling machine	**P1**. Observe the personal and work place safety. P2. Set up the drilling machine for producing holes according to a job requirement. P3. Manipulate the machine tool controls safely and correctly in line with the operational procedures. P4. Produce components to the required quality and within the specified dimensional accuracy. P5. Carry out quality sampling checks at suitable intervals. P6. Shut down the equipment to a safe condition
CU2. Perform counter boring and counter sinking	P1. Select the relevant tools according to the information given in engineering drawings and job specifications. P2. Ensure the tooling is correct in terms of size, shape, type, and grade in order to perform the job / work. P3. Position the work-piece in the drill in such a way that it is aligned, secured and stable during drilling. P4. Adjust the speeds and feeds of the drill according to the size, type, and hardness of the work-piece material, in order to performs the optimum cutting without damage to the work-piece.
CU3. Perform machine reaming	P1. Observe the personal and workplace safety. P2. Clamp the work-piece in the vice properly. P3. Select the reamer according to the hole's size and drawing requirements P4. Set the reamer in the drill chuck according to procedure. P5. Use the lubricants during reaming for the smooth cutting. P6. Ensure the proper alignment of the reamer during the operations.

Knowledge & Understanding

- **K1.** Safety precautions.
- **K2.** Procedure of the setting up of a drilling machine.
- **K3.** Safe procedure for an operating drilling machines.

K4. Types of the drilling machines.
K5. Selecting and adjusting speed and feed of drilling machine.
K6. Importance of coolants in drilling operations.
K7. Methods and techniques of quality checks.
K8. Different types of drilling tools and their implications.
K9. Importance of selecting right drilling tool for the job specifications.
K10. Methods and techniques for positioning the work-piece in the drill to ensure proper alignment and stability during drilling.
K11. Using speeds and feeds chart for different types of materials and their hardness.
K12. Specific safety precautions during boring and sinking operations.
K13. Safety precautions.
K14. Selecting reamer according to hole size.
K15. Types of reamers (straight teeth or helical teeth).
K16. Method of setting reamer in the drill chuck.
K17. Importance of using lubricants during reaming.
K18. Importance of alignment of the reamer during operations.

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Make a hole in steel plate or wood
- Bore in a hole
- Finish / fine the drill hole

Tool & Equipment

- Drilling Machines
- Drill chuck with Key
- Machine Vice
- Marking Tools
- Measuring Tools
- Drill Sleeve and Socket
- Personal Protective Equipment
- Counter drill
- Cutting oil
- Tri square
- Measuring Tool

0714E&A10 Perform Shaper, Planar and Slotter Machining Operations

Overview: This competency standard covers the skills and knowledge required to produce a squared shape work piece, Produce V shaped work piece, Machining a Rack Gear, T-slot Machining, Machining Irregular Surfaces, Machining External Keyways and Machining internal Keyways

Critical Evidence	Performance Criteria
CU1. Produce a squared shape work piece	P1. Identify the safety hazards related the shaping operations in order to to avoid injury / accident. P2. Select a point cutting tool and set the machine as per requirements. P3. Mount a cutting tool and the awork piece in the machine. P4. Check the quality of the component at suitable intervals. P5. Shut down the machine at safe position after completion of work.
CU2. Produce V shaped work piece	P1. Identify the safety hazards related to the shaping operations in order to to avoid any injury / accident. P2. Dial the machine vice according to job requirement. P3. Select point cutting tool and set machine according to job requirements. P4. Mount cutting tool and work piece in the machine. P5. Check quality of the component at suitable intervals. P6. Shut down the machine in safe position after finishing the work
CU3. Machining a Rack Gear	P1. Identify safety hazards related with shaping operations and take appropriate steps to avoid any injury or accident. P2. Dial the machine vice according to job requirement. P3. Select point cutting tool and set machine according to job requirements. P4. Mount cutting tool and work piece in the machine. P5. Set the job/Tool Movement According to specified speed P6. Check quality of the component at suitable intervals. P7. Shut down the machine in safe position after finishing the work
CU4. T-slot Machining	P1. Identify safety hazards related with shaping operations and take appropriate steps to avoid any injury or accident. P2. Dial the machine vice according to job requirement.

	P3. Select point cutting tool and set machine according to job requirements. P4. Mount cutting tool and work piece in the machine. P5. Check quality of the component at suitable intervals. P6. Shut down the machine in safe position after finishing the work
CU5. Machining Irregular Surfaces	P1. Identify safety hazards related with shaping operations and take appropriate steps to avoid any injury or accident. P2. Dial the machine vice according to job requirement. P3. Select point cutting tool and set machine according to job requirements. P4. Mount cutting tool and work piece in the machine. P5. Use Different feed and speed of cutting and different points according to given drawing P6. Check quality of the component at suitable intervals. P7. Shut down the machine in safe position after finishing the work P8. Correct according to the “CU1”
CU6. Machining External Keyways	P1. Identify safety hazards related with shaping operations and take appropriate steps to avoid any injury or accident. P2. Dial the machine vice according to job requirement. P3. Select point cutting tool and set machine according to job requirements. P4. Mount cutting tool and work piece in the machine. P5. Check quality of the component at suitable intervals. P6. Shut down the machine in safe position after finishing the work
CU7. Machining internal Keyways	P1. Identify safety hazards related with shaping operations and take appropriate steps to avoid any injury or accident. P2. Dial the machine vice according to job requirement. P3. Select point cutting tool and set machine according to job requirements. P4. Mount cutting tool and work piece in the machine. P5. Check quality of the component at suitable intervals. P6. Shut down the machine in safe position after finishing the work

Knowledge & Understanding

- **K1.** List the safety hazards related to the shaper machine operations.
- **K2.** Use of Dial indicator
- **K3.** Method of the mounting of cutting tool
- **K4.** Checking of a right angle with the tri square.
- **K5.** Explain the square facing procedure.
- **K6.** Safety guidelines and procedures.
- **K7.** Safety checks for operating a shaper machine.
- **K8.** Interpreting the information given in the engineering drawings and job specifications

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Make V or square shape work piece
- Make Internal or External key ways in shaft
- Make a rack

Tool & Equipment

- ❖ Shaper, Planar or Slotter
- ❖ Machine Vice
- ❖ Tri square
- ❖ Vernier Calliper
- ❖ Dial indicator with magnet stand
- ❖ Point cutting tools
- ❖ Personal Protective Equipment
- ❖ Tri square/bevel protector

0714E&A11 Perform Milling Operations

Overview: This competency standard covers the skills and knowledge required to Prepare Blank for Generating the Gear, Select Tools and Equipment for Gear Cutting, Produce a square shaped work piece, Generate spur gear (Direct Indexing) On Milling Machine, Generate spur gear (Differential Indexing) On Milling Machine, Generate Helical Gear On Milling Machine, Perform slotting or grooving on work piece, Perform drilling or boring using milling machine, Milling a T slot, Bevel gear cutting on milling machine, Practice of spur rack cutting and Practice of helical rack cutting.

Critical Evidence	Performance Criteria
CU1. Prepare Blank for Generating the Gear	**P1**. Interpret the drawing and arrange the material according to the job requirement P2. Prepare the work-piece by required machining (sawing and filing etc.) and get it ready for turning the blank P3. Check and verify the dimensions of the blank for generating the gear as per drawing
CU2. Select Tools and Equipment for Gear Cutting	P1. Select the material, type, shape and size of cutter(s) according to the job requirements P2. Arrange the measuring instruments and holding devices to attain accuracy of the work as according to the prescribed method
CU3. Produce a square shaped work piece	P1. Identify the safety hazards related with milling operations and take appropriate steps to avoid any injury or accident. P2. Dial the machine vice according to job requirement. P3. Select the cutters and set the machine as per requirements. P4. Mount a cutters and the work piece in the machine. P5. Produce a part matching the process plan and the part print specifications. P6. Check the quality of component at the recommended intervals. P7. Shut down the machine at safe position after completion of the work / job.
CU4. Generate spur gear (Direct Indexing) On Milling Machine.	**P1.** Select the gear cutter and indexing plate on a milling machine **P2.** Mount the indexing plate on a indexing head. **P3.** Centre the indexing head and its tail stock. **P4.** Fix the indexing head and tail stock on the milling table. **P5.** Engage worm shaft from worm wheel

	P6. Adjust the speed, feed and direction of the cutter. **P7.** Mount the Gear blank on the mandrel. **P8.** Hold the one side of the mandrel on chuck of indexing head and other side in the tail stock **P9.** Start the machine and perform the cutting operation at zero point and in vertical direction . **P10.** Repeat the above step P9 in horizontal direction Apply the depth for a rough cut and configure the machine in the longitudinal direction **P11.** Move the table back at zero point. **P12.** Apply the full depth for final cut and configure machine automatically in the forward direction. **P13.** Repeat the process simultaneously until the tooth is obtained.
CU5. Generate spur gear (Differential Indexing) On Milling Machine.	**P1.** Select the gear cutter and an indexing plate on the milling machine **P2.** Mount the indexing plate on the indexing head. **P3.** Centre the indexing head and its tail stock. **P4.** Fix the indexing head and tail stock on the milling table. **P5.** Revolve the index plate forward and / or backward **P6.** Choose the number close to required division which can be indexed by simple indexing **P7.** Adjust the speed feed and direction of the cutter. **P8.** Mount the Gear blank on the mandrel. **P9.** Hold one side of the mandrel on chuck of indexing head and other side in tail stock **P10.** Start machine and carry out cutter at zero point vertically. **P11.** Carry out cutter at zero point horizontally. **P12.** Apply depth for rough cut and engage machine automatically in longitudinal direction **P13.** Move the table back at the zero point. **P14.** Apply the full depth for the final cut and engage the machine in forward direction. P15. Repeat the process until tooth is obtained.
CU6. Generate Helical Gear On Milling Machine	**P1.** Select a indexing plate to machine a helical gear on a manual machine, **P2.** Mount gear set to engage lead screw and indexing head spindle **P3.** Centre indexing head and its tail stock.

	P4. Fix indexing head and tail stock on milling table. **P5.** Adjust speed feed and direction of the cutter. **P6.** Mount Gear blank on mandrel. **P7.** Hold one side of mandrel on chuck of indexing head and other side in tail stock **P8.** Start machine and carry out cutter at zero point vertically. **P9.** Carry out cutter at zero point horizontally. **P10.** Apply depth for rough cut and engage machine automatically in longitudinal direction **P11.** Move table back at zero point. **P12.** Apply full depth for final cut and engage machine automatically in forward direction. P13. Repeat the process simultaneously until tooth is obtained.
CU7. Perform slotting or grooving on work piece	P1. Identify safety hazards related with milling operations and take appropriate steps to avoid any injury or accident. Correct according to the "CU1" and CU2 P2. Set the work piece in machine vice according to procedure. P3. Select the appropriate cutter as per specifications. P4. Adjust the milling cutter for slotting and grooving. P5. Determine the touching point of the work piece. P6. Produce slotting or grooving on the workpiece to the required quality. P7. Check quality of the component at suitable intervals. P8. Shut down the machine at safe position after finishing the work. P9. Observe personal and workplace safety at all time.
CU8. Perform drilling or boring using milling machine	P1. Identify safety hazards related with milling operations and take appropriate steps to avoid any injury or accident. P2. Select drill or boring tools according to drawings. P3. Mount and set the required work-holding devices, work piece and cutting tools. P4. Adjust the RPM of machine according to the standard chart. P5. Perform the boring operation according to the drawing. P6. Check quality of the component produced at different intervals. P7. Shut down the machine at safe position after finishing the work. P8. Observe personal and workplace safety at all time.
CU0714E&A Milling	**P1.** Layout the position of a T slot.

a T slot	**P2.** Square the vertical milling machine with machine table. **P3.** Mount the work in milling machine. **P4.** Machine the center slot to the proper depth of T slot by the end mill. **P5.** Remove the end mill and mount proper T slot cutter. **P6.** Machine the lower part of the slot.
CU10.Bevel gear cutting on milling machine.	**P1.** Cut the materials to the required size **P2.** Cut the workpiece with a lathe that is shaped into a gear blank. **P3.** Cut the gear with a Coniflex generator. **P4.** Remove the Burrs on the teeth with a deburring machine.
CU11. Practice of spur rack cutting.	**P1.** Hold the work piece in milling machine. **P2.** Hold the milling cutter in the rack milling attachment. **P3.** Hold the cutter at 90 degree for the spur cutting. **P4.** Move the table for each tooth by rack indexing attachment. **P5.** Continue the operation until the required length is obtained.
CU11. Practice of helical rack cutting	**P1.** Hold the work piece in milling machine. **P2.** Hold the milling cutter in the rack milling attachment. **P3.** Hold the cutter at some angle for helical cutting. **P4.** Move the table for each tooth by rack indexing attachment. Continue the operation until the required length is obtained.

Knowledge & Understanding

K1. List the safety hazards related with the milling machines and its operations.

K2. Use of dial indicator

K3. Methods of mounting the cutters

K4. Checking of right angle with the tri- square.

K5. Explain the square milling procedure.

K6. Safety guidelines and procedures.

K7. Safety checks for milling machine under operation.

K8. Interpretation of the information given in the engineering drawings and job specifications.

K9. Knowledge of spur gear design

K10. Identifying the safety hazards associated with the milling machine operations.

K11. Explain the procedure of slotting and grooving.

K12. Quality checks procedures and techniques.

K13. Types of drilling or boring tools and their function.

K14. Procedure of mounting and setting up of work-holding devices, work pieces and cutting tools.

K15. Method and technique for adjusting the RPM of milling machine.

K16. Safe Boring and milling procedures.

K17. Techniques for checking of the quality of the components.

K18. Milling machine operations,

K19. Bevel gear calculation

K20. Spur rack calculation

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Perform facing opeartion
- Perform drilling and boring
- Perform Turning
- Perform Internal and external threading

Tools & Equipment

- Milling machine
- Machine Vice
- Tri square
- Vernier Caliper
- Dial indicator with magnet stand
- Milling cutters
- Personal Protective Equipment
- Milling machine and its accessories
- Slotting cutter
- Vernier caliper
- Depth gauge
- End mil cutter
- Boring tools
- Internal Micrometer

Electrical Essentials & Networks

0714E&A12 Operate Measuring Instruments

Overview: This competency standard covers the skills and knowledge required to Operate Ampere meter, Volt meter & ohm meter.

Critical Evidence	Performance Criteria
CU1. Operate Ampere meter	**P1.** Identify the ampere meter. **P2.** Make a parallel circuit with three different resistors on breadboard **P3.** Adjust proper range setting of ampere meter as per load. **P4.** Connect ampere meter in series to each resistor to measure the current. **P5.** Turn on the supply and note down the reading of current against each resistor.
CU2. Operate Volt meter.	**P1.** Identify volt meter. **P2.** Build / Make a series circuit with three different resistors on a bread board. **P3.** Adjust the range setting of Volt meter as per load. **P4.** Connect volt meter across any resistor in circuit **P5.** Turn on the supply and note the reading of voltage drop against each resistor.
CU3. Operate ohm meter.	**P1.** Identify Ohm meter. **P2.** Adjust proper range of ohm meter as per resistance value. **P3.** Disconnect the resistor from the circuit **P4.** Connect ohm meter with resistor in series and parallel combination. **P5.** Record the reading.

Knowledge & Understanding

K1. Define current and its unit.

K2. Define voltage and its unit.

K3. Describe series circuit.

K4. Enlist the name of various meters

K5. Describe purpose of ampere meter

K6. Describe how ampere meter is connected in the circuit.

K7. Describe parallel circuit.

K8. Describe purpose of volt meter

K9. Describe how voltmeter is connected in the circuit.

K10. Define resistance and its unit

K11. Describe purpose of ohm meter

Tool and Equipment

- Voltmeters
- Ammeter
- Ohmmeters
- Multi meters.
- Resistors of different values.
- Small pieces of copper wire.

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Turn on the supply and note the reading of current/voltage against each resistor.
- Adjust the scale for measurements.
- Probe selection for appropriate measurement.

0714E&A13 Verify Ohm's & Kirchhoff's Laws by Implementing Series/Parallel Circuits.

Overview: This competency standard covers the skills and knowledge required to Make series circuit and measure voltage and verify KVL, make parallel circuit and measure current and verify KCL, verify resistance of a resistor, Find unknown value of ohm's law.

Critical Evidence	Performance Criteria
CU1. Make series circuit and measure voltage and verify KVL	**P1.** Construct a series circuit with different resistors on bread board and apply the supply voltage. **P2.** Measure the voltage across the each resistor. **P3.** Record the reading. **P4.** Sum the voltage drop across the each resistor. **P5.** Compare / analyze / Calculate the total voltage with the applied voltage across each resistor.
CU2. Make parallel circuit and measure current and verify KCL	**P1.** Construct a parallel circuit with different resistors on a bread board. **P2.** Connect the ampere meter in series to each resistor and measure the current. **P3.** Record the reading. **P4.** Sum the current of each resistor **P5.** Compare the sum with total consumed current.
CU3. Verify resistance of a resistor using color codes	**P1.** Select the 4 color band resistor. **P2.** Determine the value of resistor using color code. **P3.** Connect ohm meter across the resistor. **P4.** Record reading form ohm meter. **P5.** Compare both reading.
CU4. Measure resistance of incandescent lamp.	**P1.** Take 40 W lamp and 1 one digital or analog ohmmeter. **P2.** Adjust zero with shortning the ohmmeter leads. **P3.** Connect the ohmmeter with lamp terminal and note resistance **P4.** Repeat this method for 60 & 100 W lamp

Knowledge & Understanding

- **K1.** Describe characteristics of series circuit
- **K2.** Describe the use of volt meter
- **K3.** Describe characteristics of parallel circuit
- **K4.** Describe the use of ampere meter
- **K5.** Describe color codes and its use.

K6. Describe the purpose of ohm meter

K7. State Kirchhoff's voltage law.

K8. State Kirchhoff's current law

Tool and Equipment

- ❖ Voltmeters
- ❖ Ammeter
- ❖ Ohmmeters
- ❖ Multi meters.
- ❖ Resistors of different values.
- ❖ Battery
- ❖ Copper wire.
- ❖ Rheostat
- Incandescent lamp of different watts.

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Adjust zero error with shortening the analog ohmmeter leads.
- Make series circuit and measure voltage across each resistor and verify KVL
- Make parallel circuit and measure current of each resistor and verify KCL
- Verify resistance of a resistor using color code and verify using ohmmeter.

0714E&A14 Measure Electrical Power, Energy, Power Factor & Determine Phase Sequence

Overview: This competency standard covers the skills and knowledge required to Measure single phase electrical para meters using Volt-Ampere meter, watt meter & Measure consumed energy with Energy meter

Critical Evidence	Performance Criteria
CU1. Measure power using Multi meter method	**P1.** Select the load to calculate the power and apply the power supply. **P2.** Measure the voltage and current by using Multi meter. **P3.** Find power using power formula.
CU2. Measure power using watt meter	**P1.** Select a load to calculate the power and connect watt meter across the load. **P2.** Power-ON the supply and measure the power.
CU3. Measure single phase AC Power	**P1.** Select a load to calculate the power with appropriate supply. **P2.** Measure the voltage and current using Multimeter. **P3.** Calculate the power using the energy power meter.
CU4. Measure three phase AC Power	**P4.** Select a load to calculate the power with an appropriate supply. **P5.** Measure the voltage, current using Multimeter for each phase. **P6.** Calculate the power using power formula.
CU5. Measure consumed energy with Energy meter	**P1.** Connect phase line of AC supply to the energy/power meter. **P2.** Connect AC load to the output terminals of energy/power meter. **P3.** Power ON the supply and take reading of energy in terms of unit after few minutes from the display.
CU6. Measure power factor with voltmeter, ampere meter and watt meter.	**P1.** Connect voltmeter & ampere meter with inductive load (Motor) **P2.** Connect the watt/energy / power meter and measure. **P3.** Connect the AC supply and take the readings of volt, ampere and watt meter. **P4.** Utilize the above readings and calculate power factor using power formula $P=VI\cos\phi$
CU7. Measure power factor with power factor meter	**P1.** Connect the current coil of power factor meter in series to the load. **P2.** Power on the supply and measure the value of power factor from the meter.

Knowledge & Understanding

K1. Define AC/D.C power.

K2. Measure power of the circuit with meter.

K3. Differentiate between electrical and mechanical power.

K4. Define single phase & three phase system.

K5. Define wattmeter.

K6. Define relationship between the individual wattmeter readings and the total three phase power.

K7. Use of wattmeter to measure three phase load.

K8. Explain advantages of three wattmeter method.

K9. Measurement of power in star or delta connection.

K10. Define power factor.

K11. Effect of improved power factor on load Current.

Tool and Equipment.

- Voltmeter.
- Ammeter
- Wattmeter.
- Single phase power factor meter
- Connecting Leads.
- Power Supply.
- Screw Driver & Plier.
- Single Phase Load or 100 watt lamp.
- Single phase Energy Meter with connecting leads.
- Ammeter & Voltmeter.
- Single phase inductive load. Any available load at your lab (up to 1000 watt).
- Capacitor bank.
- Connecting leads as per required.
- Three phase supply source.
- Three phase supply industrial socket & plug.
- Safety switch.
- Phase sequence meter.
- Change over switch.
- Three phase supply.

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Measure single phase power using Volt-Ampere meter method, Watt meter & Measure consumed energy with Energy meter.
- Electrical connection verification as per observation.

0714E&A15 Construct Electromagnet to See Various Effects & Verify Faradays Law.

Overview: This competency standard covers the skills and knowledge required to construct Electromagnet, construct circuit to determine the effect on current carrying conductor in magnetic field, Determine the effect on conductor by varying the current with the help of rheostat, plot magnetic lines of forces of bar magnet, Verify Faradays law by moving magnet in side coil, Verify Faradays law by moving coil near the magnet field, Verify EMF through induction**.**

Critical Evidence	Performance Criteria
CU1. Construct Electromagnet	**P1.** Take the iron nail (approximately 3 inches in length) and make 30 to 40 turns of thin coated copper wire to form a coil. **P2.** Connect the dry cell battery with coil wound on the iron nail. **P3.** Bring iron nail near the iron pieces and explain / demonstrate the behavior / observation.
CU2. Implement circuit to determine the effect on current carrying conductor in magnetic field.	**P1.** Take copper rod (5 cm in length) and connect wires across it. **P2.** Connect the DC supply to copper rod through rheostat ?. **P3.** Place the current carrying copper rod inside the horse shoe magnet. **P4.** Deassemble the Simple DC motor and connect the power leads directly to the electrodes of the armature and observe the rotation.
CU3. Determine the effect on conductor by varying the current with the help of rheostat.	**P1.** Reduce the rheostat resistance. **P2.** Record the effect on copper rod. **P3.** Increase the rheostat resistance **P4.** Record the effect on copper rod.
CU4. Plot magnetic lines of forces of bar magnet.	**P1.** Place a bar magnet on a paper and outline its boundary with the help of lead pencil. **P2.** Place a compass needle at one side the magnet. **P3.** Mark points on paper where the compass needle stop. **P4.** Repeat the same procedure till compass reach at the other end of magnet. **P5.** Change the position of compass needle near the magnetic pole and repeat the procedure for P3 to P4.
CU5. Verify Faradays law by moving magnet in side coil.	**P1.** Construct a coil with hollow iron cylinder (use mm range wire diameter.) and make 150 to 200 turns on it. **P2.** Connect a Galvanometer with coil. **P3.** Move a permanent magnet inside the coil fast and slow and record

	the effect on reading of Galvanometer. **P4.** Hold the magnet inside the coil and do not move, now record the effect on reading of Galvanometer.
CU6. Verify Faradays law by moving coil near the magnet field.	**P1.** Construct a coil with hollow iron cylinder (approximately 3 inches in length 1.5 inch in diameter.) and make 150 to 200 turns on it. **P2.** Connect mm or um range Galvanometer with coil. **P3.** Fix permanent magnet and move the coil fast and slow on it and record the effect on reading of Galvanometer. **P4.** Hold the coil near the magnetic field and do not move, now record the effect on reading of Galvanometer.
CU7. Verify EMF through induction.	**P1.** Take step down transformer and connect its secondary with a Galvanometer and primary winding with a DC battery through a rheostat. **P2.** Continuously variate the rheostat and observe the reading on the Galvanometer.

Knowledge & Understanding

- **K1.** Describe magnet and magnetism
- **K2.** Describe function of iron core
- **K3.** Find the movement of current caring conductor which is placed in magnetic field
- **K4.** Fleming's left-hand rule
- **K5.** Define magnetic lines of force.
- **K6.** Define magnetic field.
- **K7.** How magnetic lines of force travel with respect to each other
- **K8.** Explain first law of Michal Faraday
- **K9.** law of Faraday
- **K10.** find the direction of induced EMF
- **K11.** role of magnetic strength in Faraday's Law
- **K12.** role of conductor's length or turns in Faraday's Law
- **K13.** define Lenz's Law
- **K14.** explain Faraday's first law of Electro-Magnetic Induction

Tool and Equipment.

- Iron nail as core
- Thin coated copper wire
- Rheostat

- Current carrying conductor
- Horse shoe magnet.
- Dry cell battery
- Magnet.
- Connecting leads.
- Transformer
- Compass needle
- Coil
- Bar Magnet
- Paper
- Lead pencil.
- Galvanometer

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Measure AC voltage, current, frequency, time period with oscilloscope, RMS value and average value of AC signal with oscilloscope

0714E&A16 Verify Law of Combination of Capacitor & Determine Break Down Voltage of Capacitor.

Overview: This competency standard covers the skills and knowledge required to Implement a series circuit of capacitors, implement a parallel circuit of capacitors, and determine the breakdown voltage of low voltage capacitor**.**

Critical Evidence	Performance Criteria
CU1. Implement a series circuit of capacitors.	**P1.** Assemble a series circuit of capacitors with 3 three different values. **P2.** Connect the battery and apply 10 volt DC to the combination of capacitors **P3.** Measure the voltage across each capacitor connected in the series **P4.** Add the voltage of each capacitor and verify / compare is it equal to applied voltage. **P5.** Use the voltage of each capacitor and its value to find the charge on each capacitor.
CU2. Implement a parallel circuit of capacitors.	**P1.** Assemble a parallel circuit of capacitors with 3 different values. **P2.** Connect the battery and apply 10 volts DC 10 volt to the combination of capacitors. **P3.** Use applied voltage and value of capacitor to find the charge on each capacitor. **P4.** Use the total voltage and total capacitance and compare it to / to verify the net charge on the capacitor.
CU3. Determine the breakdown voltage of low voltage capacitor	**P1.** Take a capacitor of 6.3 rated volts. **P2.** Connect it across a 0-30 volts D.C variable power supply **P3.** Increase the voltage of the variable power supply slowly from zero to rated 6.3v, higher than the rating and observed the voltmeter and capacitor Observe the capacitor while increasing the voltage from the rated value, it may start smoke and burn later on, . Note down the the smoke and burn voltages.

Knowledge & Understanding

- **K1.** breakdown of capacitors
- **K2.** breakdown voltage of capacitors
- **K3.** factor affecting the life of a capacitor
- **K4.** What is charging of capacitor

Tool and Equipment

- Capacitors, 4.7 µF
- Capacitors, 10, 100 & 8.2 µF.
- Voltmeter
- D.C. power supply unit
- Bridging plugs
- Connecting leads
- Multimeter. (With option of Capacitance measurement).
- Variable D.C powers supply 0-30 Voltas.
- Capacitor (Sanyo Operated Volts 6.3 V, SE 30)
- D.C Analog or Preferably Digital Voltmeter Range 0-50V.
- L.E.D (3 to 9 V) Optional.
- Connecting Leads

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Determine the breakdown voltage of small capacitor.

0714E&A17 -Maintain Tools & Equipment

Overview: This Competency Standard covers the skills and knowledge required to arrange tools/equipment, maintain tool box, insulate tools/equipment, calibrate measuring tools and manage proper inventory of used/unused tools/equipment. Trainee will be expected to follow the procedures to maintain the tools/equipment.

Critical Evidence	Performance Criteria
CU1. Arrange Tools and Equipment	**P1.** Identify the tools and equipment **P2.** Interpret job card **P3.** Prepare list of tools and equipment as per requirement **P4.** Collect tools and equipment from store
CU2. Maintain Tool Box	**P1.** Check physical conditions of tools and equipment before use **P2.** Perform preventive maintenance as per standards **P3.** Perform corrective maintenance of tools as per requirements **P4.** Clean tools and equipment after use **P5.** Place tools and equipment at appropriate place
CU3. Insulate Tools and Equipment	**P1.** Select insulated tools and equipment **P2.** Adopt insulated tools and equipment as per standards
CU4. Calibrate measuring tools	**P1.** Check calibration status of the measuring tools **P2.** Perform calibration of measuring tools as per standards **P3.** Record calibration test results
CU5. Manage Inventory of tools and equipment	**P1.** Check tools and equipment as per record **P2.** Report for faulty tools and equipment to supervisor **P3.** Generate demand for deficit tools and equipment **P4.** Maintain all records of tools and Equipment

Knowledge & Understanding

K1. Explain Various tools and equipment and their functions

K2. Define Job card/work order

K3. How an Arrangement of tools/equipment as per job is required?

K4. Differentiate between corrective and preventive maintenance

K5. Arrange tools

K6. and equipment in tool box

K7. Storage methods of tools and equipment

K8. Insulation procedure

K9. Types of insulation

K10. Methods of insulated tools and equipment.

K11. Types of calibration

K12. Methods of equipment calibration

K13. Methods of tools and equipment inventory

K14. Report writing of faulty tools and equipment

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Handle and set Lightening for Current affair program
- Describe functions of various tools and equipment
- Define job card
- Storage methods of tools and equipment
- Types of insulation
- Use of insulated tools and equipment
- Method of equipment calibration
- Report writing

0714E&A18 Make Cable/Wire Joints

Overview: This Competency Standard covers the skills and knowledge required to make joints of cable during wiring and breakage of wires, Make Cross/Twist joint, Make Straight/Married joint, Make T- Joint, Make Rat tail joint, Make Britannia joint**.**

Critical Evidence	Performance Criteria
CU1. Make Cross/Twist joint	**P1.** Select the cable. **P2.** Strip the wire according to 50 mm.always space between word and alphabets !! **P3.** Twist the conductors. **P4.** Solder the conductor **P5.** Insulate the joint
CU2. Make Straight/Married joint	**P1.** Select the cable. **P2.** Strip wire to 75 mm according to joint requirement. **P3.** Intermingle the conductors to 60 mm into each other. **P4.** Twist 60 mm conductors leaving behind 15 mm of each cable. **P5.** Solder the conductor. **P6.** Insulate the joint.
CU3. Make T- Joint	**P1.** Select the cable. **P2.** Remove the insulation of cable 1 to 50 mm from where a connection is required. **P3.** Separate conductors of cable 1 equally. **P4.** Take another 12 mm stripped wire 2. **P5.** Insert between two equally half conductors of cable 1 and twist. Half conductors clockwise and half anti-clock wise of cable 2. **P6.** Solder the joint.
CU4. Make Rat tail joint	**P1.** Select the single conductor wires. **P2.** Strip both the wires to 5mm. **P3.** Twist the conductor. **P4.** Insulate the joint. **P5.** Solder the joint.
CU5. Make Britannia joint	**P1.** Select the cable. **P2.** Strip both cables to 75mm. **P3.** Bend the tips of both cable right angle about to 6 mm.

	P4. Hold the two cables overlap 50 mm with tips in opposite direction. **P5.** Take another bare conductor of 1 mm and wrap it around in both directions to 6 mm. **P6.** Solder the joint. **P7.** Insulate the joint.

Knowledge & Understanding

- **K1.** Define conductor.
- **K2.** Differentiate between cable and wire.
- **K3.** Describe the type of soldering.
- **K4.** Differentiate between stripping and insulation removing.
- **K5.** Describe the type of joints.
- **K6.** Describe the procedure of jointing & soldering.
- **K7.** Explain the composition of solder and soldering flux

Tool and Equipmen

- Cables
- Wires.
- Wire stripper.
- Solder wire.
- Soldering paste
- Plier.
- Nose plier.
- Insulation remover.
- Solder

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Handle and set Lightening for Current affair program:
- Striping of cables.
- Twisting of cable.
- Soldering of joints

0714E&A19 Prepare and Install Distribution Boards.

Overview: This Competency Standard covers the skills and knowledge required to prepare and install distribution board according to provide protection and load division to wiring, prepare estimate for wiring material, Prepare Distribution Board, Install Distribution Board and wiring.

Critical Evidence	Performance Criteria
CU1. Prepare estimate for wiring material.	**P1.** Develop the Basic Drawing **P2.** Perform Estimation of Materials **P3.** Calculate Labor Cost
CU2. Prepare Distribution Board	**P1.** Select Distribution board w.r.t. size, current rating, voltage, No. of C.Bs and phases. **P2.** Select Main Incoming Residual Current Circuit Breaker (RCCB) having minimum sensitivity. **P3.** Select outgoing Miniature Circuit Breaker (MCB) according to load. **P4.** Provide space for future MCB. **P5.** Select Volt, ampere meter and indicator according to load and phases. **P6.** Select wire according to load and for wiring in DB. **P7.** Make neutral common for all load. **P8.** Connect accessories according to the circuit diagram.
CU3. Install Distribution Board and wiring	**P1.** Fix the distribution board. **P2.** Take wire from DB to load without joint. **P3.** Distribute load equally on all phases.

Knowledge & Understanding

- **K1.** Define distribution board.
- **K2.** Describe D.B. w.r.t. size, current rating, voltage, No. of C.Bs and phases etc.
- **K3.** Name parts of distribution board.
- **K4.** Define sensitivity of RCCB.
- **K5.** Define MCB.
- **K6.** Differentiate fuse and breaker.
- **K7.** Define wiring accessories
- **K8.** State purpose of each accessory.

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Handle and set Lightening for Current affair program Distribute load according to Phases.
- Use accurate MCB for load.
- Make common neutral.
- Provide cost effective and quality oriented Bill of Quantity (BOQ).

0714E&A20 Carryout Basic Electrical Installations

Overview: This Competency standard deal with the skills and knowledge required to lay cables, perform single & three phase connections, basic electric wiring and wiring test for carrying out basic electrical installation. The trainee will be required to follow company guidelines as well as the procedure for carrying out basic electrical installation.

Competency Units	Performance Criteria
CU1. Perform Basic Electrical wiring	P1. Measure cables as per requirement P2. Connect cables P3. Perform joints P4. Insulate Joints
CU2. Conduct wiring Test	P1. Operate multi-meter for voltage and current P2. Perform continuity test P3. Perform polarity test P4. Perform earthling test P5. Perform insulation test P6. Record test results
CU3. Lay cables	P1 Interpret electrical drawing/ document P2. Identify cables P3. Lay cables P4. Perform earthling
CU4. Perform single-phase Connection	P1. Select cable gauge P2. Select cables colors P3. Connect cables P4. Insulate Joints
CU5. Perform three phase Connection	P1. Select cable Gauge P2. Select cables colors P3. Connect cables P4. Insulate Joints

Knowledge & Understanding

- **K1.** Explain Types of cables
- **K2.** Explain Gauges of cables
- **K3.** Define single phase connection
- **K4.** Types of joints
- **K5.** Define conductor and insulator
- **K6.** Define three phase connection
- **K7.** Knowledge about cable gauging
- **K8.** Knowledge about color code of cables / phase sequence.
- **K9.** Methods of Wiring
- **K10.** Types of wiring
- **K11.** Types of connections
- **K12.** Types of wiring tests
- **K13.** Describe various wiring test
- **K14.** Color of cables
- **K15.** Distinguish between different wiring systems
- **K16.** Name of necessary materials required for each type of wiring.
- **K17.** Explain the uses of each type of wiring.

Tool and Equipment

- Cables
- Solder
- Wire stripper
- Plier
- Wires
- Nose plier
- Solder wire
- Soldering paste
- Insulation remover

Critical Evidence(s) Required

- The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:
- Handle and set Lightening for Current affair program Gauges of Cables
- Color of Cables
- Single phase connection
- Three phase connection
- Color code of cables / Phase sequence

- Cable gauging
- Types of wiring
- Types of connections.

0714E&A21 Install Single Phase Electrical Wiring

Overview:This Competency Standard covers the skills and knowledge required to make single pole switch circuit, make single pole switch socket circuit, make two-way switch circuit, make series/test lamp circuit. Make intermediate switch circuit, Make of Tunnel circuit, Make of impulse switch circuit.

Critical Evidence	Performance Criteria
CU1. Make single pole switch circuit.	**P1.** Draw wiring diagram of single pole switching circuit. **P2.** Draw Current path diagram of single pole switch circuit. **P3.** Draw layout diagram of single pole switch circuit. **P4.** Mark on working board according to layout diagram. **P5.** Install accessories according to layout diagram. **P6.** Lay wires in duct/pipe according to layout diagram. **P7.** Make connections according to wiring diagram. **P8.** Check the circuit before connect the main supply. **P9.** Make connection with main supply. **P10.** Check the function of circuit after connect the main supply
CU2. : Make single pole switch socket circuit.	**P1.** Draw wiring diagram of single pole switch socket circuit. **P2.** Draw Current path diagram of single pole switch socket circuit. **P3.** Draw layout diagram of single pole switch socket circuit. **P4.** Mark on working board according to layout diagram. **P5.** Install accessories according to layout diagram. **P6.** Lay wires in duct/pipe according to layout diagram. **P7.** Make connections according to wiring diagram. **P8.** Check the circuit before connect the main supply. **P9.** Make connection with main supply. **P10.** Check the function of circuit after connecting to the main power supply
CU3. Make two-way switch circuit.	**P1.** Draw wiring diagram of two-way switch circuit. **P2.** Draw Current path diagram of two-way switch circuit. **P3.** Draw layout diagram of two-way switch circuit. **P4.** Mark on working board according to layout diagram. **P5.** Install accessories according to layout diagram. **P6.** Lay wires in duct/pipe according to layout diagram. **P7.** Make connections according to wiring diagram. **P8.** Check the circuit before connecting to the main power supply.

	P9. Make connection with main power supply. **P10.** Check the function of circuit after connecting to the main power supply
CU4. : Make series/test lamp circuit.	**P1.** Draw wiring diagram of series circuit. Correct as the previous **P2.** Draw Current path diagram of series circuit. **P3.** Draw layout diagram of series circuit. **P4.** Mark on working board according to layout diagram. **P5.** Install accessories according to layout diagram. **P6.** Lay wires in duct/pipe according to layout diagram. **P7.** Make connections according to wiring diagram. **P8.** Check the circuit before connect the main supply. **P9.** Make connection with main supply. **P10.** Check the function of circuit after connect the main supply
CU5. : Make intermediate switch circuit.	**P1.** Draw wiring diagram of intermediate switch circuit. Correct as the previous **P2.** Draw Current path diagram of intermediate switch circuit. **P3.** Draw layout diagram of intermediate switch circuit. **P4.** Mark on working board according to layout diagram. **P5.** Install accessories according to layout diagram. **P6.** Lay wires in duct/pipe according to layout diagram. **P7.** Make connections according to wiring diagram. **P8.** Check the circuit before connect the main supply. **P9.** Make connection with main supply. **P10.** Check the function of circuit after connect the main supply
CU6. Make of Tunnel circuit	**P1.** Draw wiring diagram of tunnel circuit. Correct as the previous **P2.** Draw Current path diagram of tunnel circuit. **P3.** Draw layout diagram of tunnel circuit. **P4.** Mark on working board according to layout diagram. **P5.** Install accessories according to layout diagram. **P6.** Lay wires in duct/pipe according to layout diagram. **P7.** Make connections according to wiring diagram. **P8.** Check the circuit before connect the main supply. **P9.** Make connection with main supply. **P10.** Check the function of circuit after connect the main supply

CU7. Make impulse switch circuit.	**P1.** Draw wiring diagram of impulse switch circuit. Correct as the previous **P2.** Draw Current path diagram of impulse switch circuit. **P3.** Draw layout diagram of impulse switch circuit. **P4.** Mark on working board according to layout diagram. **P5.** Install accessories according to layout diagram. **P6.** Lay wires in duct/pipe according to layout diagram. **P7.** Make connections according to wiring diagram. **P8.** Check the circuit before connect the main supply. **P9.** Make connection with main supply. **P10.** Check the function of circuit after connect the main supply

Knowledge & Understanding

K1. Define single pole switch.
K2. Explain lamp.
K3. Explain single pole switch circuit and its use.
K4. Define current, voltage, power and resistance.
K5. Define single pole switch.
K6. Describe socket
K7. Explain two-way switch circuit and its use.
K8. Describe two-way circuit.
K9. Define two-way switch
K10. Define series circuit.
K11. Define parallel circuit.
K12. Define intermediate switch.
K13. Explain intermediate switch circuit and its use.
K14. Explain tunnel circuit and its use
K15. Define impulse switch
K16. Explain impulse switch circuit and its use.
K17. Define push button.

Tools & equipment

- Electrician Tool kit.
- PVC Pipe/Duct.
- Wooden/PVC board.
- PVC wire according to load
- Circuit Breaker.

- Screw
- Single pole switch.
- Lamp holder
- Lamp
- AVO meter.
- PVC clamp.
- Test Indicator

Critical Evidence(s) Required

Handle and set Lightening for Current affair program:

- r standards defined.

0714E&A22 Perform Testing of Electrical Wiring

Overview: This Competency Standard covers the skills and knowledge required to Perform Earth leakage Test, Perform Open Circuit Test, Perform Short Circuit Test, Perform Continuity/Loop Test, Perform Visual Test, Perform Insulation Test, Perform Polarity Test, Perform Earth Resistance Test, Perform Murray Loop Test, Perform BLAVIER & Earth Loop Test

Critical Evidence	Performance Criteria
CU1. Perform Open Circuit Test	**P1.** Disconnect the power supply source, neutral conductor and earth conductor from distribution fuse box. **P2.** Connect ohmmeter between starting and ending terminals of live conductor. **P3.** Ensure that the reading should be close to 0 ohm. **P4.** Repeat P2 to P3 for neutral and earth conductor.
CU2. Perform Short Circuit Test	**P1.** Disconnect the supply source, neutral conductor and earth conductor from distribution fuse box. **P2.** Connect one terminal of ohmmeter with live conductor. **P3.** Connect the other terminals of ohmmeter with neutral conductor. **P4.** Ensure the reading must be infinity (No reading). **P5.** Connect ohmmeter between live conductor and earth conductor. **P6.** Ensure the reading must be infinity (No reading)
CU3. Perform Continuity/Loop Test	**P1.** Connect all metal clad switches, metal parts, conduits with earth. **P2.** Open the main switch. **P3.** Turn on all the switches. **P4.** Connect earth continuity tester with conduit and earth. **P5.** Measure the resistance value with tester which must not be more than 1 ohm.
CU4. Perform Visual Test	**P1.** Check the wires joints. **P2.** Check if there is any spark. **P3.** Check over heating of wires. **P4.** Check all the appliances are On or fluctuating. **P5.** Check all indications of meters. **P6.** Check Voltages on all phases. **P7.** Check the DB and Breakers. **P8.** Check the main supply is coming properly.

CU5. Perform Insulation Test	**P1.** Switch off the main breaker. **P2.** Short circuit all lighting connections. **P3.** Connect megger between line and earth. **P4.** Rotate the megger to generate the voltage. **P5.** Read the megger dial and ensure that the insulation resistance should not be less than 50M ohm of any single circuit.
CU6. Perform Polarity Test	**P1.** Switch off the main switch. **P2.** Disconnect all loads. **P3.** Switch on all circuit control switches. **P4.** Connect ohm meter between main line and all the terminal of sockets and load points one by one. **P5.** Ensure meter reading value must be less than 1 ohm.
CU7. Perform Earth Resistance Test	**P1.** Place 3 electrodes in earth at distance of 10m apart between every electrode. **P2.** Connect terminal E of earth resistance tester to first electrode. **P3.** Connect terminal P of earth resistance tester to the second electrode. **P4.** Connect terminal C of the earth resistance tester with third electrode. **P5.** Measure the resistances after applying specific voltage. **P6.** Repeat P1 to P5 by interacting earthing regions. **P7.** Ensure 3 readings must be equal.
CU8. Perform Earth leakage Test.	**P1.** Ensure the socket must be at least 13A for RCD plug in. **P2.** Adjust the sensitivity of RCD. **P3.** Ensure tripping time should not exceed from 200 msec. **P4.** Plug the RCD in socket and switch on socket outlet. **P5.** Ensure P-N and P-E light up. **P6.** Press the test button. **P7.** Ensure that RCD will trip and reading should not be less than 200 msec. **P8.** Move the selection switch to 180^{o}. **P9.** Press the test button. **P10.** Ensure that RCD will trip and reading should not be less than 200msec. **P11.** Move selection switch to 0^{0}.

	P12. Press the test button. **P13.** Ensure that RCD will trip and reading must be shown less than 200msec.
CU9. Perform Murray Loop Test	**P1.** Connect galvanometer with Wheatstone bridge. **P2.** Connect positive terminal of DC source with Wheatstone bridge. **P3.** Connect negative terminal of DC source with ground. **P4.** Connect remaining two terminal of Wheatstone bridge with two cores of the cable. **P5.** Short the other end of these two cores of cable. **P6.** Note the reading of galvanometer. **P7.** Calculate Rx. **P8.** Repeat the P1 to P7 for other cores of the cable.
CU10. Perform BLAVIER & Earth Loop Test	**P1.** Connect galvanometer with Wheatstone bridge. **P2.** Connect positive terminal of DC source with Wheatstone bridge. **P3.** Connect negative terminal of DC source with ground. **P4.** Connect remaining two terminal of Wheatstone bridge with two cores of the cable. **P5.** Short the other end of these two cores of cable. **P6.** Note the reading of galvanometer. **P7.** Calculate Rx. **P8.** Repeat the P1 to P7 for other cores of the cable.

Knowledge & Understanding

K1. Define RCD

K2. Define sensitivity

K3. Explain P-E and P-N

K4. Explain the function of RCD.

K5. Explain the function of distribution box.

K6. Explain the function of fuse.

K7. Explain which meters are used for open circuit and short circuits test.

K8. What does it mean by 0 ohm reading in open circuit test?

K9. What does it mean by no reading in short circuit test?

K10. Explain the purpose of continuity test.

K11. Explain the purpose of polarity test.

K12. Explain the purpose of insulation resistance test.

K13. Explain the purpose of Murray loop test.

K14. Explain the purpose of BLAVIER's loop test.

K15. Describe why Wheatstone bridge is attached in Murray loop test.

K16. Explain the purpose of DC supply in Murray loop test?

K17. Explain the purpose of Galvanometer.

Tool and Equipment

- RCD
- Loads
- Supply source
- Distribution Box
- Ohmmeter
- Earth resistance tester
- Continuity
- Tester.
- Breakers
- Magger
- Sockets

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Perform any wiring test, as per standards

0714E&A23 Operate Single Phase Transformer

Overview: This competency standard identifies the competencies required to identify types of transformer, Measure transformer ratio of single phase transformer, make transformer winding, determine voltage regulation of single phase transformer with different load and perform parallel operation of single phase transformer**.**

Critical Evidence		Performance Criteria	
CU1.	Identify types of transformer.	**P1.**	Identify the number of windings in the primary and secondary side of transformer.
		P2.	Identify the types of transformer cores.
		P3.	Identify connection of the windings.
		P4.	Separate single phase, three phase and auto transformer.
CU2.	Measure transformation ratio of single phase transformer.	**P1.**	Connect volt meters on both side of the transformer.
		P2.	Apply rated voltage to the primary.
		P3.	Note the volt meter reading.
		P4.	Calculate transformation ratio using ratio formula.
		P5.	Repeat P1 to P4 for different secondary tapping.
CU3.	Make transformer winding	**P1.**	Design the core of transformer according to the transformer rating.
		P2.	Select the wire for primary and secondary winding.
		P3.	Perform winding according to require turns with the help of winding machine.
		P4.	Cover the winding with insulating paper.
		P5.	Adjust the core pieces into the winding.
		P6.	Remove the insulation of enameled wire.
		P7.	Cover the ends of wire with sleeve.
		P8.	Perform continuity test with ohm meter.
CU4.	Determine voltage regulation of single phase transformer with different load.	**P1.**	Connect watt meter, ampere meter, and volt meter to the primary side of transformer.
		P2.	Connect the voltmeter to secondary side of transformer.
		P3.	Connect resistive load to secondary side.
		P4.	Apply rated voltage to primary side of transformer.
		P5.	Calculate voltage drop and voltage regulations (%) from meter readings.
		P6.	Repeat from P1 to P5 for inductive load.
		P7.	Repeat from P1 to P5 for capacitive load.

CU5.	Perform parallel operation of single phase transformer.	**P1.** Identify two transformer having same rated voltage, frequency and transformation ratio. **P2.** Mark the terminals with the help of polarity test. **P3.** Connect secondary sides of both transformers in parallel. **P4.** Connect secondary sides of both transformers with load bus bar having ampere meters between them. **P5.** Connect the primary side of both transformers in parallel. **P6.** Connect primary side of transformer with generation bus bar. **P7.** Adjust the ammeter readings to zero by adding inductor and resistor in series with secondary side of the transformer.

Knowledge & Understanding:

K1. Define primary and secondary windings of transformer.
K2. Explain the types of transformer cores.
K3. Explain connection of the windings.
K4. Differentiate single phase, three phase, auto and instrument transformer.
K5. How to connect volt meters on both side of the transformer.
K6. How to apply voltage to the primary?
K7. Explain transformer ratio.
K8. Define the tapping of the transformer.
K9. How to select the wire for primary and secondary winding?
K10. Explain winding procedure.
K11. Explain winding insulation with insulating paper.
K12. How to adjust the core pieces into the winding?
K13. How to remove the insulation of enameled wire.
K14. Explain sleeve.
K15. Explain continuity test with ohm meter.
K16. Explain voltage regulation of the transformer.
K17. Explain the word voltage drop.
K18. Explain polarity test of transformer.
K19. Describe the conditions for paralleling of the transformer.
K20. Explain indicator.

Tools & Equipment:

- Single phase transformer
- Three phase transformer
- Voltmeters

- Connecting wires
- Core
- Winding wire
- Winding machine
- Insulating paper
- Sleeve
- Ohmmeter
- Hammer
- Single phase transformer
- Ammeter
- Resistive load
- Inductive load
- Capacitive load

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard

- Measure transformation ratio of single phase transformer.
- Determine voltage regulation of single phase transformer with different load.

0714E&A24 Perform Tests on Single Phase Transformer

Overview: This competency standard identifies the competencies required to Perform polarity test of single phase transformer, Perform Open circuit test of transformer, Perform Short Circuit Test of Transformer, calculate efficiency of transformer by direct method and calculate efficiency of transformer by Back to Back test**.**

Critical Evidence	Performance Criteria
CU1. Perform polarity test of single phase transformer.	**P1.** Connect the circuit according to the diagram. **P2.** Note the reading of both voltmeter. **P3.** Identify additive and subtractive polarity. **P4.** Mark the terminal according to the additive and subtractive polarity.
CU2. Perform Open circuit test of transformer.	**P1.** Connect watt meter, ampere meter, and volt meter to the lower voltage side of transformer. **P2.** Open the high voltage side of transformer. **P3.** Apply rated voltage to lower voltage side of transformer. **P4.** Read the instrument /meters reading. **P5.** Calculate iron losses and excitation branch component (Ro, Xo).
CU3. Perform Short circuit Test of Transformer.	**P1.** Connect watt meter, ampere meter, and volt meter to the higher voltage side of transformer. **P2.** Connect lower voltage side terminal with each other (Short Circuit) **P3.** Apply 10 % to 15 % of rated voltage to higher voltage side of transformer. **P4.** Read the instrument/meters readings. **P5.** Calculate copper losses and winding component (Ro1, Xo1)
CU4. Calculate efficiency of transformer by direct method.	**P1.** Perform open circuit test. **P2.** Perform short circuit test. **P3.** Calculate iron losses and copper losses from above tests. **P4.** Calculate input power and output power. **P5.** Calculate efficiency from calculated powers.
CU5. Calculate efficiency of transformer by Back to Back test.	**P1.** Identify two transformer of same rating. **P2.** Connect both transformer in parallel. **P3.** Connect another variable voltage transformer to secondary

	side of parallel transformers. **P4.** Connect a switch, watt meter and ammeter between variable voltage transformer and parallel transformer. **P5.** Connect voltmeter and watt meter to primary side of transformer parallel transformer. **P6.** Apply rated voltage to the primary side of the parallel transformers. **P7.** Open the switch. **P8.** Calculate iron losses. **P9.** Close the switch **P10.** Adjust the voltage of variable voltage transformer until the full load current passes from secondary side of parallel transformers. **P11.** Calculate copper losses. **P12.** Calculate efficiency from above calculated losses.

Knowledge & Understanding:

K1. Differentiate between additive and subtractive polarity.

K2. How to mark the terminal according to the additive and subtractive polarity?

K3. How to use watt meter?

K4. Explain theconnect wattmeter ampere meter, and volt meter to the lower voltage side of transformer.

K5. Explain theopen high voltage side of transformer instead of low voltage side.

K6. Explain iron loss.

K7. How many components of excitation branch?

K8. Explain theconnect watt meter, ampere meter, and volt meter to the higher voltage side of transformer in short circuit test.

K9. Explain theshort Circuit the low voltage side of the transformer in short circuit test.

K10. Explain the reason to apply 10 % to 15 % of rated voltage to higher voltage side of transformer.

K11. Explain copper loss.

K12. How many components of transformer winding..

K13. Explain iron loss.

K14. Explain copper loss.

K15. Explain the term efficiency.

K16. Explain the perform open circuit test in transformer.

K17. Explain the perform short circuit test in transformer.

K18. Explain iron loss.

K19. Explain copper loss.

K20. Explain back to back connection

K21. Explain the term efficiency of transformer.

Tools & Equipment:

- Single phase transformer
- Voltmeters
- Connecting wires
- Wattmeter
- Ammeter
- Connecting wires

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard

- Perform Back to Back test in order to determine efficiency of Transformer

Digital Skills

0714E&A25 Install computer operating systems and hardware

Overview: This unit describes the performance outcomes, skills and knowledge required to select, configure and use computer operating systems and basic computer hardware.

Unit of Competency	Performance Criteria
CU1. Identify operating system and hardware components	**P1.** Determine ICT organizational requirements and specifications **P2.** Identify and select the operating system **P3.** Identify appropriate external hardware components **P4.** Identify internal hardware components
CU2. Install and configure operating system and application software with hardware components	**P1.** Install and configure operating system to meet organizational requirements **P2.** Identify the functions associated with the operating system and associated boot process **P3.** Configure power-management settings to minimize power consumption as an environmentally sustainable measure **P4.** Use both the graphical user interface and the command line interface to perform basic tasks **P5.** Install or upgrade application software onto the operating system and hardware configuration **P6.** Determine the relationship between an application program, the operating system and hardware **P7.** Identify general differences between the different computer platforms and their respective operating systems
CU3. Optimize operating system and hardware components	**P1.** Optimize operating system using included tools or third-party utilities **P2.** Customize the graphical user interface **P3.** Use techniques unique to the command line interface **P4.** Set up and configure external hardware components and check functionality **P5.** Install drivers as appropriate and check functionality

Knowledge & Understanding

K1: Basic knowledge of current industry-accepted operating system, hardware and software products

K2: Compatibility of an operating system, in respect to other versions

K3: Function of single-user and multi-user operating systems

K4: Interoperability between operating systems

K5: OHS principles and responsibilities, including ergonomic principles to avoid injury associated with using computer systems.

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) to be competent in this competency standard:

A person who demonstrates competency in this unit must be able to provide evidence of the ability to select, configure and use computer operating systems and basic computer hardware. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- Use an operating system in a variety of scenarios and across functions, including:
    - scheduling, loading, initiating, and supervising the execution of programs
    - allocating storage
    - initiating and controlling input and output operations
    - handling errors
- Identify and install suitable hardware components
- Install and upgrade application software.

0714E&A26 Operate digital media technology

Overview: This unit describes the performance outcomes, skills and knowledge required to identify, select and use a digital media package and supporting technologies.

Unit of Competency	Performance Criteria
CU1. Use appropriate OHS office work practices	**P1.** Use safe work practices **P2.** Use wrist rests and document holders where appropriate **P3.** Use monitor anti-glare and radiation reduction screens where appropriate
CU2. Identify and select appropriate digital media package	**P1.** Identify the basic requirements of a design brief, including user environment **P2.** Research and review suitable available digital media packages **P3.** Select an appropriate digital media package to meet design brief requirements
CU3. Use digital media package	**P1.** Procure or create suitable data to meet requirements of the brief **P2.** Manipulate data using digital media package tools **P3.** Ensure naming and storing of documents in appropriate file format in directories or folders
CU4. Review digital media design	**P1.** Evaluate design for creative, dramatic and technical quality, file size, and suitability to meet the brief **P2.** Test and run any incorporated graphics, video or sound as part of a digital media presentation and present designs in the appropriate format **P3.** Review final product against the design

Knowledge & Understanding

K1: Basic principles of visual design

K2: Functions and features of digital media packages and technologies

K3: Graphic design and stylistic language conventions

K4: OHS principles and responsibilities for ergonomics, such as work periods and breaks

K5: Principles of digital imaging and file formats, video and sound file formats, file management and transfer systems

K6: Vendor product directions in digital media hardware and software

K7: Visualization and interpreting creative information, scripts (text) and images

Critical Evidence(s) Required

A person who demonstrates competency in this unit must be able to provide evidence of the ability to identify, select and use a digital media package and supporting technologies. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorised work practices, safety requirements and environmental constraints. Demonstrated evidence of the ability to:

- Identify basic requirements of a design brief
- Use digital media package to meet organizational requirements
- Use OHS principles and responsibilities for ergonomics, such as work periods and breaks
- Use help manuals and online help when appropriate
- Use digital media technologies to support design brief requirements.

0714E&A27 Perform computer operations

Overview: This unit covers the knowledge, skills and attitudes and values needed to perform computer operations which include inputting, accessing, producing and transferring data using the appropriate hardware and software.

Unit of Competency	Performance Criteria
CU1. Plan and prepare for task to be undertaken	**P1.** Requirements of task are determined as per standard Start with action word !!! **P2.** operating the procedures **P3.** Appropriate hardware and software is selected according to task assigned and required outcome **P4.** Task is planned to ensure
CU2. Input data into computer	**P5.** Data are entered into the computer using appropriate Start with action word !!! **P1.** program/application in accordance with company procedures **P2.** Accuracy of information is checked and information is saved in accordance with standard operating procedures **P3.** Inputted data are stored in storage media according to requirements **P4.** Work is performed within ergonomic guidelines
CU3. Access information using computer	**P1.** Correct program/application is selected based on job requirements **P2.** Program/application containing the information required is accessed according to company procedures **P3.** Desktop icons are correctly selected, opened and **P4.** closed for navigation purposes **P5.** Keyboard techniques are carried out in line with OH & S requirements for safe use of keyboards
CU4. Produce/output data using computer system	**P1.** Entered data are processed using appropriate software commands **P2.** Data are printed out as required using computer hardware/peripheral devices in accordance with standard operating procedures **P3.** Files and data are transferred between compatible **P4.** systems using computer software, hardware/ eripheral **P5.** devices in accordance with standard operating
CU5. Maintain computer equipment and systems	**P1.** Systems for cleaning, minor maintenance and replacement of consumables are implemented correct as above

	P2. Procedures for ensuring security of data, including regular back-ups and virus checks are implemented in accordance with standard operating procedures **P3.** Basic file maintenance procedures are implemented in line with the standard operating procedures

Knowledge & Understanding

K1: Basic ergonomics of keyboard and computer use
K2: Main types of computers and basic features of different operating systems
K3: Main parts of a computer
K4: Storage devices and basic categories of memory
K5: Relevant types of software
K6: General security
K7: Viruses
K8: OH & S principles and responsibilities
K9: Calculating computer capacity

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) to be competent in this competency standard:

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- Selected and used hardware components correctly and according to the task requirement
- Identified and explain the functions of both hardware and software used, their general features and capabilities
- Produced accurate and complete data in accordance with the requirements
- Used appropriate devices and procedures to transfer files/data accurately
- Maintained computer system

0714E&A28 Use computer applications

Overview: This unit describes the performance outcomes, skills and knowledge required to identify, select and operate three commercial software packages, including a word-processing, a spreadsheet and presentation application package.

Unit of Competency	**Performance Criteria**
1. Use appropriate OHS office work practices	1.1 Use safe work practices 1.2 Use appropriate wrist rests and document holders 1.3 Use monitor anti-glare and radiation reduction screens where appropriate
2. Install and remove software	2.1 Select software to be installed 2.2 Follow installation instructions 2.3 Delete unwanted software
3. Use appropriate word-processing software	3.1 Select word-processing software appropriate to perform activity 3.2 Identify document purpose, audience and presentation requirements, and clarify with the concern personnel 3.3 Identify organizational requirements for text-based business documents and design document structure and layout to ensure consistency of style and image 3.4 Match document requirements with software functions to provide efficient production of documents 3.5 Use technical functions, other data and formatting to finalize documents 3.6 Ensure the naming and storing of documents in appropriate directories or folders and the printing of documents to the required specifications
4. Use appropriate spreadsheet software	4.1 Select spreadsheet software appropriate to perform activity 4.2 Identify document purpose, audience and presentation requirements, and clarify with personnel as required 4.3 Enter simple formulas and functions using cell referencing where required 4.4 Customize spreadsheet settings and format documents to meet requirements 4.5 Ensure the naming and storing of documents in appropriate

	directories or folders and the printing of documents to the required specifications
5. Use appropriate presentation software	5.1 Select software application package appropriate to perform activity 5.2 Identify purpose, audience and presentation requirements, and clarify with personnel as required 5.3 Use technical functions, other data and formatting to finalize documents 5.4 Ensure documents are named and stored in appropriate directories or folders and printed to required specifications 5.5 Make a presentation

Knowledge & Understanding

K1: Application software packages used by the organization
K2: Basic technical terminology related to reading help files and responding to system help prompts
K3: Basic knowledge of system usage
K4: Current business practices related to using software to prepare reports
K5: Features and functions of commercial computing packages
K6: Import and export software functions
K7: Linking documents
K8: OHS principles and responsibilities for ergonomics, such as work periods and breaks
K9: Purpose, use and functions of applications
K10: Use of input and output devices
K11: Functions and uses of word processing, spreadsheet and presentation software

Critical Evidence(s) Required

A person who demonstrates competency in this unit must be able to provide evidence of the ability to identify, select and operate three commercial software packages, including a word-processing and a spreadsheet application package. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Evidence of the ability to:

- Produce workplace documents using a minimum of three different software application packages
- Open, amend and save files and documents according to organizational requirements
- Use OHS principles and responsibilities for ergonomics, such as work periods and breaks
- Use help manuals and online help.

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- Use an operating system in a variety of scenarios and across functions, including:
    - scheduling, loading, initiating, and supervising the execution of programs
    - allocating storage
    - initiating and controlling input and output operations
    - handling errors
- Identify and install suitable hardware components
- Install and upgrade application software.

0714E&A29 Create user documentation

Overview: This unit describes the performance outcomes, skills and knowledge required to create user documentation that is clear to the target audience and easy to navigate.

Unit of Competency	**Performance Criteria**
1. Determine documentation standards and requirements	1.1 Determine documentation requirements 1.2 Investigate documentation and industry standards for requirements and determine appropriate application to user documentation 1.3 Design documentation templates using appropriate software and obtain approval from appropriate person
2. Produce user documentation	2.1 Conduct a review of the subject system, program, network or application in order to understand its functionality 2.2 Gather existing technical, design or user specifications and supporting documentation 2.3 Create user documentation based on template to record the operation of the subject system, program, network or application
3. Review and obtain sign-off	3.1 Submit user documentation to target audience for review 3.2 Gather and analyze feedback 3.3 Make changes to user documentation 3.4 Submit user documentation to appropriate person for approval

Knowledge & Understanding

K1: Content features, including clarity and readability

K2: Document design, web design and usability

K3: Functions and features of templates and style guides

K4: Instructional design principles

Critical Evidence(s) Required

A person who demonstrates competency in this unit must be able to provide evidence of the ability to create user documentation that is clear to the target audience and easy to navigate. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to create user documentation that:

- Meets business requirements
- Caters for a diverse readership
- Is clear to the target audience
- Is easy to navigate.

0714E&A30 Create technical documentation

Overview: This unit describes the performance outcomes, skills and knowledge required to create technical documentation that is clear to the target audience and easy to navigate.

Unit of Competency	**Performance Criteria**
1. Identify and analyze documentation requirements and client needs	1.1 Consult with client to identify documentation requirements 1.2 Interpret and evaluate documentation requirements and confirm details with client 1.3 Investigate industry and documentation standards for requirements 1.4 Define and document the scope of work to be produced 1.5 Consult with client to validate and confirm the scope of work
2. Design documentation	2.1 Identify information requirements with reference to layout and document structure 2.2 Create document templates and style guides consistent with information requirements 2.3 Conduct a review of the system in order to understand its functionality 2.4 Extract content that meets information requirements according to copyright restrictions 2.5 Develop the structure of the technical documentation giving focus to the flow of information, style, tone and content format 2.6 Validate the technical documentation structure with the client
3. Develop documentation	3.1 Write technical documentation based on the template and scope of work using the information gathered 3.2 Translate technical terminology into simple / plain English where appropriate 3.3 Apply content format and style according to documentation standards and templates
4. Evaluate and edit documentation	4.1 Submit technical documentation to appropriate person for review 4.2 Gather and analyze feedback 4.3 Incorporate alterations into the technical documentation 4.4 Edit the technical documentation for technical and grammatical errors.
5. Prepare documentation for publication	5.1 Check that the completed technical documentation meets client requirements and scope of work 5.2 Submit the technical documentation to appropriate person for

	approval correct as previous 5.3 Prepare the technical documentation for publication and distribution using appropriate channels

Knowledge & Understanding

K1: Content features, such as clarity and readability

K2: Document design, web design and usability

K3: Functions and features of templates and style guides

K4: Instructional design principles

K5: Organizational policies, procedures and standards that cover document design.

Critical Evidence(s) Required

A person who demonstrates competency in this unit must be able to provide evidence of the ability to create technical documentation that is clear to the target audience and easy to navigate. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- Establish customer needs
- Design and develop technical documentation, such as system, procedures, training material and user guides, incorporating appropriate standards
- Update document with client feedback
- Prepare documentation for publication.

0714E&A31 Create basic databases

Overview: This unit describes the skills and knowledge required to design, develop and test a database in order to meet a specification. It applies to individuals who may be either database, or web designers, required to create a simple database to store information for an online application, using a simple entity relational database.

Unit of Competency	**Performance Criteria**
1. Analyze the requirements for the database	1.1 Determine the information that the database is required to hold 1.2 Develop a written requirement report for the functionality of the database 1.3 Complete the documentation, and submit it to an appropriate person in order to be approved
2. Use data modeling to design the database to suit requirements	2.1 Design an entity-relationship (ER) diagram to model the relationships between the entities and the attributes that the database will hold 2.2 Develop primary and foreign keys to link the entities 2.3 Develop a data dictionary 2.4 Complete the documentation, and submit it to the appropriate person for approval correct as above
3. Create a database on a web or database server	3.1 Use the appropriate language on a web or database server to create few databases 3.2 Use the appropriate language on a web or database server to create few tables 3.3 Populate the database fields
4. Test the database and debug	4.1 Test the database on the web or a database server 4.2 Ensure that the information represented matches the requirements

Knowledge & Understanding

K1: outline the principles of open platforms, including browsers and databases

K2: list the processes associated with the creation of entities, attributes, and I populating fields, using both software solutions and script- based input

K3: describe data-modeling techniques to design a database

K4: outline the steps in database design, modeling and implementation

K5: describe the internet operation related to web servers and clients

K6: identify the naming conventions appropriate to database design

K7: identify security restrictions on servers, incorporating some theoretical concepts

K8: describe best practice communication, and accessibility, for audiences with special needs.

Critical Evidence(s) Required

A person who demonstrates competency in this unit must be able to provide evidence of the ability to create technical documentation that is clear to the target audience and easy to navigate. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- research client requirements for a database solution
- design a database that meets client requirements
- create a database on a web hosting service or server to meet client requirements by a due date
- Test and debug the database.

0714E&A32 Use social media tools for collaboration and engagement

Overview: This unit describes the performance outcomes, skills and knowledge required to establish a social networking presence using social media tools and applications. The unit specifically identifies the requirement to review, compare and use different types of social networking tools and applications.

Unit of Competency	**Performance Criteria**
1. Describe different types of social media tools and applications	1.1 Explain characteristics of the term social media 1.2 Identify different types of social-media tools and applications 1.3 Illustrate various issues associated with the use of social media tools and applications
2. Compare different types of social media tools and applications	2.1 Select one social media type for review 2.2 Review most popular tools and applications within that social media 2.3 Itemize benefits across a range of the most popular tools and applications 2.4 Select most appropriate social media tool or application
3. Set up and use popular social media tools and applications	3.1 Identify social media tools and applications for possible implementation 3.2 Initiate preferred social media tools and applications 3.3 Establish social media interface using text and file content 3.4 Initiate social network interaction 3.5 Test and evaluate tools and applications for ease of use 3.6 Report and elaborate the findings

Knowledge & Understanding

K1: Basic technical terminology in relation to social networking and social media applications and tools

K2: Basic knowledge of uploading images, text files, pdf files, audio files, video files and link associated files

K3: Features and functions of social media applications

K4: Import and export software functions

K5: Linking documents

K6: OHS principles and responsibilities for ergonomics, including work periods and breaks

K7: Tagging to facilitate collaborative folksonomy

K8: Social media applications and procedures for connecting to social networking sites

K9: Use of input and output devices

K10: Use of RSS feeds to connect a social network.

Critical Evidence(s) Required

A person who demonstrates competency in this unit must be able to provide evidence of the ability to create technical documentation that is clear to the target audience and easy to navigate. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- Establish customer needs
- Design and develop technical documentation, such as system, procedures, training material and user guides, incorporating appropriate standards
- Update document with client feedback
- Prepare documentation for publication.

0714E&A33 E-Commerce- SEO (Search Engine Optimization)

Overview: The aim of this module is to develop efficient E-Marketing strategies in accordance with the Vision and Mission statement of the organization driven by Electronic means.

Unit of Competency	**Performance Criteria**
1. SEO (Search Engine Optimization)	1.1 Apply various SEO techniques 1.2 Employ several SEO key words 1.3 Demonstrate SEO techniques to priorities their site or web application using automated tools

Knowledge & Understanding

K1: Explain different SEO Methods including but not limited to Getting Indexed, Preventing Crawling, and Increasing Prominence.

K2: Elaborate White-hat, Black-hat SEO techniques for web application

K3: Knowledge of SEO key words for web pages translation.

K4: Application of SEO tools usage

Critical Evidence(s) Required

A person who demonstrates competency in this unit must be able to provide evidence of the ability to write and edit copy that is clear to the target audience and easy to navigate. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

0714E&A34 E-Commerce- SCM (Supply Chain Management)

Overview: The aim of this module is to develop efficient E-Marketing strategies in accordance with the Vision and Mission statement of the organization driven by Electronic means.

Unit of Competency	**Performance Criteria**
1. SCM (Supply Chain Management)	1.1 Identity and connect with various potential Suppliers 1.2 Connect and Evaluate their market status and reputation 1.3. Select / short list an appropriate supplier 1.3 Place order as per requirement /inventory 1.4 Inspect received order 1.5 Maintain Inventory as per Inventory Control / store keeping techniques 1.6 Identity the various different available transportation mode 1.7 Identify steps of reverse SCM i-e from consumer to organization

Knowledge & Understanding

K1: Elaborate knowledge of procurement Cycle (Launch of RFP/RFQ, Tender, Bidding, Comparative Statement, Award of Contract, Maintenance)

K2: Explain different techniques to manage

K3: Explain product delivery and their traceability

K4: Knowledge of Incorporation of Outsourcing in logistics.

K5: Information about electronic Data Interchange methodologies and format

Critical Evidence(s) Required

A person who demonstrates competency in this unit must be able to provide evidence of the ability to write and edit copy that is clear to the target audience and easy to navigate. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

0714E&A35 E-Commerce- Social Media Marketing

Overview: The aim of this module is to develop efficient E-Marketing strategies in accordance with the Vision and Mission statement of the organization driven by Electronic means.

Unit of Competency	**Performance Criteria**
1. Social Media Marketing	1.1 Identify various Social media marketing techniques 1.2 Apply suitable Classified Advertisement techniques on social media 1.3 Perform Electronic Mail Marketing 1.4 Creation of Blogs

Knowledge & Understanding

K1: Describe Knowledge of different social media sites that is Facebook, Twitter, LinkedIn, Google+ etc., Comparative Statement, Award of Contract, Maintenance)
K2: Explain Brand pages creation on social media sites.
K3: Evaluate familiarity of banner ads integration on different web sites like newspaper site in any demographic region.
K4: Mention skills to regularly update brand/product/service blogs.K5: Information about electronic Data Interchange methodologies and format
K5: Elaborate direct marketing techniques e.g. Email, SMS (Mobile- Commerce) for the projection of company newsletters

Critical Evidence(s) Required

A person who demonstrates competency in this unit must be able to provide evidence of the ability to implement e-marketing strategies that is clear to the target audience and easy to navigate. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

0714E&A36 Use digital devices

Overview: This unit describes the skills and knowledge required to use a range of digital devices, such as a digital camera, video camera, or personal digital assistant (PDA) device. It applies to individuals who require entry level information and communications technology (ICT) knowledge and literacy skills to support their work in a home office or small office environment.

Unit of Competency	**Performance Criteria**
1. Prepare to use the digital device	1.1 Review and identifiy the instruction manual and ensure components are available 1.2 Identify the physical components of the digital device 1.3 Turn on and follow access procedures to activate the digital device 1.4 Alter/use the digital device settings to best suit intended 1.5 Configure power management settings where appropriate to minimize power consumption, as an environmentally sustainable measure
2. Set up and use the digital device	2.1 Identify and set the basic operating, security and menu settings 2.2 Navigate and manipulate the screen environment 2.3 Customize screen icons and access to applications where applicable 2.4 Use the digital device, save and edit the output where applicable 2.5 Identify more advanced features available and use as required
3. Access and use basic connectivity devices	3.1 Connect to external digital devices, such as computer devices or storage devices, to retrieve, copy, move and save information 3.2 Check physical connectivity of computer devices or storage devices to ensure operation and performance 3.3 Connect to a printer either through a computer device or directly, and use printer settings and print data 3.4 Access audio-visual devices to view and play a multimedia file
4. Shut down digital device	4.1 Save current work and back up important data 4.2 Close open programs on the digital device and any computer device or storage device 4.3 Shut down digital devices, according to manufacturer instructions

Knowledge & Understanding

K1: outline the capabilities and connectivity requirements of relevant:

- audio-visual devices

- peripheral devices
- storage devices

K2: list basic security functions

K3: explain basic software operation and associated applications

K4: explain digital device functions

K5: explain digital device settings.

Critical Evidence(s) Required

A person who demonstrates competency in this unit must be able to provide evidence of the ability to use digital devices that is clear to the target audience and easy to navigate. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- turn on a digital device
- use the menu features and navigate a graphical user interface
- use device features to perform tasks
- Save the results of work.

0714E&A37 Operate word-processing applications

Overview: This unit describes the skills and knowledge required to operate word- processing applications and perform basic operations, including creating and formatting documents, creating tables and printing labels. It applies to individuals in the workplace using fundamental knowledge of word-processing under direct supervision or with limited responsibility.

Unit of Competency	**Performance Criteria**
1. Apply workplace health and safety (WHS) practices	1.1 Use workplace ergonomic work practices and strategies 1.2 Organize work area to ensure an ergonomic work environment
2. Create documents	2.1 Open word-processing application, create document and add data according to information requirements 2.2 Use document templates as required 2.3 Use simple formatting tools when creating the document 2.4 Save document to directory
3. Customize basic settings to meet page layout conventions	3.1 Adjust page layout to meet information requirements 3.2 Open and view various toolbars 3.3 Change font format to suit document purpose 3.4 Change alignment and line spacing according to document information requirements 3.5 Modify margins to suit the document purpose 3.6 Open and switch between several documents
4. Format documents	4.1 Use formatting features and styles as per required 4.2 Highlight and copy text from another area in the document or from another active document 4.3 Insert headers and footers to incorporate necessary data 4.4 Save document in another file format 4.5 Save and close document to a storage device
5. Create tables	5.1 Insert standard table into document 5.2 Change the cells to meet the required information 5.3 Insert and delete columns and rows as necessary 5.4 Use formatting tools according to the style of requirements
6. Add images	6.1 Insert appropriate images into document and customize as necessary 6.2 Position and resize images to meet document formatting needs
7. Print documents	7.1 Preview the document in print preview mode 7.2 Select basic print settings

7.3 Print document or part of document from printer

Knowledge & Understanding

K1: describe formatting styles and their effect on formatting, readability and appearance of documents

K2: identify organizational requirements for ergonomics, including work periods and breaks

K3: select organizational style guide to use

K4: outline purpose, use and function of word-processing software.

Critical Evidence(s) Required

A person who demonstrates competency in this unit must be able to provide evidence of the ability to create word documents that is clear to the target audience and easy to navigate. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- follow organizational ergonomic work health and safety (WHS) requirements and practices
- create, open and retrieve documents using customized basic settings
- format documents by creating tables and adding text, objects and images
- Save and prints documents.

0714E&A38 Operate spreadsheet applications

Overview: This unit describes the skills and knowledge required to operate word- processing applications and perform basic operations, including creating and formatting documents, creating tables and printing labels. It applies to individuals in the workplace using fundamental knowledge of word-processing under direct supervision or with limited responsibility.

Unit of Competency	**Performance Criteria**
1. Create presentations	1.1 Open presentation package and create a simple design for a presentation according to organizational requirements 1.2 Open the blank presentation and add text and graphics 1.3 Apply existing styles within a presentation 1.4 Use presentation template and slides to create a presentation 1.5 Use various tools to improve the look of the presentation 1.6 Save presentation to the appropriate storage device and folder
2. Customize basic settings	2.1 Adjust display to meet user requirements 2.2 Open and view different toolbars to view options 2.3 Ensure font settings are appropriate for the presentation purpose 2.4 View multiple slides at once
3. Format presentations	3.1 Use and incorporate organizational charts and bulleted lists, and modify as required 3.2 Add objects and manipulate to meet presentation purposes 3.3 Import objects and modify for presentation purposes 3.4 Modify slide layout, including text and colors, to meet presentation requirements 3.5 Use formatting tools as required within the presentation 3.6 Duplicate slides within and across a presentation 3.7 Reorder sequence of slides and delete slides for presentation purposes 3.8 Save presentation in another format 3.9 Save to storage device and close presentation
4. Add slide show effects	4.1 Incorporate pre-set animation and multimedia effects into presentation as required to enhance the presentation 4.2 Add slide transition effects to presentation to ensure smooth progression through the presentation 4.3 Test presentation for overall effect

	4.4 Use onscreen navigation tools to start and stop slide show or move between different slides as required
5. Print presentation and notes	5.1 Select appropriate print format for presentation 5.2 Select preferred slide orientation 5.3 Add notes and slide numbers 5.4 Preview slides and run spell check before presentation 5.5 Print selected slides and submit presentation to appropriate person for feedback

Knowledge & Understanding

K1: list basic technical terminology to read help files and prompts

K2: outline the different types of:

- formal and informal presentations
- audience

K3: explain the effect of design and formatting on the readability and usability of presentations

K4: outline presentation pitfalls

K5: identify suitable presentation effects for different audiences.

Critical Evidence(s) Required

A person who demonstrates competency in this unit must be able to provide evidence of the ability to presentations that is clear to the target audience and easy to navigate. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- create, format and prepare presentations for distribution and display
- customize basic settings
- Add slide show effects.

0714E&A39 Operate presentation packages

Overview: This unit describes the skills and knowledge required to operate word- processing applications and perform basic operations, including creating and formatting documents, creating tables and printing labels. It applies to individuals in the workplace using fundamental knowledge of word-processing under direct supervision or with limited responsibility.

Unit of Competency	**Performance Criteria**
1. Create spreadsheets	1.1 Open the spreadsheet application, create spreadsheet files and enter numbers, text and symbols into cells according to information requirements 1.2 Enter simple formulae and functions using cell referencing when required 1.3 Correct formulae when error messages occur 1.4 Use a range of common tools during spreadsheet development 1.5 Edit columns and rows within the spreadsheet 1.6 Use the auto-fill function to increment data where required 1.7 Save the spreadsheet to a folder on a storage device
2. Customize basic settings	2.1 Adjust page layout to meet user requirements or special needs 2.2 Open and view different tool bars 2.3 Change font settings so they are appropriate for the document purpose 2.4 Change alignment options and line spacing according to spreadsheet formatting features 2.5 Format cell to display different styles as required 2.6 Modify margin sizes to suit the purpose of the spreadsheets 2.7 View multiple spreadsheets concurrently
3. Format spreadsheet	3.1 Use formatting features as required 3.2 Copy selected formatting features from another cell in the spreadsheet or from another active spreadsheet 3.3 Use formatting tools as required within the spreadsheet 3.4 Align information in a selected cell as required 3.5 Insert headers and footers using formatting features 3.6 Save spreadsheet as another file type 3.7 Save to storage device and close the spreadsheet
4. Incorporate object and chart in spreadsheet	4.1 Import an object into an active spreadsheet

	4.2 Manipulate the imported object by using formatting features 4.3 Create a chart using selected data in the spreadsheet 4.4 Display selected data in a different chart 4.5 Modify chart using formatting features
5. Print spreadsheet	5.1 Preview spreadsheet in print preview mode 5.2 Select basic printer options 5.3 Print spreadsheet or selected part of spreadsheet 5.4 Submit the spreadsheet to appropriate person for approval or feedback

Knowledge & Understanding

K1: list basic technical terminology related to reading help files and prompts

K2: explain the effect of formatting and appearance on the readability and usability of spreadsheets

K3: outline log-in procedures relating to accessing a personal computer (PC)

K4: describe the purpose, use and function of spreadsheet applications

Critical Evidence(s) Required

A person who demonstrates competency in this unit must be able to provide evidence of the ability to create technical documentation that is clear to the target audience and easy to navigate. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- create spreadsheets
- customize basic settings
- format spreadsheets
- create basic formulas
- insert objects and charts in spreadsheets
- Save and print spreadsheets.

0714E&A40 Perform writing and editing tasks

Overview: This unit describes the skills and knowledge required to apply the conventions of plain English to writing and editing tasks of different forms. It also includes editing and proofreading techniques. It applies to individuals in various writing contexts who write and edit texts using appropriate language, style, grammar, spelling, and standard conventions for editing and proofreading.

Unit of Competency	**Performance Criteria**
1. Apply clear and appropriate language and style to writing and editing tasks	1.1 Use safe work practices including addressing ergonomic requirements when undertaking writing tasks 1.2 Use clear, concise and plain English in writing and editing tasks 1.3. Write / Use the active form in the sentences and avoid the Passive and Indirect form in the sentences in order to avoid ambiguities. 1.3 Use / Apply the appropriate connecting words and paragraph's structures in the written materials to ensure the clarity, ease and reading comprehension 1.4 Make a clear and logical connections between sentences, paragraphs and sections with the follow and proper sequence of the reveiling knowledge and logic. 1.5 . Speak / Express / Incorporate the language and style of the audience
2. Apply the appropriate voice, tone and tense	2.1 Determine appropriate voice, tone and tense of the written materials according to audience requirements 2.2 Maintain consistent voice, tone and tense throughout written material
3. Apply appropriate grammar, spelling and punctuation	3.1 Apply appropriate grammar conventions to a range of written contexts including use of numbers, quotations, and tables 3.2 Apply appropriate spelling and punctuation conventions in writing and editing tasks.
4. Perform editing and proofreading tasks to meet requirements	4.1 Edit written material to ensure clear meaning through language and paragraphs, consistent voice, tone and tense 4.2 Copyedit written material by checking grammar, spelling and punctuation using standard editing conventions 4.3 Proofreading using style guides and by monitoring written material for errors

Knowledge & Understanding

K1: main features of clear, concise and plain English language for written material
K2: grammar, punctuation and spelling conventions that meet the task requirements
K3: editing conventions used in substantive editing and copyediting of written material
K4: basic software used to write and collect feedback

Critical Evidence(s) Required

A person who demonstrates competency in this unit must be able to provide evidence of the ability to perform writing and editing tasks that is clear to the target audience and easy to navigate. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- write and edit at least one written material (2500-4000 words) and edit another material written by another author (2500-4000 words), of different forms (e.g. blog, journal, book) that demonstrate use of:
    - clear and concise language
    - clear and logical paragraph structures
    - appropriate voice, tone, tense and language
    - plain English grammar, spelling and punctuation
    - accepted grammar conventions for a range of written contexts including use of numbers, quotation and tables
    - standard editing conventions
- complete editing and proofreading tasks using handwritten and digital methods
- accurately follow a style guide where required

follow relevant health and safety practices for writing tasks

Metrology

0714E&A41 Take measurements with graduated tools

Overview: This competency standard covers the skills and knowledge required to take measurements Steel rule, Take measurements Hook rule, Take measurements Folding rule and Take measurements with Trammels

Critical Evidence	Performance Criteria

CU1. **Take measurements Steel rule**	**P1**. Place the ruler on various work pieces. **P2**. Take the dimension and record the multiple readings on each of work piece. **P3**. Take an average of readings. **P4**. Record the results.
CU2. **Take measurements Hook rule**	**P1.** Place hook ruler at the given work piece. **P2.** Take the dimension and record multiple readings on each work piece. **P3.** Take averages of the recorded measurements or results . **P4.** Record the results.
CU3. **Take measurements Folding rule**	**P1.** Take the suitable work piece for measurement. **P2.** Measure the dimensions of work pieces. **P3.** Compute surface area, volume, of given work pieces. **P4.** Record the results in data table.
CU4. **Take measurements with Trammels**	**P1.** Open the trammel according to required dimension. **P2.** Draw circle or arc by fixing one point in the dot and rotate.

Knowledge & Understanding

K1. Explain measurements
K2. Explain Dimensions and quantities
K3. Explain linear measurement tools
K4. Describe types of measurements and its units
K5. Decimal and fraction of an inch
K6. Measurement techniques
K7. Explain of area, volume of geometric shapes.
K8. Describe line, arc and circle measurements

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Select proper measuring tool for given task
- Measure the linear dimensions of work piece

Tools & Equipment

- Steel rule
- Work piece
- Surface plate
- Steps and collars
- Hook rule
- Folding rule
- Trammel

0714E&A42 Take measurements with combination set

Overview: This competency standard covers the skills and knowledge required to Take Measurement with Square head, Perform levelling with square head as spirit level, Measure depth with square head as depth gauge, Measure height with square head as height gauge, Perform levelling /measure angle of surfaces with protractor Head, Perform cantering with centre head and Find diameter of round bar

Critical Evidence	Performance Criteria
CU1. **Take Measurement with Square head**	**P1**. Place the combination set on given drawing sheet. **P2**. Draw layout of a component with the help of combination square.
CU2. **Perform leveling with square head as spirit level**	**P1**. Place the spirit level on horizontal work piece. **P2**. Check the deviation of bubbles **P3**. Level the surface by inserting shims. **P4**. Place square head on vertical work piece. **P5**. Note the deviation and correct the level. **P6**. Check the other geometrical shapes.
CU3. **Measure depth with square head as depth gauge**	**P1**. Place the square head on work piece. **P2**. Apply force at the head to retain contact with the component. **P3**. Set square head and record the depth.
CU4. **Measure height with square head as height gauge**	**P1**. Place the square head on work piece. **P2**. Measure height of work piece with and without the help of height gauge attachment.
CU5. **Perform leveling /measure angle of surfaces with protractor Head**	**P1.** Place protractor head of combination set on work piece. **P2.** Loose screws of revolving circular disk and adjust the bubble of level to minimize deviation. **P3.** Study the angle between slopes of a component.
CU6. **Perform centering with center head**	**P1.** Place the center head on round stock. **P2.** Trace the line with scriber. **P3.** Revolve the center head by 90^{o} and draw another line. **P4.** Find center of round stock by bisecting point of lines.
CU7. **Find diameter of round bar**	**P1.** Place the center head on round stock **P2.** Note the reference point and measure point by avoiding parallax **P3.** Find the difference between reference point and measure point.

Knowledge & Understanding

K1. Explain combination set
K2. Describe level, head, square, gauge
K3. Explain deviation
K4. Measurement techniques
K5. Knowledge of dimensioning of drawings and layouts
K6. Measurement techniques
K7. Knowledge of dimensioning of drawings and layouts

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Measure depth and height with square head
- Level the work piece using spirit level
- Perform centering
- Measure angle
- Measure Diameter

Tools & Equipment

- Combination set
- Surface plate
- Scriber
- Tri square
- Divider
- Round stock

0714E&A43 Perform Levelling

Overview: This competency standard covers the skills and knowledge required to Exercise of cast iron, granite and glass surface plate, Check level of surfaces with straight edge and spirit level, Check level by Engineer's level and measurements with Engineer's parallel

Critical Evidence	Performance Criteria
CU1. **Exercise of cast iron, granite and glass surface plate**	**P1**. Place the work piece with angle plate on surface plate. **P2**. Check squarness and parallelism of components. **P3**. Check the squareness of angle plate with dial indicator.
CU2. **Check level of surfaces with straight edge and spirit level**	**P1.** Place straight edge diagonally on the surface plate **P2.** Place spirit level on the straight edge. **P3.** Check the level with bubble. **P4.** Adjust the level by feeler gauge.
CU3. **Check level by Engineer's level**	**P1**. Clean the level and surface **P2**. Place the level on work piece. **P3**. Record the difference by changing the position of level. **P4**. Calculate mean or average value. **P5**. Maintain the level of plane by providing packing as per requirement.
CU. **measurements with Engineer's parallel**	**P1.** Insert the engineer's parallel in work piece. **P2.** Measure the taper or diameter of cylindrical surface.

Knowledge & Understanding

- **K1.** Explain squareness
- **K2.** Explain parallelism
- **K3.** Measurement techniques
- **K4.** Geometric shapes
- **K5.** Describe measurements system of units (SI / Biritish)
- **K6.** Explain conversion fectors

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Check squarness and parallelism of component
- Check the level with bubble
- Measure taper and diameter of cylindrical surface

Tools & Equipment

- Surface plates
- Straight edge and spirit level
- Engineer's level
- Engineer's parallel

0714E&A44 Take measurements with gauges

Overview: This competency standard covers the skills and knowledge required to take measurement with fixed gauge, plug gauge, adjustable gauge, small hole gauge and telescope gauge

Critical Evidence	Performance Criteria
CU1. **Take measurement with fixed gauge and plug gauge.**	**P1**. Check / Compare the dimension of provided work piece against the reference standard with the help of fixed gauge. **P2**. Insert the plug gauge into the work piece to determine either dimension is of acceptable size or over size.
CU2. **Take measurement with adjustable gauge**	**P1**. Insert both "go" and "not go" gauges in the work piece. **P2**. Check the size and record the results.
CU3. **Take measurement with small hole gauge**	**P1**. Insert the small hole gauge of require size into the work piece **P2.** Record the result.
CU4. **Take measurement with telescope gauge**	**P1**. Insert the telescope gauge into the work piece **P2.** Adjust the gauge and determine the size of work piece.

Knowledge and understanding

- **K1.** Knowledge of dimensioning and measurement techniques
- **K2.** Explain go and not go gauges
- **K3.** Describe standards and refrences
- **K4.** Explain inner dia, outer dia and wall thickness

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Check the dimension of provided work piece against reference standard with the help of fixed gauge
- Insert both "go" and "not go" gauges in the work piece and Check the size and record the results.

Tools & Equipment

- ❖ Fix gauge
- ❖ Surface plate
- ❖ Surface gauge
- ❖ Dial indicator
- ❖ Adjustable gauge
- ❖ Hole gauge
- ❖ Telescope•

0714E&A45 Perform measurements through Micrometer

Overview: This competency standard covers the skills and knowledge required to take measurement with outside micro-meter, inside micrometre, depth micrometre, Measure threads with micrometre and Vernier micrometre

Critical Evidence	Performance Criteria
CU1. **Take measurement with outside micro-meter**	**P1**. Clean the gauge and surface of work piece **P2**. Open slightly larger than the part to be measured **P3** Set anvil squarely against reference surface of part **P4**. Using ratchet, slowly until it click once **P5**. Record the reading and calculate the average.
CU2. **Take measurement with inside micrometer**	**P1**. Clean the gauge and surface of work piece. **P2**. Open gauge slightly smaller than the part to be measured **P3**. Set anvil squarely against reference surface of part with ratchet, slowly until it click once. **P4**. Record readings and calculate the average.
CU3. **Take measurement with depth micrometer**	**P1.** Clean the gauge and surface of work piece. **P2**. Access the depth of groove by steel rule **P3**. Insert the rod **P4**. Place the depth micrometer gauge on the deeper groove and record the reading.
CU4. **Measure threads with micrometer**	**P1.** Clean the gauge and the threads of work piece. **P2.** Use the suitable set of thread shape tips according to thread size which is to be measured. **P3.** Record the reading.
CU5. **Take measurement with Vernier micrometer**	**P1.** Clean the surface. **P2.** Place specimen on the surface plate **P3.** Take reading accurately. **P4.** Calculate mean reading.

Knowledge and understanding

K1. Measurement techniques
K2. Geometric shapes thickness
K3. Tools usage

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Take measrements with inside and outside micrometer
- Measure threads with micrometer

Tools & equipment

- ❖ Inside Micrometer
- ❖ Outside micrometer
- ❖ Depth micrometer
- ❖ Vernier micrometer

0714E&A46 Measure dimensions with Vernier tools

Overview: This competency standard covers the skills and knowledge required to take measurement with Vernier calliper, height gauge and Vernier depth gauge

Critical Evidence	Performance Criteria
CU1. **Take measurement with Vernier caliper**	**P1**. Clean the gauge and surface of work piece. **P2**. Place the work piece on surface plate. **P3**. Open the lock screws. **P4**. Slide the jaws up to the width or size of jaws. **P5**. Open slightly larger than the part to be measured. **P6**. Set anvil squarely against reference surface of part **P7**. Maintain the proper pressure on the jaws with screw. **P8**. Lock the movable jaw with knurled screw **P9.** Measure and record the dimensions.
CU2. **Take measurement with height gauge**	**P1**. Clean the gauge and surface of work piece **P2**. Hold the work piece on angle plate. **P3**. Open the lock screws. **P4**. Set the height gauge on stud to check it with fine adjusting screw. **P8**. Lock the measuring head. **P9.** Record the reading.
CU3. **Take measurement with Vernier depth gauge**	**P1.** Clean the gauge and surface of work piece **P2**. Hold the work piece on sample plate. **P3**. Open the lock screws. **P4**.insert the gauge inside the work piece with fine adjusting screw. **P8**. Lock the measuring head. **P9.** Record the reading

Knowledge & understanding

- **K1.** Vernier gauges
- **K2.** Dimensioning
- **K3.** Measurement techniques

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Take measrements with vernier
- Measure depth with Vernier
- Measure height with Vernier

Tools & equipment

- ❖ Vernier caliper
- ❖ Depth Vernier
- ❖ Hieght Vernier

0714E&A47 Measure angles with angle measuring Instruments.

Overview: This competency standard covers the skills and knowledge required to take measurement with Bevel protractor, Measure angles with Vernier Bevel protractor, Dial protractor, Steel protractor and Sine bar

Critical Evidence	Performance Criteria
CU1. **Take measurement with Bevel protractor.**	**P1**. Clean the instrument and work piece **P2**. Set the work piece and protractor as per requirement **P3**. Make adjustment of the protractor for accurate measurement. **P4**. Record and tabulate the results.
CU2. **Measure angles with Vernier Bevel protractor**	**P1**. Set the protractor on work piece properly **P2**. Read the Vernier scale **P3**. Measure and record the angle for clock wise and counter clock wise directions
CU3. **Measure angles with Dial protractor**	**P1**. Set the protractor on work piece properly **P2**. Read the dial scale **P3**. Measure the angle accurately
CU4. **Measure angles with Steel protractor**	**P1**. Set the protractor on work piece **P2**. Measure the angle
CU5. **Measure angles with Sine bar**	P1. Select proper size Sine Bar P2. Set the Sine Bar with gauge block to measure taper P3. Calculate tapper angle accurately

Knowledge & understanding
K1. Measurement techniques
K2. Knowledge of Angles

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Maesure the angle with different protectors.
- Measure angle with sine bar

Tools & equipment

- Bevel protractor
- Vernier bevel protractor
- Dial protractor
- Steel protractor
- Sine bar

0714E&A48 Measure Threads and Gears

Overview: This competency standard covers the skills and knowledge required to Measure threads with thread gauges, Measure gear dimensions with gear tooth calliper and Measure gear dimensions with gear testing machine

Critical Evidence	Performance Criteria
CU1: **Measure threads with thread gauges**	**P1**. Place suitable sized wire in thread of work piece **P2.** Take the dimensions**.** **P3.** Note pitch of thread and calculate depth of thread by using formula**.**
CU2: **Measure gear dimensions with gear tooth caliper**	**P1**. Adjust the jaws of caliper into the tooth of gear work piece. **P2**. Measure the tooth thickness, cordials addendum and cordials thickness. **P3.** Compare the measured values with theoretical results.
CU3: **Measure gear dimensions with gear testing machine**	**P1.** Idetify componets of gear inspection machines and **P2.** draw schematic. **P3.** Measure the dimensions of spur, bevel, helical with gear testing machine

Knowledge & understanding

K1. Threads and their types

K2. Measurement techniques

K1. Gears, terminologies related to gears and its types

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Maesure the tooth thickness, cordials addendums and cordials thickness.
- Measure dimensions of given gear

Tools & equipment

- ❖ Thread gauge
- ❖ Gear tooth caliper
- ❖ Gear Inspection machine
- ❖ Gear testing machine

Basic Engineering Drawings

0714E&A49 Perform Basic Manual Drawing

Overview: This competency standard covers the skills and knowledge required to draw single stroke capital vertical lettering, draw single stroke capital inclined lettering, draw horizontal, vertical and inclined lines, use of compass, circles, half circles, radius, drawing center lines, centers, curves, and crossing of lines, construction of parallel-lines, perpendicular, bisects line, angles and equal division of lines, draw round corners, circles elements, quadrilaterals inside and outside circle and construction of angles and triangles.

Critical Evidence	Performance Criteria
CU6. Draw horizontal, vertical and inclined lines.	**P1.** Prepare the Drawing sheet. **P2.** Select the ools. **P3.** Draw the Boundaries lines as per standards. **P4.** Make the title bar. **P5.** Divide the sheets in two equal parts. **P6.** Draw lines at 30, 45, 60, 90and 120 angles.
CU7. Draw single stroke capital vertical lettering.	**P1.** Prepare the Drawing sheet. **P2.** Select the tools. **P3.** Use the dedicated pencil for lettering with the holding techniques. **P4.** Draw the Boundry lines as per standards. **P5.** Make the title bar. **P6.** Draw the upper and lower lines for lettering according to the standards. **P7.** Start with writing Vertical Lettering with the different style such as Gothic, Roman and free hand lettering.
CU8. Draw single stroke capital inclined lettering.	**P1.** Prepare the Drawing sheet. **P2.** Select the tools. **P3.** Draw Boundaries lines as per standards. **P4.** Make title bar. **P5.** Draw the upper and lower lines for lettering according to the standards. **P6.** Start writing with inclined Lettering with various styles such as Gothic, Roman and free hand lettering.
CU9. Draw circles, half circles, radius with compass.	**P1.** Prepare Drawing sheet. **P2.** Select the tools. **P3.** Draw the Boundaries lines as per standards. **P4.** Make title bar. **P5.** Divide the sheets in various equal parts.

	P6. Make the circles and half circles with different diameters
CU10. Draw Lines	**P1.** Prepare Drawing sheet. **P2.** Select the tools. **P3.** Draw the Boundaries lines as per standards. **P4.** Make the title bar. **P5.** Divide the sheets in two or various equal parts. **P6.** Draw the Center lines. **P7.** Draw the parallel-lines. **P8.** Draw the perpendicular & bisecter lines. **P9.** Draw the equal division of lines. **P10.** Make the various curves with different angles **P11.** Draw the crossing line.
CU11. Draw round corners, circles elements, quadrilaterals inside and outside circle.	**P1.** Prepare Drawing sheet. **P2.** Select the tools. **P3.** Draw Boundaries lines as per standards. **P4.** Make title bar **P5.** Divide the sheets in two or various equal parts. **P6.** Make different dia circles. **P7.** Make different types of diagrams that touch the circles at the tangent points.
CU12. Construct angles and triangles	**P1.** Prepare Drawing sheet. **P2.** Select the tools. **P3.** Draw Boundaries lines as per standards. **P4.** Make title bar **P5.** Divide the sheets in different equal parts. **P6.** Draw Equilateral Triangle, Isosceles triangle, Scalene Triangle, Right angle Triangle, Obtuse Triangle, Acute Triangle.

Knowledge & Understanding

K1. Importance of Technical Drawing.

K2. Common engineering terminology.

K3. Uses of Technical Drawing

K4. Type of Drawings

K5. Application of Technical drawings

K6. Drawing Pencil, their grading, sharpening and using techniques.

K7. Style of letters.

K8. General rules for letterings
K9. List of drawing equipments'
K10. Types of lines
K11. Importance of lines
K12. Common Types of lines and correct line weightage.
K13. Application of lines.
K14. Introduction to geometry.
K15. Introduction to sketching techniques.
K16. Introduction to the geometry (Duplicate with k14).
K17. Introduction to the sketching techniques.
K18. Techniques of sketching straight lines in different directions.
K19. Triangles, Quadrilateral, and Polygons definitions and types.

Critical Evidence

The candidate needs to produce the following **Critical Evidence**(s) in order to be competent in the following competency standards:

- Draw lines, triangles and circles.
- Draw single stroke capital letters.

Tool & Equipment

- Graph papers and drawing sheet.
- Sheet holders (tape / clipers)
- Drawing Board/Table.
- T-Square
- D / Protector
- Ruler
- Pencils and Erasers
- Set Square.
- Templetes.
- Geometry (Instrument) Box.
- Compass and Dividers.

0714E&A50 Construct different Engineering Curves.

Overview: This competency standard covers the skill and knowledge, required to Construct inscribe and circumscribe figures, Construct a pentagon, Hexagon and Octagon by circumscribe method,

Construct a pentagon, Hexagon and Octagon by inscribe method, Construct a Tangents of circles (Inside & Outside) when the centre of the given circle is known and when the circle of centre is not known, Construct an Ellipse by Concentric Circle Method, Rectangle Method, Oblong Method, Arcs of Circle Method, Rhombus Method and Basic Locus Method, Construct a parabola curve by Rectangle Method, Method of Tangents (Triangle Method) and Basic Locus Method, Construct a hyperbola curve, Construct a Archimedean Spiral curve, Construct a involutes curve of square rectangle hexagon and circle and Construct of cycloid, epicycloids, and hypocycloid.

Critical Evidence	Performance Criteria
CU1 Construct inscribe and circumscribe figures.	**P1.** Prepare the Drawing sheet. (add the after each action word) **P2.** Select the tools. **P3.** Draw Boundaries lines as per standards. **P4.** Make title bar **P5.** Divide the sheets in two or various equal parts. **P6.** Draw the square, triangle and hexagon according to the dimension.
CU2 Construct a pentagon, Hexagon and Octagon by circumscribe method.	**P1.** Prepare Drawing sheet. **P2.** Select the tools. **P3.** Draw Boundaries lines as per standards. **P4.** Make title bar **P5.** Divide the sheets in different equal parts. **P6.** Draw pentagon, Hexagon and Octagon .
CU3 Construct pentagon, Hexagon and Octagon by inscribe method	**P1.** Prepare Drawing sheet. **P2.** Select the tools. **P3.** Draw Boundaries lines as per standards. **P4.** Make title bar **P5.** Divide the sheets in different equal parts. **P6.** Draw pentagon, Hexagon and Octagon.
CU4 Construct Tangents of circles (Inside & Outside)	**P1.** Prepare Drawing sheet. **P2.** Select the tools. **P3.** Draw Boundaries lines as per standards. **P4.** Make title bar **P5.** Divide the sheets in different equal parts. **P6.** Draw the Tangents Inside of the circle When the centre of the circle is known. **P7.** Draw the Tangents Inside of the circle When the centre of the circle is unknown

	P8. Draw the Tangents outside of the circle When the centre of the circle is known **P9.** Draw Tangents outside of the circle When the centre of the circle is unknown
CU5 Construct Ellipse	**P1.** Prepare Drawing sheet. **P2.** Select the tools. **P3.** Draw Boundaries lines as per standards. **P4.** Make title bar **P5.** Divide the sheets in different equal parts. **P6.** Draw an Ellipse by Concentric Circle. **P7.** Draw an Ellipse by Rectangle Method **P8.** Draw an Ellipse by Oblong Method **P9.** Draw an Ellipse by Arcs of Circle Method **P10.** Draw the Ellipse by Rhombus Method. **P11.** Draw the Ellipse by Basic Locus Method
CU6 Construct a parabola	**P1.** Prepare Drawing sheet. **P2.** Select the tools. **P3.** Draw Boundaries lines as per standards. **P4.** Make title bar **P5.** Divide the sheets in different equal parts. **P6.** Draw a parabola by Rectangle **P7.** Draw a parabola by Method of Tangents (Triangle Method) **P8.** Draw a parabola by Basic Locus Method
CU7 Construct a hyperbola	**P1.** Prepare Drawing sheet. **P2.** Select the tools. **P3.** Draw Boundaries lines as per standards. **P4.** Make title bar **P5.** Divide the sheets in different equal parts. **P6.** Draw a hyperbola.
CU8 Construct a Archimedean Spiral curve	**P1.** Prepare Drawing sheet. **P2.** Select the tools. **P3.** Draw Boundaries lines as per standards. **P4.** Make title bar **P5.** Divide the sheets in various or two equal parts. **P6.** Draw spiral curve.

CU9 Construct involute curve	**P1.** Prepare Drawing sheet. **P2.** Select the tools. **P3.** Draw Boundaries lines as per standards. **P4.** Make title bar **P5.** Divide the sheets in different equal parts. **P6.** Draw involute curve by square **P7.** Draw involute curve by rectangle **P8.** Draw involute curve by hexagon **P9.** Draw involute curve by circle.
CU10 Construct cycloid, epicycloid, and hypocycloid	**P1.** Prepare Drawing sheet. **P2.** Select the tools. **P3.** Draw Boundaries lines as per standards. **P4.** Make title bar **P5.** Divide the sheets in different equal parts. **P6.** Draw the generating circle and the base line equal to the circumference of the generating circle **P7.** Divide the circle and the base line in the equal number of parts **P8.** Complete the cycloid, epicycloids, and hypocycloid.

Knowledge & Understanding

K1. Techniques of sketching straight lines in various directions

K2. Triangles, Quadrilateral and Polygons definiations and types

K3. Describe circular arc using various line method

K4. Describe circular arc

K5. Types of Geometric Shape

K6. Two-dimensional shapes

K7. Three-dimensional shapes

K8. Regular Polyhedrons

K9. Methods of drawing Tangents & Normal

K10. Describe ellipse

K11. Describe different methods of sketching ellipse

K12. Describe parabola

K13. Describe different methods of parabola

K14. Describe hyperbola curve

K15. Describe various methods of hyperbola curve.

K16. Describe spiral curve

K17. Describe involute curve

K18. Describe cycloid

K19. Describe epicycloids

K20. Describe hypocycloid

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in the following competency standard:

- Draw Conics (Parabola, Hyperbola and elips).
- Construct inscribe and circumscribe figures.

Tool and Equipment

- Graph papers and drawing sheet.
- Sheet holders (tape / clipers)
- Drawing Board/Table.
- T-Square
- D / Protector
- Ruler
- Pencils and Erasers
- Set Square.
- Templets.
- French Curves
- Geometry (Instrument) Box.
- Compass and Dividers

0714E&A51 Construct multi-view drawings

Overview: This competency standard covers the skills and knowledge required to Sketch Orthographic projection 1st angle, Sketch Orthographic projection 3rd angle, Sketch Oblique Drawing, Construct multi view drawing of Simple Bearing, Construct multi view drawing of Open Bearing, Sketch prism, Sketch cone and Draw pyramid.

Critical Evidence	Performance Criteria
CU1 Sketch Orthographic projection in 1st angle of Projection	**P1.** Prepare the Drawing sheet. **P2.** Select the tools. **P3.** Draw Boundaries lines as per standards. **P4.** Make title bar **P5.** Divide the sheets in equal parts. **P6.** Draw plan view **P7.** Draw front view **P8.** Draw side view
CU2 Sketch Orthographic projection 3rd angle of Projection	**P1.** Prepare Drawing sheet. **P2.** Select the tools. **P3.** Draw Boundaries lines as per standards. **P4.** Make title bar **P5.** Divide the sheets in equal parts. **P6.** Draw plan view **P7.** Draw front view **P8.** Draw side view
CU3 Sketch Oblique Drawing	**P1.** Prepare Drawing sheet. **P2.** Select the tools. **P3.** Draw Boundaries lines as per standards. **P4.** Make title bar **P5.** Divide the sheets in equal parts **P6.** Draw the front or side view of the object.
CU4 Construct multi view drawing of Simple Bearing.	**P1.** Prepare Drawing sheet. **P2.** Select the tools. **P3.** Draw Boundaries lines as per standards. **P4.** Make title bar **P5.** Divide the sheets in equal parts. **P6.** Draw plan view of simple bearing

	P7. Draw front view of simple bearing **P8.** Draw side view of simple bearing
CU5 Construct multi view drawing of Open Bearing	**P1.** Prepare Drawing sheet. **P2.** Select the tools. **P3.** Draw Boundaries lines as per standards. **P4.** Make title bar **P5.** Divide the sheets in equal parts. **P6.** Draw plan view of open bearing **P7.** Draw front view of open bearing **P8.** Draw side view of open bearing
CU6 Sketch prism	**P1.** Prepare Drawing sheet. **P2.** Select the tools. **P3.** Draw Boundaries lines as per standards. **P4.** Make title bar **P5.** Divide the sheets in equal parts. **P6.** Sketch prism
CU7 Sketch cone	**P1.** Prepare Drawing sheet. **P2.** Select the tools. **P3.** Draw Boundaries lines as per standards. **P4.** Make title bar **P5.** Divide the sheets in equal parts. **P6.** Start with a horizontal oval **P7.** draw the two sides of a triangle which meets at a common point
CU8 Draw pyramid	**P1.** Prepare Drawing sheet. **P2.** Select the tools. **P3.** Draw Boundaries lines as per standards. **P4.** Make title bar **P5.** Divide the sheets in equal parts. **P6.** Sketch pyramid

Knowledge & Understanding

K1. Explain Orthographic projection 1st angle.

K2. Explain Orthographic projection 3rd angle**.**

K3. Explain Oblique Drawing.

K4. Explain Multi view drawing of Simple Bearing.

K5. Explain Prism, Cone and pyramid

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in the following competency standard:

- Diffrentiate first and third angle projection drawings.
- Draw prism, cone and pyramid in different views.

Tool and Equipment

- Graph papers and drawing sheets.
- Sheet holders (tape / clipers)
- Drawing Boards and Tables.
- T-Square
- D / Protector
- Ruler
- Pencils and Erasers
- Set Square.
- Templets.
- French Curves
- Geometry (Instrument) Box.
- Compass and Dividers.

0714E&A52 Develop 2D CAD drawings

Overview: This competency standard covers the skills and knowledge required to Develop and prepare 2D objects

Critical Evidence	Performance Criteria
CU1. **Develop 2D Objects**	**P1.** Setup the drawing interfaces for the required specifications **P2.** Setup the user interface settings for the required specifications **P3.** Save the CAD drawing files in various file formats such as DWG, PDF, and JPG. Repeat this kind of correction each of the similar sentences repeated in next pages!!. **P4.** Create the 2D Objects with the given measurements **P5.** Edit 2D Objects to meet set standards
CU2. **Prepare Final Set of 2D Drawings**	**P1.** Use an appropriate command and tools to develop the 2D Drawing **P2.** Develop a 2D Drawing with the given project specifications and measurements **P3.** Create a title block layout as required **P4.** Plot drawing on scale according to required size and orientation

Knowledge & Understanding

K1. Basics of Drawing Settings

K2. Unit setting

K3. Limits setting

K4. User coordinate system Workspace setting

K5. Object Snap Settings

K6. Basic Commands and Concepts Angles and lines in CAD Software.

K7. Differentiate between absolute, relative and polar system

K8. DIMSTYLE and MTEXT commands

K0714E&A HATCHING concepts in CAD Software

K10. Differentiate between CHAMFER and FILLET command

K11. Types of Array

K12. OFFSET, CIRCLE and ROTATE short commands

K13. Zooming options

K14. Tools palettes window

K15. Design center

K16. Scale and paper sizes

K17. Modify dimension style and text size according to paper size

K18. Backup file

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in the following competency standard:

- Draw lines and circles in CAD software
- Draw different types of triangles in CAD software.

Tool and Equipment

- Computer with all accessories
- Engineering CAD software
- Physical Models / Prototype

0714E&A53 Develop 3D CAD drawing

Overview: This competency standard covers the skill and knowledge required to develop 3D objects along with editing, rendering and manipulations. .

Critical Evidence	Performance Criteria
C1. **Develop 3D Objects**	**P1.** Setup and save the 3D drawing interface for the required specifications. **P2.** Setup 3D user interface settings for the required specifications. **P3.** Create 3D objects with the given measurements.
C2. **Manipulate 3D objects using 3D Editing Tools**	**P1.** Modify 3D objects in line with the requirements. **P2.** Make customized 3D models according to the requirement of the given job. **P3.** Convert 3D Face objects into a single mesh objects.
C3. **Render 3D Model**	**P1.** Apply material to required 3D Model as per given specification **P2.** Apply lights to get the requisite scene of required 3D model **P3.** Assign cameras to execute different views of required 3D Model. **P4.** Render and print the 3D model according to required size & orientation. **P5.** Apply texture to 3D model as per given specification.

Knowledge & Understanding

- **A. 3D modeling in CAD** Software
  - **K1.** 3D solids,
  - **K2.** surfaces,
  - **K3.** meshes,
  - **K4.** Wireframe objects.
  - **K5.** Differentiate between Surface Modeling and Solid Modeling.
  - **K6.** 3D face and Edges
- **B. Boolean operation concepts**
  - **K7.** Subtraction
  - **K8.** Intersection
  - **K9.** Union
- **C. 3D Navigate control**
  - **K10.** Functions of different camera settings.
  - **K11.** Importance of scene creation
  - **K12.** Preset views such as isometric, top, bottom, front, left, etc.
  - **K13.** Perspective projection and parallel projection
  - **K14.** Walk
  - **K15.** Constrained Orbit
- **D. Material and light control**
  - **K16.** Planner mapping
  - **K17.** Texture map
  - **K18.** Opacity control

K19. Render context
K20. Render sampling

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in the following competency standard:

- Develop 3D model of given physical model in CAD software
- Change the attributes of 3D model (color, material, dimensions).

Tool and Equipment

- Computer with all accessories
- Engineering CAD software
- Physical Models / Prototype

Welding

0714E&A54 Interpret Part and Assembly Drawing

Overview: This competency standard covers the skills and knowledge required to Read and Understand Manufacturing Drawings, Interpret Welding Symbols, Recognize Material Specifications and Bill of Material (BOM).

Critical Evidence	Performance Criteria
CU1. Interpret Manufacturing Drawings	**P1.** Recognize basics of lines used in engineering drawings **P2.** Describe uses of lines in the engineering drawings **P3.** Recognize and explain orthographic and isometric views of a drawing **P4.** Identify the manufacturing requirements according to the drawings **P5.** Prepare job layout according to the manufacturing requirements
CU2. Interpret Welding Symbols	**P1.** Recognize the basic and supplementary welding symbols used in manufacturing drawings **P2.** Identify and differentiate between the types of welds and joints **P3.** Identify the welding requirements according to the welding symbols given in the manufacturing drawings
CU3. Recognize Material Specifications and Bill of Material (BOM)	**P1.** Identify the material specifications according to manufacturing drawing **P2.** Identify the bill of material (BOM) according to the manufacturing drawing
CU4. Interpret assembly drawings	**P1.** Interpret the dimensional tolerances according to the manufacturing drawing **P2.** Identfy the parts in an assembly drawing.

Knowledge & Understanding

The candidate must be able to demonstrate the understanding and indepth knowledge, required to carry out the tasks covered in this competency standard. This includes the knowledge of :

K1. Describe Basic elements of engineering drawing

K2. Describe Drawing symbols

K3. Explain Dimensioning techniques

K4. Define General tolerance
K5. Define Angular tolerance
K6. Define Geometric tolerance
K7. Explain Perspective
K8. Explain Exploded view
K9. Explain Hidden view technique
K10. Explain First angle projections
K11. Explain Third angle projections

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Identify the welding requirements according to welding symbols given in the manufacturing drawings
- Identify the material specifications according to the manufacturing drawing
- Identify the bill of material (BOM) according to the manufacturing drawing
- Interpret the dimensional tolerances according to the manufacturing drawing
- Interpret the assemble drawing

Tools and Equipment

- ❖ Layout tools
- ❖ Measuring devices
- ❖ Hand held calculator
- ❖ Fabrication and welding equipment

0714E&A55 Evaluate the Use of Hand and Power Tools

Overview: This competency standard covers the skills and knowledge required to Put on hand tools and Put on power tools

Critical Evidence	Performance Criteria
CU1. Maintain hand tools	**P1.** Select the hand tools appropriate to the task requirements. **P2.** Use the hand tools to produce desired outcomes to the job specifications which may include finish, tension, size or shape. **P3.** Adhere all safety requirements to before, during and after use. **P4.** Identify and mark unsafe or faulty tools for repair according to designated procedures before, during and after use. **P5.** Maintain the tools, including hand sharpening according to the standard operational procedures, principles and techniques. **P6.** Store the hand tools safely in the appropriate location according to the standard operational procedures and manufacturers recommendations.
CU2. Maintain power tools	**P1.** Select the power tools appropriate to the task requirements. **P2.** Use the power tools for a determined sequence of operations-which may include clamping, alignment and adjustment to produce desired outcomes-to job specifications which may include finish, size or shape. **P3.** Adhere all safety requirements to before, during and after use. **P4.** Identify and mark the unsafe or faulty tools before starting to use or work according to the designated procedures **P5.** Repeat the step P4 during and after completeing the use **P6.** Maintain the tools, including hand sharpening according to standard operational procedures, . **P7.** Store power tools safely in the appropriate location according to standard operational procedures and manufacturers' recommendations.

Knowledge & Understanding

The candidate must be able to demonstrate the understanding and indepth knowledge required to carry out tasks covered in this competency standard. This includes the knowledge of:

K1. Applications of different hand and power tools in a general engineering context

K2. Common faults and/or defects in hand and power tools

K3. Procedures for marking unsafe or faulty tools for repair

K4. Routine maintenance requirements for a range of hand and power tools

K5. Storage location and procedures for a range of hand and power tools

K6. Hazards and control measures associated with using hand and power tools

K7. Benefits and limits of cutting and shaping metal with auxiliary equipment

K8. Environmental benefits of maintaining auxiliary equipment

K9. Clamping /securing methods

K10. Adjustment / alignments to a range of power tools

K11. Tool sharpening techniques for a range of power tools

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Identify and mark unsafe or faulty tools for repair according to designated procedures before and after using as well as during the use.
- Maintain tools, including hand sharpening according to standard operational procedures, .
- Store hand tools safely in appropriate location according to standard operational procedures and manufacturer's recommendations.
- Identify and mark unsafe or faulty tools for repair according to designated procedures before, during and after use.
- Store power tools safely in appropriate location according to standard operational procedures and manufacturer's recommendations.

Tools and Equipment

- Work bench
- Bench vice
- Hammer
- Tri-square
- Hand hacksaw
- Scriber
- Vernier caliper
- Flat File
- Number/alphabet punch
- Scriber
- Vernier caliper
- Hand drill machine
- Disk grinder

- Pin grinder

0714E&A56 Perform Pre-Welding Operations

Overview: This competency standard covers the skills and knowledge required to Set Welding Equipment, Prepare materials for welding, Cut and Prepare Edge/s of Base Materials and Prepare Welding Consumables

Critical Evidence	Performance Criteria
CU.1 Set Welding Equipment	**P1.** Adjust the pressure of both gas cylinders with the help of regulator **P2.** Open acetylene gas knob of welding torch Make carburizing flame by increasing acetylene gas quantity **P3.** Make a neutral flame by adjusting both gases at same quantity **P4.** Make an oxidizing flame by increasing the oxygen gas quantity **P5.** Adjust pressure of gas cylinders with the help of regulator **P6.** Select the correct size of the nozzle **P7.** Set the gas flame of welding torch as per standard
CU2. Prepare materials for welding	**P1.** Select and obtain the required material/s as per job requirements **P2.** Select appropriate marking tools as per job requirements **P3.** Mark the area to be cut as per drawing / job requirements
CU3. Cut and Prepare Edge/s of Base Materials	**P1.** Select appropriate cutting equipment as per job requirements **P2.** Set-up cutting equipment as per manufacturer's instructions / job requirements **P3.** Cut the base material as per job specifications and dimensions provided in the drawing **P4.** Prepare edges of the base materials as per drawing / WPS **P5.** Check dimensions of the prepared edges as per drawing / WPS **P6.** Select proper tools and chemicals for cleaning **P7.** Clean the edges of the base materials as per job requirements
CU4. Prepare Welding Consumables	**P1.** Select the relevant welding consumables as per job requirements/WPS **P2.** Prepare the consumables in accordance with required specifications

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

K1. Describe about welding torch
K2. Identify Gas pressure regulators
K3. Explain temperature and its units
K4. Describe pre heating
K5. Explain importance of pre heating
K6. Explain metal properties
K7. Describe malleability
K8. Describe types of grinder
K9. Explain use of tri square
K10. Describe importance of filing
K11. Describe the filler rod
K12. Describe electrode baking oven
K13. Describe purpose of flux

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Adjust pressure of both gas cylinders with the help of regulator
- Make oxidizing flame by increasing oxygen gas quantity
- Adjust pressure of both gas cylinders with the help of regulator
- Cut the base material as per job specifications and dimensions provided in the drawing

Tools and Equipment

- Oxygen cylinder
- Acetylene gas cylinder
- Pressure regulators
- Cylinder key
- Welding torch
- Rubber house pipe
- Back fire arrester
- Flash back arrester
- Spark lighter
- Steel wire brush
- Work bench
- Bench vice
- Hammer
- Tri-square

- Hand hacksaw
- Scriber
- Vernier caliper
- Flat File
- Pedestal grinder
- Disk grinder
- Pin grinder
- Flat file
- Welding electrode
- Metal Filler rod
- Welding flux

0714E&A57 Perform Oxy Acetylene Welding

Overview: This competency standard covers the skills and knowledge required to Practice of making Tee Joint, Practice of making Lap Joint and Practice of Making Butt Joint

Critical Evidence	Performance Criteria
CU1. Practice of making Tee Joint	**P1.** Take Work piece as per drawing **P2.** Straiten it with the help of hammer and anvil **P3.** Grind the work pieces on grinding machine to prepare the edges flat and parallel to each other **P4.** Place the Bottom piece on work table and place the Top plate at 90^0 to each other as per drawing **P5.** Set the flame of welding torch as per standard ***P6.*** Complete the bead as per standard
CU2. Practice of making Lap Joint	**P1.** Take Work piece as per drawing **P2.** Straiten it with the help of hammer and anvil **P3.** Grind the work pieces on grinding machine to prepare the edges flat and parallel to each other **P4.** Place the Bottom piece on work table and place the Top plate along the marked line **P5.** Set the flame of welding torch as per standard ***P6.*** Complete the bead as per standard
CU3. Practice of Making Butt Joint	**P1.** Take Work piece as per drawing **P2.** Straiten it with the help of hammer and anvil **P3.** Grind the work pieces on grinding machine to prepare the edges flat and parallel to each other **P4.** Place the work pieces parallel to each other **P5.** Set the flame of welding torch as per standard ***P6.*** Complete the bead as per standard

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

K1. Explain positions of electrode according to work

K2. Knowledge of setting the current on welding machine

K3. Describe motion of electrode in ARC welding

K4. Explain importance of gap between electrode and base metal

K5. Describe use of tri square

K6. Describe importance of cleanliness of surface to be welded

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Grind the work pieces on grinding machine to prepare the edges flat and parallel to each other
- Set the flame of welding torch as per standard
- Make the Tee Joint.
- Make Lap Joint
- Make Butt Joint

Tools and Equipment

- Oxygen cylinder
- Acetylene gas cylinder
- Pressure regulators
- Cylinder key
- Welding torch
- Rubber house pipe
- Back fire arrester
- Flash back arrester

0714E&A58 Cut Metal by Oxy-Acetylene / Oxy-Fuel Flame/Grinding (Manually and Auto Cutting)

Overview: This competency standard covers the skills and knowledge required to cut metal by oxy-acetylene Welding Manually, Cut metal by oxy-acetylene Welding Automatically, Cut metal by Grinding Manually and Cut metal by Grinding Automatically

Critical Evidence	Performance Criteria
CU1. Cut metal by oxy-acetylene Welding Manually	**P1.** Take Work piece as per drawing **P2.** Straighten it with the help of hammer and anvil if required **P3.** Mark the work piece for cut **P4.** Set the flame of welding torch in oxidizing flame as per standard **P5.** Start cutting for one side of work piece **P6.** Maintain standard distance between welding torch nozzle and work piece ***P7.*** Complete the cut as per standard
CU2. Cut metal by oxy-acetylene Welding Automatically	**P1.** Take Work piece as per drawing **P2.** Straiten it with the help of hammer and anvil if required **P3.** Mark the work piece for cut **P4.** Place the work piece in auto feed machine **P5.** Set the flame of welding torch in oxidizing flame as per standard **P6.** Set cutting torch in Auto Feed machine **P7.** Set Feed Rate of machine **P8.** Start cutting for one side of work piece **P9.** Maintain standard distance between welding torch nozzle and work piece ***P10.*** Complete the cut as per standard
CU3. Cut metal by Grinding Manually	**P1.** Take Work piece as per drawing **P2.** Straiten it with the help of hammer and anvil if required **P3.** Perform marking on work piece where cutting is required **P4.** Set disk grinder on grinding machine **P5.** Set r.p.m of disk grinding machine as per standard **P6.** Cut on marked line with disk grinder by hand
CU4. Cut metal by Grinding Automatically	**P1.** Take Work piece as per drawing **P2.** Straiten it with the help of hammer and anvil if required **P3.** Perform marking on work piece where cutting is required **P4.** Set disk grinder on grinding machine

	P5. Set r.p.m of disk grinding machine as per standard **P6.** Set the guide blade of disk grinding machine as per requirement **P7.** Set feed of disk grinding machine **P8.** Cut on marked line with disk grinding machine

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

K1. Explain metal marking gauges.
K2. Explain various types of cutting processes.
K3. Explain Gas cutting process.
K4. Explain various cutting positions
K5. Describe pre-heating
K6. Describe motion of welding torch
K7. Explain importance of gap between torch and base metal
K8. Describe importance of cleanliness of surface to be cut.
K9. Explain various cutting process by grinding.
K10. Describe cutting disk types and grades.
K11. Explain speed of grinder and its effects.

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Cut the metal by GAS welding
- Cut the metal by grinding cut disk

Tools and Equipment

- Work piece
- Hammer and Anvil
- Marking tool / gauge
- Oxygen cylinder
- Acetylene gas cylinder
- Pressure regulators
- Cylinder key
- Welding torch

- Rubber house pipe
- Back fire arrester
- Flash back arrester
- Auto feed Machine
- Grinder Machine
- Cutting grinding disks

0714E&A59 Perform Gas Welding On Mild Steel Plates (1F, 2F, 3F)

Overview: This competency standard covers the skills and knowledge required to Gas Welding on Mild Steel Plates (1F), Gas Welding on Mild Steel Plates (2F) and Gas Welding on Mild Steel Plates (3F)

Critical Evidence	Performance Criteria	
CU1. Gas Welding On Mild Steel Plates (1F)	**P1.**	Open the gas cylinder with the help of cylinder key
	P2.	Adjust the pressure of both gas cylinders with the help of regulator
	P3.	Open acetylene gas knob of welding torch
	P4.	Ignite acetylene gas with help of spark lighter
	P5.	Open oxygen gas knob of welding torch
	P6.	Set the work piece as per standard
	P7.	Perform fore hand welding method
	P8.	Perform the post welding operations
CU2. Gas Welding On Mild Steel Plates (2F)	**P1.**	Open the gas cylinder with the help of cylinder key
	P2.	Adjust pressure of both gas cylinders with the help of regulator
	P3.	Open acetylene gas knob of welding torch
	P4.	Ignite acetylene gas with help of spark lighter
	P5.	Open oxygen gas knob of welding torch
	P6.	Set work piece as per standard
	P7.	Perform the welding in right hand welding method
	P8.	Perform post welding operations
CU3. Gas Welding On Mild Steel Plates (3F)	**P1.**	Open gas cylinder with the help of cylinder key
	P2.	Adjust pressure of both gas cylinders with the help of regulator
	P3.	Open acetylene gas knob of welding torch
	P4.	Ignite acetylene gas with help of spark lighter
	P5.	Open oxygen gas knob of welding torch
	P6.	Set work piece as per standard
	P7.	Perform welding in downward welding method
	P8.	Perform post welding operations

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

K1. Explain various types of GAS welding processes

K2. Explain advantages of Gas welding
K3. Describe the principle of Gas welding
K4. Explain various welding positions
K5. List Personal Protective Equipment
K6. Demonstrate the method to correctly wear PPE
K7. Explain safe working practices
K8. Identify hazards associated with Gas welding and take remedial measures
K9. Describe Welding procedure specifications (WPS)
K10. Describe Method of Pre- heating of base metal
K11. Describe Fillet lap joint
K12. Describe Tee-fillet joint
K13. Describe Corner joint
K14. Describe Butt joint
K15. Describe Double J joint
K16. Define Visual welding defects
K17. Describe Welding codes and standards

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Adjust the pressure of both gas (Acetylene and Oxygen) cylinders as per standard
- Weld the mild steel plates at 1F, 2F and 3F positions

Tools and Equipment

- Work piece
- Marking tool / gauge
- Oxygen cylinder
- Acetylene gas cylinder
- Pressure regulators
- Cylinder key
- Welding torch
- Rubber house pipe
- Back fire arrester
- Flash back arrester

0714E&A60 Gas Metal Arc Welding (GMAW) in Flat (1F, 1G), H (2F, 2G), V (3F, 3G) and O.H (4F, 4G) Positions

Overview: This competency standard covers the skills and knowledge required to Prepare Welding Machine and Accessories for GMAW, Make Fillet Welds on Carbon Steel Plate, Make Groove Welds on Carbon Steel Plate, Make Fillet Welds on Carbon Steel Plate, Make Groove Welds on Carbon Steel Plate and Perform Post Welding Operations

Critical Evidence	Performance Criteria
CU1. Prepare Welding Machine and Accessories for GMAW	**P1.** Identify the welding requirements from the job, welding procedure specifications and/or technical drawings **P2.** Prepare the GMAW welding machine in accordance with welding procedure specifications/ manufacturer instructions **P3.** Set up welding machine accessories and consumables as per job requirements, welding procedure specifications and/or manufacturer instructions **P4.** Connect the welding machine to an independent power supply **P5.** Set polarity indicated in the welding procedure specifications
CU2. Make Fillet Welds on Carbon Steel Plate	**P1.** Adjust welding parameters (current, voltage, wire feed speed etc.) as per welding procedure specifications/job requirements to produce acceptable weld **P2.** Maintain the gap between electrode and base metal as per standard practices **P3.** Carry out welding in Flat (1F) and Horizontal (2F) positions following standard procedures **P4.** Follow applicable manufacturing codes and standards for acceptance criteria of visual welding defects
CU3. Make Groove Welds on Carbon Steel Plate	**P1.** Adjust welding parameters (current, voltage, wire feed speed etc.) as per welding procedure specifications/job requirements to produce acceptable weld **P2.** Maintain gap between electrode and base metal as per standard practices **P3.** Carry out welding in Flat (1G) and Horizontal (2G) positions following standard procedures **P4.** Deposit root pass as per welding procedure specifications/job requirements

	P5. Deposit filling passes as per welding procedure specifications/job requirements **P6.** Deposit capping pass as per welding procedure specifications/job requirements **P7.** Check the root, filling and capping passes for any visual discontinuities as per acceptance standards **P8.** Follow applicable manufacturing codes and standards for acceptance criteria of the visual welding defects
CU4. Make Fillet Welds on Carbon Steel Plate	**P1.** Adjust welding parameters (current, voltage, wire feed speed etc.) as per welding procedure specifications/job requirements to produce acceptable weld **P2.** Maintain the gap between electrode and base metal as per standard practices **P3.** Carry out welding in Vertical (3F) and Overhead (4F) positions following standard procedures **P4.** Follow applicable manufacturing codes and standards for acceptance criteria of visual welding defects
CU5. Make Groove Welds on Carbon Steel Plate	**P1.** Adjust welding parameters (current, voltage, wire feed speed etc.) as per welding procedure specifications/job requirements to produce acceptable weld **P2.** Maintain gap between electrode and base metal as per standard practices **P3.** Carry out welding in Vertical (3G) and Overhead (4G) positions following standard procedures **P4.** Deposit root pass as per welding procedure specifications/job requirements **P5.** Deposit filling passes as per welding procedure specifications/job requirements **P6.** Deposit capping pass as per welding procedure specifications/job requirements **P7.** Check root, filling and capping passes for any visual discontinuities as per acceptance standards **P8.** Follow applicable manufacturing codes and standards for acceptance criteria of visual welding defects
CU6. Perform Post Welding	**P1.** Carry out finishing work of welds following standard

Operations	procedures **P2.** Inspect weld visually and mark any visual defects, as required **P3.** Carry out repair work in accordance with approved procedures, as required **P4.** Clean work area in accordance with workplace safety practices **P5.** Maintain and store tools / equipment / consumable materials in accordance with organization guidelines

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

K1. Explain various types of welding processes
K2. Explain advantages of GMAW
K3. Describe the principle of MIG welding
K4. List Personal Protective Equipment required for MIG welding and state their use
K5. Demonstrate the method to correctly wear PPE
K6. Explain Specifications/ classification of electrode/s required for the job
K7. Explain safe working practices to be followed while carrying out MIG welding
K8. Identify hazards associated with MIG welding and take remedial measures
K9. Define Electrical parameters like (voltage, current etc.) and their effects on weld
K10. Explain Welding techniques as per WPS/instruction sheet
K11. Describe Welding procedure specifications (WPS)
K12. Describe Method of Pre- heating of base metal
K13. Explain Polarity setting according to standard specifications
K14. Explain the factors to be considered in TIG welding like type and thickness of the base metal, current type and polarity, type of shielding gas to be used
K15. Define Visual welding defects
K16. Describe Welding codes and standards
K17. State the purpose of using shielding gas in TIG welding
K18. Identify various gases / combination of gases for shielding

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Prepare the GMAW welding machine as per requirement
- Carry out the welding the 1F and 2F positions
- Carryout the welding the 1G and 2G positions
- Carryout the welding the 3F and 4F positions
- Carryout the welding the 3G and 4G positions

Tools and Equipment

- ❖ Work piece
- ❖ Marking tool / gauge
- ❖ ARC welding unit
- ❖ Electrode holder
- ❖ Glass eye protector
- ❖ Electrodes with flux
- ❖ Sheilding Gas
- ❖ Power cable
- ❖ Hand gloves
- ❖ Work piece cleaner/scraber

0714E&A61 Gas Tungsten Arc Welding (GTAW) in Flat (1F, 1G), H (2F, 2G), V (3F, 3G) and O.H (4F, 4G) Positions

Overview: This competency standard covers the skills and knowledge required to Prepare Welding Machine and Accessories for GTAW, Make Fillet Welds on Carbon Steel Plate, Make Groove Welds on Carbon Steel Plate, Make Fillet Welds on Carbon Steel Plate, Make Groove Welds on Carbon Steel Plate and Perform Post Welding Operations

Critical Evidence	Performance Criteria
CU1. Prepare Welding Machine and Accessories for GTAW	**P1.** Identify the welding requirements from the job, welding procedure specifications and/or technical drawings **P2.** Prepare the GTAW welding machine in with accordance with welding procedure specifications/ manufacturer´s instructions **P3.** Set up welding machine accessories and consumables as per job requirements, welding procedure specifications and/or manufacturer's instructions **P4.** Connect the welding machine to an independent power supply **P5.** Set the polarity indicated in the welding procedure specifications
CU2 . Make Fillet Welds on Carbon Steel Plate	**P1.** Adjust welding parameters (current, voltage etc.) as per welding procedure specifications/job requirements to produce acceptable weld **P2.** Maintain gap between electrode and base metal as per standard practices **P3.** Carry out welding in Flat (1F) and Flat (1G) positions following standard procedures **P4.** Follow applicable manufacturing codes and standards for acceptance criteria of visual welding defects
CU3. Make Groove Welds on Carbon Steel Plate	**P1.** Adjust welding parameters (current, voltage etc.) as per welding procedure specifications/job requirements to produce acceptable weld **P2.** Maintain gap between electrode and base metal as per standard practices **P3.** Carry out welding in Horizontal (2F) and Horizontal (2G) positions following standard procedures **P4.** Deposit root pass as per welding procedure specifications/job

	requirements **P5.** Deposit filling passes as per welding procedure specifications/job requirements **P6.** Deposit capping pass as per welding procedure specifications/job requirements **P7.** Check root, filling and capping passes for any visual discontinuities as per acceptance standards **P8.** Follow applicable manufacturing codes and standards for acceptance criteria of visual welding defects
CU4. Make Fillet Welds on Carbon Steel Plate	**P1.** Adjust welding parameters (current, voltage etc.) as per welding procedure specifications/job requirements to produce acceptable weld **P2.** Maintain gap between electrode and base metal as per standard practices **P3.** Carry out welding in Vertical (3F) and Vertical (3G) positions following standard procedures **P4.** Deposit root pass as per welding procedure specifications/job requirements **P5.** Deposit filling passes as per welding procedure specifications/job requirements **P6.** Deposit capping pass as per welding procedure specifications/job requirements **P7.** Check root, filling and capping passes for any visual discontinuities as per acceptance standards **P8.** Follow applicable manufacturing codes and standards for acceptance criteria of visual welding defects
CU5. Make Groove Welds on Carbon Steel Plate	**P1.** Adjust welding parameters (current, voltage etc.) as per welding procedure specifications/job requirements to produce acceptable weld **P2.** Maintain gap between electrode and base metal as per standard practices **P3.** Carry out welding in Overhead (4F) and Overhead (4G) positions following standard procedures **P4.** Deposit root pass as per welding procedure specifications/job requirements

	P5.	Deposit filling passes as per welding procedure specifications/job requirements
	P6.	Deposit capping pass as per welding procedure specifications/job requirements
	P7.	Check root, filling and capping passes for any visual discontinuities as per acceptance standards
	P8.	Follow applicable manufacturing codes and standards for acceptance criteria of visual welding defects
CU6. Perform Post Welding Operations	**P1.**	Carry out finishing work of welds following standard procedures
	P2.	Inspect weld visually and mark any visual defects, as required
	P3.	Carry out repair work in accordance with approved procedures, as required
	P4.	Clean work area in accordance with workplace safety practices
	P5.	Maintain and store tools/equipment/consumable materials in accordance with organization guidelines

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- **K1.** Explain the various types of welding processes
- **K2.** Explain advantages of GTAW
- **K3.** Describe the principle of TIG welding
- **K4.** Explain various welding positions
- **K5.** List Personal Protective Equipment required for the TIG welding and state their use
- **K6.** Demonstrate the method to correctly wear PPE
- **K7.** Explain Specifications / classification of electrode / s required for the job
- **K8.** Explain the safe working practices to be followed while carrying out TIG welding
- **K9.** Identify hazards associated with TIG welding and take remedial measures
- **K10.** Define Electrical parameters like (voltage, current etc.) and their effects on weld
- **K11.** Explain Welding techniques as per WPS/instruction sheet
- **K12.** Describe Welding procedure specifications (WPS)
- **K13.** Describe Method of Pre- heating of base metal
- **K14.** Describe Welding codes and standards

K15. State the purpose of using shielding gas in TIG welding

K16. Identify various gases/combination of gases for shielding

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Prepare the TIG welding machine as per requirement
- Carriout the welding the 4F and 4G positions
- Follow code and standards for visual welding deffects

Tools and Equipment

- Work piece
- Marking tool / gauge
- ARC welding unit
- Tonguston Electrode
- Glass eye protector
- Filler metal
- Sheilding Gas
- Power cable
- Hand gloves
- Work piece cleaner/scraber

0714E&A62 Shielded Metal Arc Welding (SMAW) in Flat (1F, 1G), H (2F, 2G), V (3F, 3G) and O.H (4F, 4G) Positions

Overview: This Competency Standard is designed to gain basic knowledge and skills required to perform Shielded Metal Arc Welding (SMAW) operations in Flat (1F, 1G) and Horizontal (2F, 2G) positions at workplace. The standard covers specific knowledge of performing the Shielded Metal Arc Welding (SMAW) by selecting and setting up welding equipment, installing consumables, adjusting welding parameters and making fillet and groove welds in Flat (1F, 1G) and Horizontal (2F, 2G) positions of plate. The standard also covers post welding operations comprising cleaning, measuring, inspecting and repairing welds at workplace

Critical Evidence	Performance Criteria
CU1. Prepare Welding Machine and Accessories for SMAW	**P1.** Identify the welding requirements from the job, welding procedure specifications and/or technical drawings **P2.** Prepare SMAW welding machine in accordance with welding procedure specifications/ manufacturer instructions **P3.** Set up welding machine accessories and consumables as per job requirements, welding procedure specifications and/or manufacturer's instructions **P4.** Connect the welding machine to an independent power supply **P5.** Set the polarity indicated in the welding procedure specifications
CU2 . Make Fillet Welds on Carbon Steel Plate	**P1.** Adjust the welding parameters (current, voltage etc.) as per welding procedure specifications/job requirements to produce acceptable weld Maintain gap between electrode and base metal as per standard practices **P2.** Carry out the welding in Flat (1F) and Flat (1G) positions according to the standard procedures **P3.** Follow applicable manufacturing codes and standards for acceptance criteria of visual welding defects
CU3. Make Groove Welds on Carbon Steel Plate	**P1.** Adjust welding parameters (current, voltage etc.) as per welding procedure specifications/job requirements to produce acceptable weld **P2.** Maintain gap between electrode and base metal as per standard practices **P3.** Carry out welding in Horizontal (2F) and Horizontal (2G) positions following standard procedures **P4.** Deposit root pass as per welding procedure specifications/job requirements

	P5. Deposit filling passes as per welding procedure specifications/job requirements **P6.** Deposit capping pass as per welding procedure specifications/job requirements **P7.** Check root, filling and capping passes for any visual discontinuities as per acceptance standards **P8.** Follow applicable manufacturing codes and standards for acceptance criteria of visual welding defects
CU4. Make Fillet Welds on Carbon Steel Plate	**P1.** Adjust welding parameters (current, voltage etc.) as per welding procedure specifications/job requirement to produce acceptable weld **P2.** Maintain gap between electrode and base metal as per standard practices **P3.** Carry out welding in Vertical (3F) and Vertical (3G) positions following standard procedures **P4.** Deposit root pass as per welding procedure specifications/job requirements **P5.** Deposit filling passes as per welding procedure specifications/job requirements **P6.** Deposit capping pass as per welding procedure specifications/job requirements **P7.** Check root, filling and capping passes for any visual discontinuities as per acceptance standards **P8.** Follow the applicable manufacturing codes and standards for acceptance criteria of visual welding defects
CU5. Make Groove Welds on Carbon Steel Plate	**P1.** Adjust welding parameters (current, voltage etc.) as per welding procedure specifications/job requirements to produce acceptable weld **P2.** Maintain gap between electrode and base metal as per standard practices **P3.** Carry out welding in Overhead (4F) and Overhead (4G) positions following standard procedures Deposit root pass as per welding procedure specifications/job requirements **P4.** Deposit filling passes as per welding procedure specifications/job requirements **P5.** Deposit capping pass as per welding procedure specifications/job requirements

	P6. Check root, filling and capping passes for any visual discontinuities as per acceptance standards **P7.** Follow applicable manufacturing codes and standards for acceptance criteria of visual welding defects
CU6. Perform Post Welding Operations	**P1.** Carry out finishing work of welds following standard procedures **P2.** Inspect weld visually and mark any visual defects, as required **P3.** Carry out repair work in accordance with approved procedures, as required **P4.** Clean work area in accordance with workplace safety practices **P5.** Maintain and store tools/equipment/consumable materials in accordance with organization guidelines

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- **K1.** Understanding of technical drawings
- **K2.** Electrical supply AC and DC
- **K3.** Specifications / classification of electrode/s required for the job
- **K4.** Electrical parameters like (voltage, current etc.) and their effects on weld
- **K5.** Welding techniques as per WPS / instruction sheets
- **K6.** Welding procedure specifications (WPS)
- **K7.** Method of Pre- heating of base metal
- **K8.** Polarity setting according to standard specifications
- **K9.** Visual welding defects
- **K10.** Welding codes and standards

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Prepare the welding unit as per requirement
- Carryout the welding the 4F and 4G positions
- Perform post-welding operations
- Follow code and standards for visual welding deffects

Tools and Equipment

- Work piece
- Marking tool / gauge
- ARC welding unit
- Electrode
- Glass eye protector
- Filler metal
- Sheilding Gas
- Power cable
- Hand gloves
- Work piece cleaner/scraber

0714E&A63 Flux Cored Arc Welding (FCAW)

Overview: This competency standard covers the skills and knowledge required to Prepare Welding Machine and Accessories for FCAW, Make Fillet Welds on Carbon Steel Plate, Make Groove Welds on Carbon Steel Plate, Make Fillet Welds on Carbon Steel Plate, Make Groove on Carbon Steel Plate and Preform Post Welding Operations

Critical Evidence	Performance Criteria
CU1. Prepare Welding Machine and Accessories for FCAW	**P1.** Identify welding requirements from the job, welding procedure specifications and/or technical drawings **P2.** Prepare FCAW welding machine in accordance with welding procedure specifications/manufacturer instructions **P3.** Set up welding machine accessories and consumables as per job requirements, welding procedure specifications and/or manufacturer instructions **P4.** Connect welding machine to an independent power supply **P5.** Set polarity indicated in the welding procedure specifications
CU2 . Make Fillet Welds on Carbon Steel Plate	**P1.** Adjust welding parameters (current, voltage, wire feed speed etc.) as per welding procedure specifications/job requirements to produce acceptable weld Maintain gap between electrode and base metal as per standard practices **P2.** Carry out welding in in Flat (1F) and Horizontal (2F) Positions following standard procedures **P3.** Follow applicable manufacturing codes and standards for acceptance criteria of visual welding defects
CU3. Make Groove Welds on Carbon Steel Plate	**P1.** Adjust welding parameters (current, voltage, wire feed speed etc.) as per welding procedure specifications/job requirements to produce acceptable weld **P2.** Maintain gap between electrode and base metal as per standard practices **P3.** Carry out welding in Flat (1G) and Horizontal (2G) Positions following standard procedures **P4.** Deposit root pass as per welding procedure specifications/job requirements **P5.** Deposit filling passes as per welding procedure specifications/job requirements

	P6.	Deposit capping pass as per welding procedure specifications/job requirements
	P7.	Check root, filling and capping passes for any visual discontinuities as per acceptance standards
	P8.	Follow applicable manufacturing codes and standards for acceptance criteria of visual welding defects
CU4. Make Fillet Welds on Carbon Steel Plate	**P1.**	Adjust welding parameters (current, voltage, wire feed speed etc.) as per welding procedure specifications/job requirements to produce acceptable weld
	P2.	Maintain gap between electrode and base metal as per standard practices
	P3.	Carry out welding in Vertical (3F) and Overhead (4F) positions following standard procedures
	P4.	Follow applicable manufacturing codes and standards for acceptance criteria of visual welding defects
CU5. Make Groove on Carbon Steel Plate	**P1.**	Adjust welding parameters (current, voltage, wire feed speed etc.) as per welding procedure specifications/job requirements to produce acceptable weld
	P2.	Maintain gap between electrode and base metal as per standard practices
	P3.	Carry out welding in Vertical (3G) and Overhead (4G) positions following standard procedures
	P4.	Deposit root pass as per welding procedure specifications/job requirements
	P5.	Deposit filling passes as per welding procedure specifications/job requirements
	P6.	Deposit capping pass as per welding procedure specifications/job requirements
	P7.	Check root, filling and capping passes for any visual discontinuities as per acceptance standards
	P8.	Follow applicable manufacturing codes and standards for acceptance criteria of visual welding defects
CU6. Preform Post Welding Operations	**P1.**	Carry out finishing work of welds following standard procedures
	P2.	Inspect weld visually and mark any visual defects, as required
	P3.	Carry out repair work in accordance with approved procedures,

	as required **P4.** Clean work area in accordance with workplace safety practices **P5.** Maintain and store tools/equipment/consumable materials in accordance with organization guidelines

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- **K1.** Explain application of flux
- **K2.** Explain types of flux
- **K3.** Describe flux grades
- **K4.** Classify flux electrodes as per required for the job
- **K5.** Electrical parameters like (voltage, current etc.) and their effects on weld
- **K6.** Welding techniques as per WPS/instruction sheet
- **K7.** Welding procedure specifications (WPS)
- **K8.** Polarity setting according to standard specifications
- **K9.** Visual welding defects
- **K10.** Welding codes and standards
- **K11.** Describe consumables.
- **K12.** Describe finishing of weld joint.

Critical Evidence

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Prepare the welding unit as per requirement
- Carriout the welding the 4F and 4G positions
- Perform post-welding operations
- Follow code and standards for visual welding deffects

Tools and Equipment

- ❖ Work piece
- ❖ Marking tool / gauge
- ❖ ARC welding unit
- ❖ Flux cored Electrode
- ❖ Glass eye protector
- ❖ Filler metal
- ❖ Power cable

- Hand gloves
- Work piece cleaner/scraber

0714E&A64 Perform Soldering and Brazing Operations

Overview: This competency standard covers the skills and knowledge required to Soldering Operation and Brazing Operation

Critical Evidence	Performance Criteria
CU1. Soldering Operation	**P1.** Perform marking as per drawing **P2.** File work piece before soldering **P3.** Use copper filler rod as filler metal **P4.** Perform soldering operation as per standard
CU2 . Brazing Operation	**P1.** Perform marking as per drawing **P2.** Cut the metal sheet according to drawing using shearing machine **P3.** Straighten the material with help of hammer **P4.** File work piece before soldering **P5.** Open gas cylinder with the help of cylinder key **P6.** Adjust pressure of both gas cylinders with the help of regulator **P7.** Select the correct size of the nozzle **P8.** Set flame to carburizing flame as per standard **P9.** Use copper filler rod as filler metal **P10.** Perform brazing as per standard

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

K1. Describe soldering
K2. Describe sheet metal gauge
K3. Explain disadvantages of soldering
K4. Describe brazing
K5. Define carburizing flame
K6. Define neutral flame
K7. Define oxidizing flame

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Perform the soldering operation
- Perform the Brazing operation
- Set flame to carburizing flame

Tool & Equipment

- Solder gun
- Solder wire
- Oxygen cylinder
- Acetylene gas cylinder
- Pressure regulators
- Cylinder key
- Welding torch
- Rubber house pipe
- Back fire arrester
- Flash back arrester
- Marking tools
- Copper Filler rod
- Spark lighter
- Steel wire brush

Microprocessor and Microcontroller

0714E&A65. Design Microprocessor applications

Overview

After completion of this competency standard the student will be able to perform a variety of tasks on a microprocessor and will be able to integrate the programming knowledge into the microprocessor

Critical Evidence	Performance Criteria
CU1. Identify microprocessors	P1. Describe the Microprocessor architecture P2. Compare and contrast the characteristics of Microprocessor & Microcontroller P3. Explain micro-processor selection criteria P4. Understand processor features and Pin-Configuration
CU2. Identify function of microprocessors and their associated pins	P1. Describe memory functions and their allocation P2. Describe Arithmetic and Logic units P3. Explain the bus structure of microprocessor P4. Understand the IOs and their application
CU3. Program a microprocessor using basic instruction set	P1. List Down Basic instruction set and explain any P2. Explain addressing mode P3. Explain data transfer via accumulator
CU4. Program a microprocessor to perform basic arithmetic and logical operation	P1. List Down and explain arithmetic and logical operation. a. Addition & Subtraction b. Multiplication & Division c. AND, OR, NOT operation d. Jump operation
CU5. Program a microprocessor to perform special operations	P1. List Down and explain special function operations a. Loops b. Input / Output c. Subroutines and interrupt P2. Explain Debugging and its procedure

Knowledge and understanding

- Learn to identify microprocessor IC & their applications in different circuits
- Learn to identify Functions of microprocessor & their applications in different circuits
- Learn to Understand Instruction Sets and how to read and implement them
- Learn to Understand Memory types, their allocation and addressing procedures
- Learn to Implement basic microprocessor operations including move, arithmetic and logical operations
- Learn to implement Loops, Conditions, IOs, Subroutines, Interrupt and other Special function registers
- Learn to troubleshoot the problems via debugging tool

Tools & Equipment

SN	
1.	Microprocessor
2.	Development Kit
3.	Breadboard
4.	IC remover tool
5.	Voltmeter
6.	Programming Computer
7.	Power supply
8.	Trainer

Critical Evidence(s) Required

The student needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

Evidence of the following is essential:

- Identify various microprocessor and there data sheet
- Program a microprocessor to perform complex set of instructions

0714E&A66 Identify Microcontroller Types and its Architecture

Overview: This competency standard covers the skills and knowledge required to install, run, simulate and apply on field work.

Critical Evidence	Performance Criteria
CU1. Introduction to Microcontroller (Arduino, Raspberry Pi, etc.)	P1. Identify the various Microcontrollers and their models. P2. Identify RAM, SRAM, RAM, ROM, EEPROM, EPROM. P3. Identify Timer, Counters, Clock/processing speed of Microcontrollers P4. Identify busses and Processing Speed (4, 8, 16, 32, 64 bits) P5. Identify number of Analog to digital converters (ADCs) and Digital to analog converter (DAC), P6. Identify Analog Input and Output Pins. P7. Identify Digital Input and Output Pins. P8. Identify the PWM Pins. P9. Identify the UART Pins. P10. Identify the I2C pins.
CU2. Introduction to Arduino IDE	P1. Perform the Arduino IDE Installations. P2. Perform Arduino Sketch/Programming P2. Use Arduino supporting libraries and functions P3. Write down sketch for Arduino in IDE. P4. Identify the Shields, Accessories, and Sensors for Arduino
CU3. Program Arduino Microcontroller by using conditional and loop instructions.	P1. Use Boolean Expressions P2. Use If, If-Else, Nested if Statements P3. Identify Logical Operators P4. Identify Simple Recursion P5. Use While Loop P6. Use for loop
CU4. Perform programing using Timer, and Interrupt.	P1. Identify Timers in microcontroller P2. Identify Interrupts in microcontroller P3. Differentiate Internal and External interrupts P4. Identify Interrupt priority P5. Use While Loop P6. Use for loop

Knowledge and understanding

K1. Describe PIC Microcontroller
K2. Explain Architecture of 8051 Microcontroller
K3. Describe microprocessors and microcontrollers
K4. Differentiate between micro-processor and micro controllers
K5. Define the components of a micro-processing system (Central Processing Unit, Input Output Interfaces and Memory)
K6. Explain the functions of various registers.
K7. Understand interrupt structure of 8051.
K8. Explain Analog to digital converters (ADCs) and Digital to analog converter (DAC),
K9. Understand serial data communication concepts
K10. Describe the types of buses (data bus, address bus, control bus)
K11. Describe the architecture of a microprocessor and its major components (arithmetic and logic unit (ALU), registers and its types, control units, clock generator)
K12. Describe the memory of a micro processing system for storage; understand its various types and functions of each type (ROM, PROM, EPROM, EEPROM, RAM, and Flash)
K13. Describe the input and output ports for external connectivity (peripheral devices, making connections, polling/interrupts, parallel and serial I/O).
K14. Describe 8-bit, 16-bit and 32-bit microcontrollers
K15. Basics of embedded control and software.
K16. Describe to AVR family IC

Equipment and Tools

- 8051 Microcontroller
- Arduino Microcontroller with development board
- Computer
- Programming software.
- Raspberry Pi Microcontroller with development board
- SD card
- Simulation software
- Communication cable.
- Power Adaptor
- Jumpers

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Writing program
- Execution of program
- Output & results from program
- Identify Microcontrollers.
- Installation of software for microcontroller

0714E&A67 Interface Microcontroller with system

Overview: This competency standard covers the skills and knowledge required to install, run, simulate and apply on field work.

Critical Evidence	Performance Criteria
CU1. Interface Analog Sensor with microcontroller.	P1. Identify Analog Sensors and pin configurations P2. Open Arduino IDE software. P2. Select and connect analog sensor to Analog Input Pin. P3. Make a source code/sketch. P4. Compile and Debug P5. Run Program. P6. Get results (Analog values)
CU2. Interface Digital Sensors with microcontroller.	P1. Identify Digital Sensors and pin configurations P2. Open Arduino IDE software. P2. Select and connect digital sensor to Analog Input Pin. P3. Make a source code/sketch. P4. Compile and Debug P5. Run Program. P6. Get results (Digital values 0 or 1)
CU3. Interface 7 segment display and LCD display with microcontroller.	P1. Identify pin configurations P2. Open Arduino IDE software. P2. Select and connect LCD display Module to Pin.? P3. Make a source code/sketch to display the number 3 on 7 segment display, and display text PAKISTAN on LCD display Module. P4. Compile and Debug P5. Run Program. P6. Get results (PAKISTAN, 3)
CU3. Interface Servomotor with microcontroller.	P1. Identify pin configurations P2. Open Arduino IDE software. P2. Select and connect Servo motor to desired Pin. P3. Make a source code/sketch to rotate about 45 degrees. P4. Compile and Debug P5. Run Program. P6. Get results (Rotation value 45^{o})

CU4. Interface Serial (UART) based communication	P1. Open Arduino IDE software. P2. Connect module serial out TX pin with Arduino board serial RX pin and connect module serial RX pin with Arduino board TX pin. P3. Make a source code and set baud rate. P4. Compiling and Debugging. P5. Run Program.
CU5. Interface I2C based communication	P1. Open Arduino IDE software. P2. Connect two wires of sensor with SCL and SDA pins of Arduino board. P3. Make a source code using two wire (I2C) libraries. P4. Compiling and Debugging. P5. Run Program.

Knowledge and understanding

K1. Describe interfacing
K2. Describe five senses: (vision, hearing, smell, taste, and touch)
K3. Describe input and output of sensors and actuators.
K4. Describe Acceleration, Shock and Vibration Sensors
K5. Explain SCADA as interfacing techniques using ADC and DAC.
K6. Describe Sensor interfacing
K7. Describe Actuator/relay interfacing
K8. Describe Input/key/switch/Keypad interfacing
K9. Describe communication interfacing
K10. Describe I2C interfacing
K11. Describe SPI. (Serial Peripheral Interface)
K12. Describe RS232 interfacing

Equipment and Tools

- Arduino development board
- Computer
- Programming software.
- Simulation software
- Communication cable.
- Power Adaptor

- ❖ Servo Motor
- ❖ Analog Sensors
- ❖ Digital Sensors
- ❖ Display Module
- ❖ I2C module for LCD Display

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Identify components.
- Installation of Arduino IDE software.
- Run Arduino IDE and design source code.
- Interface sensors and actuators.

0714E&A68 Carryout various Microcontroller Applications.

Overview: This competency standard covers the skills and knowledge required to install, run, simulate and apply in the field work.

Critical Evidence	Performance Criteria
CU1. Perform a task by connecting level/floating sensor and ON/OFF relay with microcontroller.	P1. Identify level sensors to detect the level of water. P2. Identify relay to ON/OFF the water pump. P3. Identify the Input and Output pins. P4. Identify the Digital, Analog and PMW pins. P5. Make a layout and connect components P6. Write, compile, debug and upload a program to microcontroller. P7. RUN and Get results (ON/OFF depends on level)
CU2. Perform a task by connecting light sensor and servomotor with microcontroller.	P1. Identify light sensors to detect the resistivity of light. P2. Identify servo motor to rotate/position the system. P3. Identify the Input and Output pins. P4. Identify the Digital, Analog and PMW pins. P5. Make a layout and connect components P6. Write, compile, debug and upload a program to microcontroller. P7. RUN and Get results (Position depends on resistivity)
CU3. Perform a task by connecting pressure sensor and pneumatic actuator with microcontroller.	P1. Identify pressure sensors . P2. Identify pneumatic actuator to apply force in system. P3. Identify the Input and Output pins. P4. Identify the Digital, Analog and PMW pins. P5. Make a layout and connect components P6. Write, compile, debug and upload a program to microcontroller. P7. RUN and Get results (Force depends on pressure)
CU4. Perform a task by connecting potentiometer and Servomotor with microcontroller.	P1. Identify potentiometer to detect the resistance/angle. P2. Identify servomotor to position the system. P3. Identify the Input and Output pins. P4. Identify the Digital, Analog and PMW pins. P5. Make a layout and connect components P6. Write, compile, debug and upload a program to

microcontroller.

P7. RUN and Get results (Angle depends on Potentiometer)

Knowledge and understanding

K1. Describe microcontroller applications,

K2. Describe problem identification

K3. Define need to solve problems

K4. Describe the solution for problems

K5. Describe the importance of solution

K6. Describe application of

K7. Consumer Electronics Products: (Toys, Cameras, Robots, Washing Machine, Microwave Ovens etc.)

K8. Instrumentation and Process Control: (Oscilloscopes, Multi-meter, Leakage Current Tester, Data Acquisition and Control etc.)

K9. Medical Instruments: (ECG Machine, Accu-Check etc.)

K10. Communication: (Cell Phones, Telephone Sets, Answering Machines etc.)

K11. Office Equipment: (Fax, Printers etc.)

K12. Multimedia Application: (Mp3 Player, PDAs etc.)

K13. Automobile: (Speedometer, Auto-breaking system etc.)

Equipment and Tools

- Arduino development board
- Computer
- Programming software.
- Simulation software
- Communication cable.
- Power Adaptor
- Servo Motor
- Analog Sensors
- Digital Sensors
- Display Module
- I2C module for LCD Display

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Identify components.
- Installation of Arduino IDE software.
- Run Arduino IDE and design source code.
- Interface sensors and actuators.

0714E&A69 Apply Microcontroller to build Control System.

Overview: This competency standard covers the skills and knowledge required to install, run, simulate and apply on field work.

Critical Evidence	Performance Criteria
CU1. Build a Access Control System Using RFID Reader.	P1. Identify RFID (radio frequency identification devices). P2. Identify tag, read/write devices for RFID P3. Identify host system for data collection, processing, and transmission. P4. Identify the Digital, Analog and PMW pins. P5. Make a layout and connect components P6. Write, compile and debug a program for writing P7. Write, compile and debug a program for reading P8. upload a program to microcontroller for writing a valid key. P9. upload a program to microcontroller for reading key and unlock the door if key is valid.
CU2. Build a System to Control Light Using Smart Phone.	P1. Identify light sensors to detect the Intensity of light. P2. Identify servomotor to rotate/position the system. P3. Identify the Input and Output pins. P4. Identify the Digital, Analog and PMW pins. P5. Make a layout and connect components P6. Write, compile, debug and upload a program to microcontroller. P7. RUN and Get results (Position depends on resistivity)

Knowledge and understanding

K1. Describe the Radio Frequencies

K2. Describe the Servomotor

K3. Describe the tag

K4. Describe the read and write devices.

K5. Describe the types of light sensors

K6. Define the types of Timers.

Equipment and Tools

- ❖ RFID tag
- ❖ RFID Device
- ❖ Computer/laptop
- ❖ Arduino development board
- ❖ USB/Data cable
- ❖ Light sensor
- ❖ Servomotor
- ❖ Bluetooth device

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Identify components.
- Installation of Arduino IDE software.
- Run Arduino IDE and design source code.
- Interface sensors and actuators.

Analogue Electronics

0714E&A70 Identify Basic Electronics Components

Overview: This competency standard covers the skills and knowledge required to Identify Various Diodes, Identify Resistors in circuit, Identify Capacitor in circuit, identify Inductor in circuit and Identify IC's Packages**.** After this competency standard the candidate will be able to identify variety of basic electronic components and their usage in industry.

Critical Evidence	Performance Criteria
CU1. Identify Various Diodes	**P1.** Identify the Diodes **P2.** Identify its types & polarities **P3.** Draw the Diode characteristics curves in forward and reverse Biased
CU2. Identify Resistors in circuit	**P1.** Identify the Resistor & its types **P2.** Recognize Coding &Color coding of resistor **P3.** Design series & Parallel circuit of Resistor **P4.** Use formulae for Series & parallel circuit of resistors
CU3. Identify Capacitor in circuit	**P1.** Identify Capacitor & its types **P2.** Recognize Coding &rating of Capacitor **P3.** Design Parallel and series circuit of Capacitor **P4.** Use formulae for Series & parallel circuit of Capacitor
CU4. Identify Inductor in circuit	**P1.** Identify an Inductor **P2.** Recognize Coding & Rating of Inductor **P3.** Use formulas for Series & Parallel circuit of Inductor **P4.** Analyze Circuit of Inductor
CU5. Identify IC's Packages.	**P1**. Identify IC Packages & types. **P2**. Apply the appropriate ICs Packages in circuit

Knowledge & Understanding:

- **K1.** Describe the diodes, polarities & their applications in circuits
- **K2.** Explain the uses of Multimeter& power Supply
- **K3.** Explain the data sheets
- **K4.** Explain Resistor & their applications in Parallel & Series circuits
- **K5.** Describe Capacitor& their applications in circuits

K6. Describe the Inductor& their applications in circuits

K7. Describe the basics of IC Packages

K8. Understand the data sheets

Tools & Equipment:

- Multimeter
- Power supply
- Trainer
- Resistor
- Inductor
- ICs
- Source of data sheets

Critical Evidence(s) Required

The candidates need to produce following **Critical Evidence**(s) in order to be competent in this competency standard

Identification of resistor, capacitor, inductor, IC packages & Diode types.

0714E&A71 Design a Rectifier Using Diode

Overview: This competency standard covers the skills and knowledge required to. This Identify The parameter of Diode and Draw the characteristic curve of Diode, Design Full Wave Rectifier (two diode rectifier) and Design Full Wave Rectifier using Diode Bridge competency standard will help the candidate in construction of Diode rectifier and its uses in industry.

Critical Evidence	Performance Criteria
CU1. Identify The parameter of Diode and Draw the characteristic curve of Diode	**P1.** Identify the Diodes and their terminals (Anode and Cathode) whith the help of Datasheet **P2.** Describe various parameter (i.e. Current, Voltage, and power rating) of Diode using Diode Data sheets. Don't capitalize the wors's first letter !! **P3.** Implement the Diode in forward and Revers Configuration **P4.** Perform the forward and reveres biases operation **P5.** Monitor the Output waveform on oscilloscope **P6.** Draw the characteristic curves in forward and reverse Biased **P7.** Generate the Lab report
CU2. Design half wave and Full Wave Rectifier (two diode rectifier)	**P1.** Identify Full Wave and half wave Rectifier components Draw circuit Diagram of half wave Rectifier Don't capitalize the wors's first letter !! **P2.** **P3.** Draw circuit Diagram of Full Wave Rectifier **P4.** Observe the INPUT and Output wave form on oscilloscope **P5.** Calculate the ripple Factor **P6.** Calculate output voltage using proper formulae **P7.** Generate output report
CU3. Design Full Wave Rectifier using Diode Bridge	**P1.** Identify Full Wave Rectifier components **P2.** Draw circuit Diagram of Full Wave Rectifier **P3.** Observe the INPUT and Output wave form on oscilloscope **P4.** Calculate the ripple Factor **P5.** Calculate output voltage

Knowledge & Understanding:

- **K1.** Study the basic of diodes, & their applications in circuits
- **K2.** Knowledge of basic electronics
- **K3.** Understand Multimeter& power Supply

K4. Understand the data sheets

K5. Explain basics of diodes, AC & DC voltages, transformers & Rectifiers.

K6. Explain the uses of Multimeter

K7. Explain the uses oscilloscope and Power Supply

Tools & Equipment:

- Multimeter
- Power supply
- Trainer
- Diodes
- Digital
- Oscilloscope
- Datasheets
- Oscilloscope
- Resistors
- Center taped Transformer

Critical Evidence(s) Required

The candidates need to produce following **Critical Evidence**(s) in order to be competent in this competency standard.

- Perform half- wave rectification.
- Perform full-wave rectification with diode.
- Perform full-wave rectification with bridge rectification.

0714E&A72 Carry Out Diode Application

Overview: This competency standard covers the skills and knowledge required to make voltage regulator using zener diode**.**Make Seven Segment Using Light Emitting Diode After completing this competency standard, the student will be able to design a voltage regulator circuit using a zener diode to maintain a constant DC output voltage across the load in spite of variations in the input voltage or changes in the load current.

Critical Evidence	Performance Criteria
CU1. Make voltage regulator using Zener diode	**P1.** the the voltage Regulator circuit **P2.** Select the components according to the drawing **P3.** Buit / for voltage regulator circuits on the breadboard / PCB / board. **P4.** Measure Input and outputs of the voltage regulator **P5.** Verify the output with respect to the required output and specifications **P6.** Generate the input / output report
CU2. Make Seven Segment Using LED(Light Emitting Diode)	**P1.** Draw the Seven Segment Display Circuit **P2.** Select required components according to the drawing Placed and assemble the circuit on the breadboard / PCB **P3.** Perform basic operations of Seven Segment Display and Verify it with specifications and requirements. Generate the report.

Knowledge & Understanding:

- **K1.** Learn basic knowledge of zener Diode& its applications
- **K2.** Learn knowledge of components
- **K3.** Learn to use oscilloscope &power Supply
- **K4.** Understand the data sheets
- **K5.** Learn to Solder the Components
- **K6.** Learn adequate knowledge of hand tools
- **K7.** Learn basic knowledge of LED & its applications
- **K8.** Learn knowledge of components
- **K9.** Learn to use power Supply

Tools & Equipment:

- ❖ Oscilloscope
- ❖ Zener diode

- Soldering iron
- Connecting wire
- Light Emitting diode
- Resistor,
- Variable DC power supply,
- Millimeter

Critical Evidence(s) Required

The candidates need to produce following **Critical Evidence**(s) in order to be competent in this competency standard.

- Regulated power supply using zener diode.
- Seven segment display using LED (light emitting diode.)

0714E&A73 Implement Bipolar Junction Transistor (BJT) in Different Applications

Overview: This competency standard covers the skills and knowledge required to Perform the Biasing of Transistors, Implement Transistor as an amplifier using CB Configuration, Implement Transistor as an amplifier using CC Configuration, Implement Transistor as an amplifier using CE Configuration, Design the circuit of Class A Power Amplifier and Implement BJT as a switch After completion of this competency standard the student will be able to regulate the current or voltage flow and implement a switch for electronic signals.

Critical Evidence	Performance Criteria
CU1. Perform the Biasing of Transistors	**P1**. Identify the Transistor& its types. **P2**. Identify the base, collector & Emitter of transistors **P3**. Perform the standard Biasing of PNP & NPN Transistor
CU2. Implement Transistor as an amplifier using CB Configuration.	**P1.** Draw the Circuit of CB configuration of transistor **P2.** Select the components for CB configurations. **P3.** Place the components for CB amplifier **P4.** Calculate the gain of transistor in CB modes. **P5.** Draw VI characteristics curve for CB
CU3. Implement Transistor as an amplifier using CC Configuration.	**P1.** Draw the Circuit of CC configuration of transistor **P2.** Select the components for CC configurations. **P3.** Place the components for CC amplifier **P4.** Calculate the gain of transistor in CC modes. **P5.** Draw VI characteristics curve for CC
CU4. Implement Transistor as an amplifier using CE Configuration.	Draw the Circuit of CE configuration of transistor **P1.** Select the components for CE configurations. **P2.** Place the components for CE amplifier **P3.** Calculate the gain of transistor in CE modes. **P4.** Draw VI characteristics curve for CE
CU5. Design the circuit of Class A Power amplifier	**P1.** Identify the Class a Power Amplifier **P2.** Select the component for Class a Power Amplifier **P3.** Implement the circuit of PNP OR NPN transistor in Class A Power Amplifier Configuration **P4.** Analyze the different parameter of Class A Power Amplifier **P5.** Monitor the Output waveform on oscilloscope

	P6. Draw the characteristic curves of Class A Power Amplifier **P7.** Calculate the Voltage gain and Power Gain of Class A Power Amplifier **P8.** Generate the Lab report
CU6. Implement BJT as a switch.	**P1.** Draw the Circuit of transistor in switching configuration. **P2.** Select the components for switching circuits **P3.** Place the components **P4.** Operate an LED using transistor as a switch **P5.** Measure the output and generate the report

Knowledge & Understanding:

- **K1.** Learn basic concepts of transistor & Biasing
- **K2.** Study semiconductor theory
- **K3.** Learn Doping Procedure.
- **K4.** Study the datasheet of transistor
- **K5.** Learn basic concepts & working principles of transistor
- **K6.** Learn basics of Coupling Capacitor.
- **K7.** Learn the V-I Characteristics
- **K8.** Learn Doping Procedure.
- **K9.** Study the basic of BJTs, & their applications in circuits
- **K10.** Knowledge of basic electronics
- **K11.** Understand Multimeter & Oscilloscope
- **K12.** Power Supply

Tools & Equipment:

- Trainer
- Transistors
- Multimeter
- Capacitors
- Resistors
- Power Supplies
- Oscilloscope
- Datasheets

Critical Evidence(s) Required

The candidates need to produce following **Critical Evidence**(s) in order to be competent in this competency standard

- Testing of BJT.
- Gain of transistor.
- Transistor as a Switch.

- Transistor as an amplifier.

0714E&A74 Implement Field Effect Transistors (FET) In Different Applications

Overview: This competency standard covers the skills and knowledge required to Perform the Biasing of FET, Implement MOSFET as a switch, Draw the VI characteristics curves for FETs, Design the circuit of Common Drain (CD) Amplifier, Design the circuit of Common Gate (CG) Amplifier, design a switching Circuit Using MOSFET and Design a Low voltage transistor based regulated power supply**.** After completion of this competency standard the student will be able to implement the FET (Field Effect Transistor) to control the current flow through the device.

Critical Evidence	Performance Criteria
CU1. Perform the Biasing of FET	**P1**. Identify the FET and & its types. **P2**. Identify the Drain, Gate and & Source of FET **P3**. Perform the standard Biasing of MOSFET (N-channel, P-channel) **P4**. Measure the Gate-Source voltage (Veg's) & Threshold Voltage (Vth)
CU2. Implement MOSFET as a switch.	**P1.** Draw the Circuit of MOSFET in switching configuration. **P2.** Select the components for switching circuits **P3.** Place the components **P4.** Operate an DC lamp using MOSFET as a switch **P5.** Measure the output and generate the report
CU3. Draw the VI characteristics curves for FETs	**P1**. Construct an amplifier circuit using FETs **P2**. Apply Vds & Vgs **P2**. Measure the drain current **P4**. Draw VI characteristic curves
CU4.Design the circuit of Common Drain (CD) Amplifier	**P1.** Identify the FET and there terminal (gate, drain and Sources) whit the Help of Datasheet **P2.** Select the components for Common Drain (CD) Amplifier **P3.** Implement the circuit of Common Drain (CD) Amplifier **P4.** Analyze the different parameter of Common Drain (CD) Amplifier **P5.** Monitor the Output waveform on oscilloscope **P6.** Draw the characteristic curves of Common Drain (CD) Amplifier **P7.** Generate the Lab report

CU5. Design the circuit of Common Gate (CG) Amplifier	**P1.** Identify the FET and there terminal (gate, drain and Sources) whit the Help of Datasheet **P2.** Select the components for Common Gate (CG) Amplifier **P3.** Implement the circuit of Common Gate (CG) Amplifier **P4.** Analyze the different parameter of Common Gate (CG) Amplifier **P5.** Monitor the Output waveform on oscilloscope **P6.** Draw the characteristic curves of Common Gate (CG) Amplifier **P7.** Generate the Lab report
CU6. Design a switching Circuit Using MOSFET	**P1.** Identify the MOSFET and there terminal (gate, drain and Sources) whith the Help of Datasheet **P2.** Select the components for the Switching Circuit **P3.** Implement Switching Circuit using MOSFET **P4.** Perform the operation of switching **P5.** Monitor the Output **P6.** Generate the Lab report
CU7. Design a Low voltage transistor based regulated power supply	**P1.** Draw the Schematic of power supply **P2.** Select the components for power supply **P3.** Implement the circuit of power supply **P4.** Perform individual operations on different sections of a power supply **P5.** Measure Output Voltage **P6.** Generate the Lab report

Knowledge & Understanding:

K1. Learn the basics of FET

K2. Learn the concept of FET Biasing.

K3. Learn the power rating of FET

K4. Study The datasheet of FET

K5. Learn the Switching theory

K6. Learn the behavior of current and voltage in FET's

K7. Learn biasing mechanism and basic formulae of FET's

K8. Learn the vgs, vds, Idss&Rds as per datasheet.

K9. Study the basic of FETs, & their applications in circuits

K10. Knowledge of basic electronics

K11. Understand Multimeter & power Supply

K12. Understand the data sheets

K13. Study the basic of FETs, & their applications in circuits

K14. Study the basic of BJTs, ICs & their applications in circuits

K15. Knowledge of basic electronics and amplifier

K16. Understand Multimeter, Oscilloscope & power Supply

Tools & Equipment:

- Multimeter
- Capacitors
- Resistors
- Trainer
- Oscilloscope
- Simple FET
- MOSFET
- FET Trainer
- Power supply
- Datasheets

Critical Evidence(s) Required

The candidates need to produce following **Critical Evidence**(s) in order to be competent in this competency standard.

- Testing of transistor.
- Transistor as a switch
- Transistor as an amplifier.
- MOSFET as a power transistor.

0714E&A75 Implement (Uni Junction Transistor, Silicon Control Rectifier, Diac and Triac) in various application

Overview: This competency standard covers the skills and knowledge required to Implement the UJT in electronic circuits as switch, Implement the SCR in electronic circuits as switch and Construct the dimmer circuit using Diac &Triac**.** After the completion of this standard the candidate will be able to install Uni junction Transistor (UJT), Silicon-controlled rectifier (SCR) in power Control Application.

Critical Evidence	Performance Criteria
CU1. Implement the UJT in electronic circuits as switch	**P1.** Identify the UJT **P2.** Draw the circuit of switch using UJT. **P3.** Select the components for the relaxation oscillator circuits **P4.** Construct the relaxation oscillator circuits using UJT **P5.** Measure the input and output voltage **P6.** Generate the lab report
CU2. Implement the SCR in electronic circuits as switch	**P1.** Identify the SCR terminals **P2.** Draw the circuit of switch using SCR. **P3.** Select the components for SC switching circuits. **P4.** Construct the SC switching circuit. **P5.** Apply the trigger Pulse and Check out the desired outputs
CU3. Construct the dimmer circuit using Diac &Triac.	**P1.** Identify the Diacv and Triac **P2.** Draw the dimmer circuit using Diac and & Triac. **P3.** Select the components for the dimmer circuit. **P4.** Construct the dimmer circuits. **P5.** Control the load using dimmer Generate the lab report

Knowledge & Understanding:

- **K1.** Learn the basics of UJT
- **K2.** Understand the data sheets
- **K3.** Learn adequate knowledge of hand tools
- **K4.** Learn basics of SCR
- **K5.** Learn the uses of oscilloscope, power Supply& Multimeter
- **K6.** Learn the basics of diac&triac
- **K7.** Learn the uses of oscilloscope, power

Tools & Equipment:

- Oscilloscope
- UJT,
- Resistor,
- Variable DC power supply,
- Multimeter
- Soldering iron, wire
- Breadboard or trainer
- Trainer/Breadboard
- SCR, Diodes, Resistors, Inductors, Capacitors & connecting wire
- Power supply
- Diac &Triac resistors
- Diode/ Capacitor

Critical Evidence(s) Required

The candidates need to produce following **Critical Evidence**(s) in order to be competent in this competency standard

- Testing of transistor.
- Transistor as switch with SCR.
- Transistor as an AC regulator

0714E&A76 Design Operation Amplifier

Overview: This competency standard identifies the competencies required to Construct a Non-inverting amplifier using operational amplifier, construct an Inverting amplifier using and Construct a differentiator circuit using operational amplifier. Construct Operation Amplifier.

Critical Evidence	Performance Criteria
CU1. Construct a Non-inverting amplifier using operational amplifier	**P1.** Identify the Operational amplifier and its terminals (Inverting, Non-inverting Inputs &Outputs) with the Help of Datasheet **P2.** Identify different parameters (Current, Voltage, and power rating) of Op-Amp using datasheet. **P3.** Draw the Schematic diagram of non-Inverting Op-Amp. **P4.** Select the components for Non-Inverting Op-Amp. **P5.** Implement Non-Inverting Op-Amp circuit. **P6.** Perform the operations of Non-Inverting Op-Amp circuit. **P7.** Measure the output frequency response & gain **P8.** Draw the characteristic curves of Op-Amp. **P9.** Generate the Output report
CU2. Construct an Inverting amplifier using operational amplifier	**P1.** Identify the Operational amplifier and its terminals (Inverting, Non-inverting Inputs &Outputs) with the Help of Datasheet **P2.** Identify different parameters (Current, Voltage, and power rating) of Op-Amp using datasheet. **P3.** Draw the Schematic diagram of Inverting Op-Amp. **P4.** Select the components for Inverting Op-Amp. **P5.** Implement Non-Inverting Op-Amp circuit. **P6.** Perform the operations of Inverting Op-Amp circuit. **P7.** Measure the output frequency response & gain **P8.** Draw the characteristic curves of Op-Amp. **P9.** Generate the Output report
CU3. Construct a differentiator circuit using operational amplifier	**P1.** Draw the Schematic diagram of differentiator circuit using Op-Amp. **P2.** Select the components for differentiator circuit. **P3.** Implement differentiator circuit. **P4.** Perform the operations of differentiator circuit.

	P5. Measure the output, frequency response & gain **P6.** Draw the characteristic curves of differentiator circuit. **P7.** Generate the Output report

Knowledge & Understanding:

K1. Study the basics of Transistors, ICs, Capacitors, Resistors, Op-Amp & their applications in circuits

K2. Explain the basics of electronics & its applications

K3. Understand Multimeter, Oscilloscope & power Supply & their applications

K4. Understand the data sheets

K5. Explain the basics of electronics, Differentiator and their applications

Tool & Equipment:

- Multimeter
- Power supply
- Trainer
- Op-Amp
- Resistors
- Inductors
- Capacitors
- Digital Oscilloscope
- Datasheets
- Functions Generator

Critical Evidence(s) Required

The candidates need to produce following **Critical Evidence**(s) in order to be competent in this competency standard

Op-amp as inverting & non-inverting amplifier.

Soft Skills

0714E&A77. Develop workplace policy and procedures for sustainability

Overview: This unit describes the skills and knowledge required to develop and implement a workplace sustainability policy and to modify the policy to suit changed circumstances. It applies to individuals with managerial responsibilities who undertake work developing approaches to create, monitor and improve strategies and policies within workplaces and engage with a range of relevant stakeholders and specialists.

Unit of Competency	**Performance Criteria**
1. Develop workplace sustainability policy	P1 Define scope of sustainability in the policies P2 Gather information from a range of sources to plan and develop policy P3 Identify and consult stakeholders as a key component of the policy development process P4 Include appropriate strategies in policy at all stages of work for minimizing resource use, reducing toxic material and hazardous chemical use and employing life cycle management approaches P5 Make recommendations for policy options based on likely effectiveness, timeframes and cost P6 Develop policy that reflects the organization s commitment to sustainability as an integral part of business planning and as a business opportunity P7 Agree to appropriate methods of implementation, outcomes and performance indicators
2. Communicate workplace sustainability policy	P1 Promote workplace sustainability policy, including its expected outcome, to key stakeholders P2 Inform those involved in implementing the policy about expected outcomes, activities to be undertaken and assigned responsibilities
3. Implement workplace sustainability policy	P1 Develop and communicate procedures to help implement workplace sustainability policy P2 Implement strategies for continuous improvement in resource efficiency P3 Establish and assign responsibility for recording systems to track continuous improvements in sustainability approaches
4. Review workplace sustainability policy implementation	P1 Review workplace sustainability policy implementation P2 Investigate successes or otherwise of policy P3 Monitor records to identify trends that may require remedial action

	and use to promote continuous improvement of performance P4 Modify policy and or procedures as required to ensure improvements are made

Knowledge & Understanding

K1: outline the environmental or sustainability legislation, regulations and codes of practice applicable to the organization identify internal and external sources of information and explain how they can be used to plan and develop the organization s sustainability policy

K2: explain policy development processes and practices

K3: outline organizational systems and procedures that relate to sustainability

K4: outline typical barriers to implementing policies and procedures in an organization and possible strategies to address them. Assessment Conditions

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) to be competent in this competency standard:

A person who demonstrates competency in this unit must be able to provide evidence of the ability to Develop workplace policy and procedures for sustainability. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- scope and develop organizational policies and procedures that comply with legislative requirements and support the organization s sustainability goals covering at a minimum:
  - minimizing resource use
  - resource efficiency
  - reducing toxic material and hazardous chemical use
  - employing life cycle management approaches
  - continuous improvement
- plan and implement sustainability policy and procedures including:
  - agreed outcomes
  - performance indicators
  - activities to be undertaken
  - assigned responsibilities
  - record keeping, review and improvement processes

- consult and communicate with relevant stakeholders to generate engagement with sustainability policy development, implementation and continuous improvement
- Review and improve sustainability policies.

0714E&A78. Manage meetings

Overview: This unit describes the skills and knowledge required to manage a range of meetings including overseeing the meeting preparation processes, chairing meetings, organizing the minutes and reporting meeting outcomes. It applies to individuals employed in a range of work environments who are required to organize and manage meetings within their workplace, including conducting or managing administrative tasks in providing agendas and meeting material. They may work as senior administrative staff or may be individuals with responsibility for conducting and chairing meetings in the workplace.

Unit of Competency	**Performance Criteria**
1. Prepare for meetings	P1 Develop agenda in line with stated meeting purpose P2 Ensure style and structure of meeting are appropriate to its purpose P3 Identify meeting participants and notify them in accordance with organizational procedures P4 Confirm meeting arrangements in accordance with requirements of meeting P5 Dispatch meeting papers to participants within designated timelines
2. Conduct meetings	P1 Chair meetings in accordance with organizational requirements, agreed conventions for type of meeting and legal and ethical requirements P2 Conduct meetings to ensure they are focused, time efficient and achieve the required outcomes P3 Ensure meeting facilitation enables participation, discussion, problem-solving and resolution of issues P4 Brief minute-taker on method for recording meeting notes in accordance with organizational requirements and conventions for type of meeting
3. Follow up meetings	P1 Check transcribed meeting notes to ensure they reflect a true and accurate record of the meeting and are formatted in accordance with organizational procedures and meeting conventions P2 Distribute and store minutes and other follow-up documentation within designated timelines, and according to organizational requirements P3 Report outcomes of meetings as required, within designated timelines

Knowledge & Understanding

K1: outline meeting terminology, structures, arrangements

K2: outline responsibilities of the chairperson and explain group dynamics in relation to managing meetings
K3: describe options for meetings including face-to-face, teleconferencing, web-conferencing and using webcams
K4: identify the relevant organizational procedures and policies regarding meetings, chairing and minutes including identifying organizational formats for minutes and agendas.

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) to be competent in this competency standard:

A person who demonstrates competency in this unit must be able to provide evidence of the ability to manage meetings. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- apply conventions and procedures for formal and informal meetings including:
    - developing and distributing agendas and papers
    - identifying and inviting meeting participants
    - organizing and confirming meeting arrangements
    - running the meeting and following up
- organize, take part in and chair a meeting
- record and store meeting documentation
- Follow organizational policies and procedures.

0714E&A79. Manage recruitment selection and induction processes

Overview: This unit describes the skills and knowledge required to manage all aspects of recruitment selection and induction processes in accordance with organizational policies and procedures. It applies to individuals or human resource personnel who take responsibility for managing aspects of selecting new staff and orientating those staff in their new positions. It is not assumed that the individual will be directly involved in the selection processes themselves, although this may well be the case.

Unit of Competency	**Performance Criteria**
1. Develop recruitment, selection and induction policies and procedures	P1 Analyze strategic and operational plans and policies to identify relevant policies and objectives P2 Develop recruitment, selection and induction policies and procedures and supporting documents P3 Review options for technology to improve efficiency and effectiveness of recruitment and selection process P4 Obtain support for policies and procedures from senior managers P5 Trial forms and documents supporting policies and procedures and make necessary adjustments P6 Communicate policies and procedures to relevant staff and provide training if required
2. Recruit and select staff	P1 Determine future human resource needs in collaboration with relevant managers and sections P2 Ensure current position descriptors and person specifications for vacancies are used by managers and others involved in recruitment, selection and induction processes P3 Provide access to training and other forms of support to all persons involved in recruitment and selection process P4 Ensure advertising of vacant positions complies with organizational policy and legal requirements P5 Utilize specialists where necessary P6 Ensure selection procedures are in accordance with organizational policy and legal requirements P7 Ensure processes for advising applicants of selection outcome are followed P8 Ensure job offers and contracts of employment are executed promptly, and new appointments are provided with advice about salary, terms and conditions

3. Manage staff induction	P1 Provide access to training and ongoing support for all persons engaged in staff induction P2 Check induction processes are followed across the organization P3 Oversee management of probationary employees and provide them with feedback until their employment is confirmed or terminated P4 Obtain feedback from participants and relevant managers on extent induction process is meeting its objectives P5 Make refinements to induction policies and procedures

Knowledge & Understanding

K1: describe recruitment and selection methods, including assessment centers

K2: explain the concept of outsourcing

K3: describe the purpose of employee contracts and industrial relations

K4: summarize relevant legislation, regulations, standards and codes of practice that may affect recruitment, selection and induction

K5: explain why terms and conditions of employment are an important aspect of recruitment

K6: explain the relevance of psychometric and skills testing programs to recruitment.

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) to be competent in this competency standard:

A person who demonstrates competency in this unit must be able to provide evidence of the ability to manage recruitment selection and induction processes. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- develop or critically analyze a policy and procedures framework for recruitment, selection and induction
- identify the need for recruitment
- prepare and oversee appropriate documentation required for recruitment
- select and advise job applicants appropriately
- manage the induction process
- Comply with relevant legislation and organizational requirements.

0714E&A80. Manage personal work priorities and professional development

Overview: This unit describes the skills and knowledge required to create systems and process to organize information and prioritize tasks. It applies to individuals working in managerial positions who have excellent organizational skills. The work ethic of individuals in this role has a significant impact on the work culture and patterns of behavior of others as managers at this level are role models in their work environment.

Unit of Competency	**Performance Criteria**
1. Establish personal work goals	P1 Serve as a positive role model in the workplace through personal work planning P2 Ensure personal work goals, plans and activities reflect the organization s plans, and own responsibilities and accountabilities P3 Measure and maintain personal performance in varying work conditions, work contexts and when contingencies occur
2. Set and meet own work priorities	P1 Take initiative to prioritize and facilitate competing demands to achieve personal, team and organizational goals and objectives P2 Use technology efficiently and effectively to manage work priorities and commitments P3 Maintain appropriate work-life balance, and ensure stress is effectively managed and health is attended to
3. Develop and maintain professional competence	P1 Assess personal knowledge and skills against competency standards to determine development needs, priorities and plans P2 Seek feedback from employees, clients and colleagues and use this feedback to identify and develop ways to improve competence P3 Identify, evaluate, select and use development opportunities suitable to personal learning style/s to develop competence P4 Participate in networks to enhance personal knowledge, skills and work relationships P5 Identify and develop new skills to achieve and maintain a competitive edge

Knowledge & Understanding
K1: explain principles and techniques involved in the management and organization of:

- performance measurement
- personal behavior, self-awareness and personality traits identification

- a personal development plan
- personal goal setting
- time

K2: discuss management development opportunities and options for self

K3: describe methods for achieving a healthy work-life balance

K4: outline organization s policies, plans and procedures

K5: explain types of learning style/s and how they relate to the individual

K6: describe types of work methods and practices that can improve personal performance.

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) to be competent in this competency standard:

A person who demonstrates competency in this unit must be able to provide evidence of the ability to manage personal work priorities and professional development. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- use business technology to create and use systems and processes to organise and prioritise tasks and commitments
- measure and maintain personal work performance including assessing competency against competency standards and seeking feedback
- maintain an appropriate work-life balance to manage personal health and stress
- participate in networks
- develop a personal development plan which includes career objectives and an action plan
- Develop new skills.

0714E&A81. Manage workforce planning

Overview: This unit describes the skills and knowledge required to manage planning in relation to an organization's workforce including researching requirements, developing objectives and strategies, implementing initiatives and monitoring and evaluating trends. It applies to individuals who are human resource managers or staff members with a role in a policy or planning unit that focuses on workforce planning.

Unit of Competency	**Performance Criteria**
1. Research workforce requirements	P1 Review current data on staff turnover and demographics P2 Assess factors that may affect workforce supply P3 Establish the organization's requirements for a skilled and diverse workforce
2. Develop workforce objectives and strategies	P1 Review organizational strategy and establish aligned objectives for modification or retention of the workforce P2 Consider strategies to address unacceptable staff turnover, if required P3 Define objectives to retain required skilled labor P4 Define objectives for workforce diversity and cross-cultural management P5 Define strategies to source skilled labor P6 Communicate objectives and rationale to relevant stakeholders P7 Obtain agreement and endorsement for objectives and establish targets P8 Develop contingency plans to cope with extreme situations
3. Implement initiatives to support workforce planning objectives	P1 Implement action to support agreed objectives for recruitment, training, redeployment and redundancy P2 Develop and implement strategies to assist workforce to deal with organizational change P3 Develop and implement strategies to assist in meeting the organization's workforce diversity goals P4 Implement succession planning system to ensure desirable workers are developed and retained P5 Implement programs to ensure workplace is an employer of choice
4. Monitor and evaluate workforce trends	P1 Review workforce plan against patterns in exiting employee and workforce changes

	P2 Monitor labor supply trends for areas of over- or under-supply in the external environment P3 Monitor effects of labor trends on demand for labor P4 Survey organizational climate to gauge worker satisfaction P5 Refine objectives and strategies in response to internal and external changes and make recommendations in response to global trends and incidents P6 Regularly review government policy on labor demand and supply P7 Evaluate effectiveness of change processes against agreed objectives

Knowledge & Understanding

K1: explain current information about external labor supply relevant to the specific industry or skill requirements of the organization

K2: outline industrial relations relevant to the specific industry

K3: describe labor force analysis and forecasting techniques

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) to be competent in this competency standard:

A person who demonstrates competency in this unit must be able to provide evidence of the ability to manage workforce planning. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- review and interpret information from a range of internal and external sources to identify:
    - current staff turnover and demographics
    - labor supply trends factors that may affect workforce supply
    - organization's workforce requirements objectives and strategies
- manage workforce planning including developing, implementing, monitoring and reviewing strategies to meet workforce needs
- review relevant trends and supply and demand factors that will impact on an organization's workforce
- Develop a workforce plan that includes relevant research and specific strategies to ensure access to a skilled and diverse workforce.

0714E&A82. Undertake project work

Overview: This unit describes the skills and knowledge required to undertake a straightforward project or a section of a larger project. It covers developing a project plan, administering and monitoring the project, finalizing the project and reviewing the project to identify lessons learned for application to future projects. This unit applies to individuals who play a significant role in ensuring a project meets timelines, quality standards, budgetary limits and other requirements set for the project.

Unit of Competency	**Performance Criteria**
1. Define project	P1 Access project scope and other relevant documentation P2 Define project stakeholders P3 Seek clarification from delegating authority of issues related to project and project parameters P4 Identify limits of own responsibility and reporting requirements P5 Clarify relationship of project to other projects and to the organization's objectives P6 Determine and access available resources to undertake project
2. Develop project plan	P1 Develop project plan in line with the project parameters P2 Identify and access appropriate project management tools P3 Formulate risk management plan for project, including Work Health and Safety (WHS) P4 Develop and approve project budget P5 Consult team members and take their views into account in planning the project P6 Finalize project plan and gain necessary approvals to commence project according to documented plan
3. Administer and monitor project	P1 Take action to ensure project team members are clear about their responsibilities and the project requirements P2 Provide support for project team members, especially with regard to specific needs, to ensure that the quality of the expected outcomes of the project and documented time lines are met P3 Establish and maintain required recordkeeping systems throughout the project P4 Implement and monitor plans for managing project finances, resources and quality

	P5 Complete and forward project reports as required to stakeholders P6 Undertake risk management as required to ensure project outcomes are met P7 Achieve project deliverables
4. Finalize project	P1 Complete financial recordkeeping associated with project and check for accuracy P2 Ensure transition of staff involved in project to new roles or reassignment to previous roles P3 Complete project documentation and obtain necessary sign-offs for concluding project

Knowledge & Understanding

K1: give examples of project management tools and how they contribute to a project

K2: outline types of documents and other sources of information commonly used in defining the parameters of a project

K3: explain processes for identifying and managing risk in a project

K4: outline the organization's mission, goals, objectives and operations and how the project relates to them

K5: explain the organization's procedures and processes that are relevant to managing a project including:

- lines of authority and approvals
- quality assurance
- human resources
- budgets and finance
- recordkeeping
- reporting

Outline the legislative and regulatory context of the organization in relation to project work, including work health and safety (WHS) requirements**.**

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) to be competent in this competency standard:

A person who demonstrates competency in this unit must be able to provide evidence of the ability to undertake project work. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- define the parameters of the project including:
    - project scope
    - project stakeholders, including own responsibilities
    - relationship of project to organizational objectives and other projects
    - reporting requirements
    - resource requirements
- use project management tools to develop and implement a project plan including:
    - deliverables
    - work breakdown
    - budget and allocation of resources
    - timelines
    - risk management
    - recordkeeping and reporting
- consult and communicate with relevant stakeholders to generate input and engagement in planning, implementing and reviewing the project
- provide support to team members to enable them to achieve deliverables and to transition them as appropriate at completion of the project
- finalize the project including documentation, sign-offs and reporting

Review and document the project outcomes.

0714E&A83. Identify and communicate trends in career development

Overview: This unit describes the skills and knowledge required to conduct research to identify and communicate career trends. It establishes the need to interact professionally with others in assessing career needs, to effectively assist clients identify competencies they require for a career and employability in a given context. It also examines how to maintain quality of career development services and professional practice. It applies to individuals seeking to identify and communicate trends in career development.

Unit of Competency	**Performance Criteria**
1. Research and confirm career trends	P1 Apply knowledge of changing organizational structures, lifespan of careers and methods of conducting work search, recruitment and selection processes P2 Analyze changing worker and employer issues, rights and responsibilities in context of changing work practices P3 Examine importance of quality careers development services P4 Maintain all research, documentation, sources and references (electronic or physical) to a high degree of currency and relevance P5 Analyze implications of relevant policy, legislation, professional codes of practice and national standards relating to worker and employer issues P6 Research changes and trends in theory of career development counseling and practice P7 Confirm clusters, levels and combinations of transferable employability skills and preferences that may open employment options spanning more than one occupation or career pathway
2. Assess and confirm ongoing career development needs of target group	P1 Analyze history and records in assessing needs of target group P2 Assess success of previous career development services and techniques used for individual or target group P3 Deploy other means to investigate appropriate care and counseling approaches as required P4 Maintain privacy and security of all data, research and personal records according to relevant policy, legislation, professional codes of practice and national standards P5 Establish existing work-life balance requirements, issues and needs
3. Maintain quality of career development	P1 Analyze and review relevance of career theories, models, frameworks

services and professional practice	and research for target group P2 Incorporate into career development services and professional practice, major changes and trends influencing workplace and career-related options and choices P3 Comply with all relevant policy, legislation, professional codes of practice and national standards that influence delivery of career development services

Knowledge & Understanding

K1: explain client care and counseling techniques and processes in the context of career development services

K2: describe diversity and its potential effects on career choices

K3: outline human psychological development and needs in relation to careers development

K4: outline relevant policy, legislation, codes of practice and standards relevant to career development

K5: explain recruitment and selection processes in the context of career development services

K6: describe a range of data gathering and research techniques

K7: explain techniques used to analyze trends.

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) to be competent in this competency standard:

A person who demonstrates competency in this unit must be able to provide evidence of the ability to identify and communicate trends in career development. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- research and analyze current economic, labor market, employment, career and vocational, educational and training trends
- identify choices and career development needs for individuals and target groups within a given context
- report and document management of research and career development materials
- Comply with all relevant local, state/territory and national legislation, policies and practices.

0714E&A84. Apply specialist interpersonal and counseling interview skills

Overview: This unit describes the skills and knowledge required to use advanced and specialized communication skills in the client-counselor relationship. This unit applies to individuals whose job role involves working with clients on personal and psychological issues within established policies, procedures and guidelines.

Unit of Competency	**Performance Criteria**
1. Communicate effectively	P1 Identify communication barriers and use strategies to overcome these barriers in the client-counselor relationship P2 Facilitate the client-counselor relationship through selection and use of micro skills P3 Integrate the principles of effective communication into work practices P4 Observe and respond to non-verbal communication cues P5 Consider and respond to the impacts of different communication techniques on the client-counselor relationship in the context of individual clients P6 Integrate case note taking with minimum distraction
2. Use specialized counseling interviewing skills	P1 Select and use communication skills according to the sequence of a counseling interview P2 Identify points at which specialized counseling interviewing skills are appropriate for inclusion P3 Use specialized counseling communication techniques based on their impacts and potential to enhance client development and growth P4 Identify and respond appropriately to strong client emotional reactions
3. Evaluate own communication	P1 Reflect on and evaluate own communication with clients P2 Recognize the effect of own values and beliefs on communication with clients P3 Identify and respond to the need for development of own skills and knowledge

Knowledge & Understanding

K1: legal and ethical considerations for communication in counseling practice, and how these are applied in individual practice:

- codes of conduct/practice

- discrimination
- duty of care
- human rights
- practitioner/client boundaries
- privacy, confidentiality and disclosure
- rights and responsibilities of workers, employers and clients
- work role boundaries responsibilities and limitations of the counselor role
- work health and safety

K2: principles of person-centered practice
K3: key objectives of counseling interviewing
K4: stages of a counseling interview
K5: potential impacts of using different communication skills and techniques in counseling contexts
K6: communication techniques and micro-skills including:

- attending behaviors active listening, reflection of content feeling, summarizing
- questioning skills open, closed, simple and compound questions
- client observation skills
- noting and reflecting skills
- providing client feedback

K7: specialized counseling communication techniques, and how they are used, including:

- challenging
- reframing
- focusing

K8: components of the communication process including:

- encoder
- decoder

K9: primary factors that impact on the communication process including:

- context
- participants
- rules
- messages
- channels
- noise
- feedback

K10: communication barriers and resolution strategies, including:

- environmental
- physical
- individual perceptions
- cultural issues
- language
- age issues
- disability

K11: observational techniques including:

- facial expressions
- non-verbal behavior
- posture
- silence

K12: ways in which different people absorb information, including:

- visual
- auditory
- kinesthetic

K13: obstacles to the counseling process

K14: impacts of trauma and stress on the communication process, including on:
- concentration and attention
- memory
- use of verbal and written language
- use of body language
- challenging within the counseling session

K15: self-evaluation practices, including:
- how to recognize own biases
- Impact of own values on the counseling relationship.

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) to be competent in this competency standard:

A person who demonstrates competency in this unit must be able to provide evidence of the ability to apply specialist interpersonal and counseling interview skills. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- interviewed at least 3 different clients using specialized interpersonal communication and counseling interviewing skills, including:
- micro-skills and communication techniques, including:
    - attending behaviors active listening,
    - reflection of content, summarizing
    - questioning skills open, closed, simple and compound questions
    - client observation skills
    - noting and reflecting skills
    - providing client feedback
- specialized counseling interviewing skills, including:
    - challenging
    - reframing
    - focusing
- integrated clear case note taking into the interview process
- Completed a structured process of self-reflection and evaluation of own communication used during the 3 interviews.

0714E&A85. Work safely in an office environment

Overview: This unit describes the performance outcomes, skills and knowledge required to participate in workplace occupational health and safety (OHS) processes to protect workers own health and safety, and that of others.

Unit of Competency	**Performance Criteria**
1. Work safely	P1 Follow established safety procedures when conducting work P2 Carry out pre-start systems and equipment checks in accordance with workplace procedures
2. Implement workplace safety requirements	P1 Identify designated persons for reporting queries and concerns about safety in the workplace P2 Identify existing and potential hazards in the workplace, report them to designated persons and record them in accordance with workplace procedures P3 Identify and implement workplace procedures and work instructions for controlling risks P4 Report emergency incidents and injuries to designated persons
3. Participate in OHS consultative processes	P1 Contribute to workplace meetings, inspections or other consultative activities P2 Raise OHS issues with designated persons in accordance with organizational procedures P3 Take actions to eliminate workplace hazards or to reduce risks
4. Follow safety procedures	P1 Identify and report emergency incidents P2 Follow organizational procedures for responding to emergency incidents

Knowledge & Understanding

K1: Explain responsibilities of employers and employees under relevant health and safety regulation

K2: describe emergency procedures including procedures for fires, accidents and evacuation

K3: outline commonly used hazard signs and safety symbols

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) to be competent in this competency standard:

A person who demonstrates competency in this unit must be able to provide evidence of the ability to participate in workplace OHS processes. The evidence should integrate employability skills with

workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. The unit assessment must ensure the safety processes; hazards and risk are relevant to the area of work. Evidence of the following is essential:

- Accurately following all relevant safety procedures
- Identifying and reporting hazards to designated personnel
- Knowledge of relevant health and safety regulations
- Knowledge of relevant materials, equipment and work processes.

0714E&A86. Develop workplace documents

Overview: This unit covers interpreting and composing a range of workplace documents from a number of sources. It includes interpreting written information for workplace purposes as well as planning, drafting and reviewing a basic document before writing the final version. The focus is on the content and structure of written materials and not on the use of computer technology

Unit of Competency	**Performance Criteria**
1. Interpret written information	P1 Read workplace materials to identify the subject and key information for using or reporting to others. P2 Read procedural manuals and codes of practice to locate specific information to carry out work functions in accordance with policy and standards. P3 Read a range of written materials to locate and select required information for summaries, short reports and responses to requests. P4 Identify the cultural context and prior knowledge required to interpret workplace information and obtain assistance when required. P5. Determine audience and purpose for the document P6 Seek assistance with interpretation of complex materials in accordance with organizational procedures.
2. Develop written materials	P1 Identify and comply with established requirements for a range of written materials in accordance with organizational procedures and standard templates. P2. Determine format and structure P3. Establish key points for inclusion P4. Identify organizational requirements P5. Establish method of communication P6. Establish means of communication
3. Draft document	P1 Develop draft document to communicate key points P2. Obtain and include any required additional information P3 Prepare written information in an accurate, concise and unambiguous manner that meets intended audience and organizational requirements.
4. Review document	P1 Check draft for suitability of tone for audience, purpose, format and communication style P2. Check draft for readability, grammar, spelling, sentence and

	paragraph construction and correct any inaccuracies or gaps in content. P3. Check draft for sequencing and structure P4. Check draft to ensure it meets organizational requirements P5. Ensure draft is proofread, where appropriate, by supervisor or colleague
5. Write final document	P1 Make and proofread necessary changes P2. Ensure document is sent to intended recipient within required time frames P3. File copy of document in accordance with organizational policies and procedures

Knowledge & Understanding

K1: Explain the reading and writing procedures at a level to cope with a range of workplace materials

K2: Explain the integration of information from a number of sources in order to generate meaning

K3: Describe the ways to write and sequence paragraphs according to the required purpose of written material

K4: Outline the linking ideas in written material through selection and use of words, grammatical structures, headings and punctuation appropriate to the purpose

K5: Elaborate spelling, punctuation and grammar for workplace documents at an experienced level

K6: Explain the response to diversity, including gender and disability

K7: Explain the implementation of ergonomic requirements for office work

K8: Explain the environmental policies such as those relating to paper use/wastage/recycling

K9: Describe the preparation of general information and papers according to target audience

K10: Elaborate the ways of proofreading and editing documents to ensure clarity of meaning and conformity to organizational requirements

K11: Describe the problem-solving skills to determine document design and production processes

K12: Explain the usage of resources to assist in document production, such as dictionary, thesaurus, templates, style sheets

K13: Describe the ways to produce business letters, memos, job applications, resumes, meeting agendas and minutes

K14: Explain the ways to fold and insert letters into a standard and window faced envelope.

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) to be competent in this competency standard:

A person who demonstrates competency in this unit must be able to provide evidence of the ability to interpret written information for workplace purposes and plan, draft and review a basic document before writing the final version. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Evidence of the following is essential:

- Producing a range of documents that accurately convey required information including single and multipage business letters, memos, job applications, resumes, meeting agendas and minutes.
- Using formatting suitable for intended audience
- Knowledge of organizational policies and procedures for document production

0714E&A87. Prepare and implement negotiation

Overview: This unit covers the skills, knowledge and attitudes required to prepare for and participate in a process of negotiation.

Unit of Competency	**Performance Criteria**
1. Prepare for the negotiation	P1 Identify objectives and preferred outcome of the negotiation and determine minimum acceptable outcome P2 Understand in relation to what can be offered and what is needed from the other party P3 Gather information regarding the other party objectives, needs, preferences, resources, what they want to achieve - in order to determine best negotiating points P4 List and rank the issues to consider that may be made. P5 Find examples and refine negotiation argument. P6 Check information to ensure it is correct and up-to-date. P7 Develop a negotiation plan that includes information about the other party and its interests and a set of responses and strategies to the anticipated tactics. P8 Prepare an agenda in advance, which includes discussion topics, participants, location and schedule
2. Participate in negotiations	P1 Analyze all aspects of the incident for degree of hazard, priorities, optional outcomes and appropriate strategies P2 Analyze and determine strategies and priorities on the incident sought from a range of sources P3 Assess long term objectives against resources and priorities P4 Apply a range of communication techniques to make and maintain contact with the key people P5 Provide clear and factual information to enable an honest and realistic assessment of the interests of the key people and their positions P6 Resolve the conflict and express their likely consequences clearly and do an analysis of the benefits P7 Re assess points of disagreements for common positive positions
3. Coordinate support services	P1 Assess the need for support services in terms of the determined strategies and priorities

	P2 Negotiate the resources of support services according to established procedures and availability P3 Provide information on strategies to support services and maintain the communication P4 Delegate roles and responsibilities according to expertise and resources
4. Restore order	P1 Assess the incidents for degree of risk and take appropriate action to reduce and remove the impact of the incident and restore order P2 Take action designed to minimize risk and the preserve the safety and security of all involved P3 Take action to prevent the escalation of the incident appropriate to the circumstances and agreed procedures. P4 Carry out the use of force for the restoration of control and the maintenance of security in the least restrictive manner. P5 Complete reports accurately and clearly provided to the appropriate authority promptly P6 Review, evaluate and analyze the incident and the organizational response to it and report it promptly and accurately.
5. Provide leadership. direction and guidance to the work group	P1 Link between the function of the group and the goals of the organization P2 Participate in decision making routinely to develop, implement and review work of the group and to allocate responsibilities where appropriate P3 Give opportunities and encouragement to others to develop new and innovative work practices and strategies P4 Identify conflict and resolve with minimum disruption to work group function P5 Provide staff with the support and supervision necessary to perform work safely and without risk to health P6 Allocate tasks within the competence of staff and support with appropriate authority, autonomy and training P7 Supervise appropriately the changing priorities and situations and takes into account the different needs of individuals and the requirements of the task

Knowledge & Understanding

K1: Explain organization's policies, guidelines and procedures related to control and surveillance, safety and preventing and responding to incidents and breaches of orders covered in the range of variables.

K2: Explain organization's management and accountability systems

K3: Describe teamwork principles and strategies

K4: Outline the principles of effective communication

K5: Outline the guidelines for use of equipment and technology

K6: Explain code of conduct

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) to be competent in this competency standard:

A person who demonstrates competency in this unit must be able to provide evidence of the ability to solve problems which jeopardize safety and security. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Evidence of the following is essential:

- evidence of effective communication strategies including negotiation, counseling, mediation, advocacy demonstrated under pressure working effectively in a team environment
- evidence of knowledge and application of organizations policies, procedures and
- guidelines for critical incidents
- evidence of accurate and safe use of all emergency equipment
- evidence of managing effective outcomes using strategic planning, team leadership and situational analysis

0714E&A88. Maintain professionalism in the workplace

Overview: This unit of competency describes the outcomes required maintain a professional image in the workplace, including behaving ethically, demonstrating motivation, respecting timeframes and maintaining personal appearance.

Unit of Competency	**Performance Criteria**
1. Respect work timeframes	P1 Demonstrate punctuality in meeting, set working hours and times. P2 Utilize working hours follow company regulations. P3 Complete work tasks within deadlines according to order of priority P4 Supervisors are informed of any potential delays in work times or projects.
2. Maintain personal appearance and hygiene	P1 Clean hair, body and nails regularly. P2 Wear suitable cloths for the workplace, and respect local and cultural contexts P3 Meet specific company dress code requirements
3. Maintain adequate distance with colleagues and clients	P1 Respect personal space of colleagues and clients with reference to local customs and cultural contexts. P2 Keep sufficient distance from others P3 Avoid cross transmission of infections (especially through respiration).
4. Work in an ethical manner	P1 Follow company values/ethics codes of ethics and/or conduct, policies and guidelines. P2 Use company resources in accordance with company ethical standards. P3 Conduct personal behavior and relationships in accord with ethical standards and company policies. P4 Undertake work practices in compliance with company ethical standards, organizational policy and guidelines. P5 Instruct co-workers on ethical, lawful and reasonable directives. P6 Share company values/practices with co-workers using appropriate behavior and language. P7 Report work incidents/situations and/or resolved in accordance with company protocol/guidelines.

Knowledge & Understanding

K1: Explain application of good manners and right conduct

K2: Explain basic practices for oral and personal hygiene
K3: Describe common products used for oral and personal hygiene
K4: Outline the company code of conduct/values
K5: Outline the Company regulations, performance and ethical standards
K6: Explain work responsibilities/job functions
K7: Describe communication skills
K8: State workplace hygiene standards

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) to be competent in this competency standard:

A person who demonstrates competency in this unit must be able to provide evidence of the ability to maintain professionalism in the workplace .The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Evidence of the following is essential:

- clarify and affirm work values/ethics/concepts consistently in the workplace;
- comply with required working times;
- conduct work practices satisfactorily and consistently, in compliance with work ethical standards, organizational policy and guidelines;
- Develop suitable hygiene

Keep adequate distance while interacting with colleagues and clients.

0714E&A89. Organize schedules

Overview: This unit describes the skills and knowledge required to manage appointments and diaries for personnel within an organization, using manual and electronic diaries, schedules and other appointment systems. It applies to individuals employed in a range of work environments who provide administrative support to teams and individuals.

Unit of Competency	**Performance Criteria**
1. Establish schedule requirements	P1 Identify organizational requirements and protocols for diaries and staff planning tools P2 Identify organizational procedures for different types of appointments P3 Determine personal requirements for diary and schedule items for individual personnel P4 Establish appointment priorities and clarify in discussion with individual personnel
2. Manage schedules	P1 Identify recurring appointments and deadlines, and schedule these in accordance with individual and organizational requirements P2 Establish availability of attendees, and schedule new appointments in accordance with required timelines and diary commitments P3 Negotiate alternative arrangements and confirm when established appointments are changed P4 Record appointments and manage schedules in accordance with organizational policy and procedures

Knowledge & Understanding

K1: identify the key provisions of relevant legislation, standards and codes that affect aspects of business operations or the achievement of team goals

K2: describe organizational requirements for managing appointments for personnel within the organization

K3: summarize the range of appointment systems that could be used

K4: outline important considerations when managing the schedules of others.

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) to be competent in this competency standard:

A person who demonstrates competency in this unit must be able to provide evidence of the ability to organize schedules. The evidence should integrate employability skills with workplace

tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- Appropriately manage the schedules of various individuals through a process of careful planning and negotiation.

Computer Programming

0714E&A90. Installation of C++, IDE for Arduino and Python

Overview: This competency standard covers the skills and knowledge required to develop how to write a computer program. It will create the knowledge to write lists of instructions for a computer to follow and to develop the software programs, the scripts, or other sets of instructions for the computers to execute.

Critical Evidence	Performance Criteria
CU1. Install Turbo C++ on Windows	P1. Download Turbo C++ P2. Create turboc directory inside C drive and extract the tc3. zip inside c:\turboc P3. Double click on install.exe file P4. Click on the tc application file located inside c:\TC\BIN to write the C program.
CU2. Install Arduino IDE on Windows	P1. Download the Arduino Software (IDE) P2. RUN setup file and choose components to install. P3. Choose the installation directory and complete installation. P4. Proceed with board specific instructions (Uno, Mega, etc.) P5. Open software to view IDE.
CU3. Install Python IDE on Windows	P1. Download the Python 3 Installer P2. Run the installer P3. Download the python IDE P4. Identify Interpreter vs Script Mode P5. Enabling VNC Server P6. Enabling VNC Server graphically

P7. Enabling VNC Server at the command line
P8. Connecting to your Raspberry Pi with VNC Viewer
P9. Establishing a direct connection
P10. Establishing a cloud connection
P11. Authenticating to VNC Server
P12. Creating a virtual desktop

Knowledge and understanding

K1. Describe the System Software
K2. Describe C++
K3. Describe Arduino microcontroller
K4. Describe Raspberry Pi microcontroller
K5. Define Interpreter and Script Mode
K6. Describe the Programming Software
K7. Describe the Application Software
K8. Describe the Program languages
K9. Describe VNC Server
K10. Describe the syntax and semantics.
K11. Differentiate Programs and Algorithms.

Equipment and Tools

- Computer/Laptop System
- Turbo C++ Software
- Arduino Software
- Python Software
- Arduino Development Board
- Raspberry Pi Development Board
- SD Card

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Installation Software
- Running of Software

0714E&A91. Carryout Basic C++ Programming

Overview: This competency standard covers the skills and knowledge required to develop how to write a computer program. It will create the knowledge to write lists of instructions for a computer to follow and to develop the software programs, the scripts, or other sets of instructions for the computers to execute. This unit will cover the knowledge of programming language C which has variety of data types and powerful operators. Due to this, students will be able to write computer programs efficiently and easily.:

Critical Evidence	Performance Criteria
CU1. Develop a computer program for mathematic functions	P1. Open turbo C++ software P2. Create new file P3. Write a program for addition / subtraction / multiplication / Division. P4. Save and run the program P5. Identify the error in compiler P6. Remove the error if required
CU2. Develop a computer program for trigonometric functions	P1. Open turbo C++ software P2. Create new file P3. Write a program for sin / cosine / tan P4. Save and run the program P5. Identify the error in compiler P6. Remove the error if required
CU3. Develop a computer simple program for given problem.	P1. Analyze the given problem P2. Open the IDE for coding P3. Code a simple program P4. Compile a code P5. Debug the code (in case of error) P6. Run a code
CU4. Develop a program based on control structures	P1. Identify the keywords and identifiers P2. Perform comments, indentation and statements P3. Recognize variables and data types P4. Check standard Input and Output P5. Use Operators P6. Use of IF statement P7. Use of IF ELSE statement

	P8. Use of SWITCH statement
CU5. Develop program using loop structuers	P1. Use of FOR loop P2. Use of WHILE loop P3. Use of DO-WHILE loop P4. Use of nested loop P5. Use Break and Continue
CU6. Develop a program using Arrays	P1. Use of Arrays P2. Use of one dimension array declaration. P3. Use of Array declaration. P4. Use of Array initialization. P5. Use of Array elements accessing. P6. Use of Two dimension array declaration.

Knowledge and understanding

K1. Define Compiler
K2. Define C++ language
K3. Describe basic purpose of C++ language.
K4. Describe Data Type
K5. Describe operational procedure of C++.
K6. Describe of complex number and rectangular and polar form.
K7. Define a given problem
K8. Describe the basic programming concept
K9. Define IDE
K10. Define basics of C language
K11. Define Constants and Variables.
K12. Define basic input and output statements.
K13. Define debugging of a code
K14. Define IF statement
K15. Define IF ELSE statement
K16. Describe the use of SWITCH statement
K17. Define loop structure
K18. Define FOR loop
K19. Define WHILE loop
K20. Define DO-WHILE loop
K21. Define nested loop
K22. Define language translator

Equipment and Tools

- Computer/Laptop System
- Turbo C++ Software
- Arduino Software
- Python Software
- Arduino Development Board
- Raspberry Pi Development Board
- SD Card

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Develop program using loops
- Develop program using conditions

0714E&A92. Carryout Basic Programming using python

Overview: This competency standard covers the skills and knowledge required to develop how to write a computer program. It will create the knowledge to write lists of instructions for a computer to follow and to develop the software programs, the scripts, or other sets of instructions for the computers to execute. This unit will cover the knowledge of programming language C which has variety of data types and powerful operators. Due to this, students will be able to write computer programs efficiently and easily.

Critical Evidence	Performance Criteria
CU1. Introduction to LINUX commands	P1. Opening Linux Terminal P2. Perform Basics of Linux Terminal P3. Use Commands to display directory P4. Create file on the directory P5. Use Commands to run the file on LINUX
CU2. Develop a program based on control structures	P1. Identify Basic Data Types P2. Use Assignment Operators P3. Use print() function P4. Use Comments in Python P5. Use input() functions P6. Identify the Code Blocks and Indentation P7. Identify Reserved words in Python P8. Use Assignment Operators and Expressions P9. Use Arithmetic Operations P10. Identify Precedence and Associativity P11. Identify Docstring
CU3. Develop program Using Conditional Structures and Operators	P1. Use Boolean Expressions P2. Use If Statement P3. Use If-Else P4. Use Nested-If P5. Use If-Elif-Else P6. Identify Membership Operators P7. Identify Logical Operators P8. Use Bitwise Operators P9. Identify Simple Recursion P10. Use Factorial with Recursion

	P11. Program to display Fibonacci sequence using recursion P12. Use Indirect Recursion
CU4. Develop program using loop	P1. Use While Loop P2. Use While-break P3. Use While-Continue P4. Use for-list P5. Use for-range P6. Use for-continue-break P7. Program to display prime numbers in an interval P8. Calculate factorial P9. Compute Fibonacci Series
CU5. Develop a program using Functions	P1. Use of simple FUNCTIONS. P2. Use of Function Declaration. P3. Use of Function Prototype. P4. Use of Function Arguments P5. Use of Function definition. P6. Use of Function Call. P7. Use of passing parameters to Function. P8. Use of Function Arbitrary Arguments
CU6. Python file handling	P1. Create a Text File P2. Append Data to a File P3. Read a File P4. Read a File line by line P5. Identify File Modes in Python P6. Handling of CSV file P7. Handling of Excel File
CU7. Develop a program using Python Data Structrre	P1. Declare Strings P2. Create Lists in python P3. Apply Lists methods P4. Constructing Tuples in python P5. Apply Tuples methods P6. Create Sets P7. Use Operators on Sets P8. Create Dictionary P9. Methods to query information from dictionaries

P10. Create Strings
P11. Formatters and Operator on String
P12. Methods on String

Knowledge and understanding

K1. Understand Installation of python
K2. Understand Raspbian environment
K3. Define VNC connection
K4. Understand the LINUX commands
K5. Define File handling of python
K6. Define Tuples and its methods
K7. Define Operators and sets
K8. Define Dictionary and mrthods
K9. Define Strings and its methods
K10. Define Relational operators
K11. Define Logical operators.
K12. Define conditional operator.
K13. Define Arrays.
K14. Explain one dimension array declaration.
K15. Explain the initialization of array.
K16. Explain the accessing of array elements.
K17. Define the declaration of two dimension array.
K18. Define Functions.
K19. Explain types of functions
K20. Explain function prototype
K21. Explain function definition.
K22. Explain the use of function call.
K23. Explain the passing parameters to Function.
K24. Define the pointer

Equipment and Tools

- Computer/Laptop System
- Turbo C++ Software
- Arduino Software
- Python Software
- Arduino Development Board

- ❖ Raspberry Pi Development Board
- ❖ SD Card

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Develop program using Structures

0714E&A93. Perform basic programming using microcontrollers

Overview: This competency standard covers the skills and knowledge required to develop how to write a computer program. It will create the knowledge to write lists of instructions for a computer to follow and to develop the software programs, the scripts, or other sets of instructions for the computers to execute. This unit will cover the knowledge of programming language C which has variety of data types and powerful operators. Due to this, students will be able to write computer programs efficiently and easily.

Critical Evidence	Performance Criteria
CU1. Introduction to Arduino IDE	P1. Perform the Arduino IDE Installations. P2. Perform Arduino Sketch / Programming P2. Use Arduino supporting libraries and functions P3. Write down the sketch for Arduino in IDE. P4. Identify the Shields, Accessories, and Sensors for Arduino
CU2. Program Arduino Microcontroller for mathematical function	P1. Open Arduino IDE software. P2. Connect Display with Arduino P3. Make a source code/sketch for addition / subtraction / multiplication / Division. P4. Compile and Debug P5. Run Program. P6. Display results
CU3. Program Arduino Microcontroller for Invers Trigonometric function	P1. Open Arduino IDE software. P2. Connect LCD Display with Arduino P3. Make a source code/sketch for inverse sine / cosine / tan P4. Compile and Debug P5. Run Program. P6. Display the results
CU2. Program Arduino Microcontroller by using conditional and loop instructions.	P1. Use Boolean Expressions P2. Use If, If-Else, Nested if Statements P3. Identify Logical Operators P4. Identify Simple Recursion P5. Use While Loop P6. Use for loop P7 Display values from 1 to 100 as per given instructions.

Knowledge and understanding

K1. Define librarires
K2. Define Arduino shields
K3. Describe LCD Display
K4. Describe interfacing LCD Display
K5. Define conditional operator.
K6. Define Arrays.
K7. Explain one dimension array declaration.
K8. Explain the initialization of array.
K9. Explain the accessing of array elements.
K10. Define the declaration of two dimension array.
K11. Define Functions.
K12. Explain types of functions
K13. Explain function definition.
K14. Explain the use of function call.
K15. Explain the passing parameters to Function.

Equipment and Tools

- Computer/Laptop System
- Turbo C++ Software
- Arduino Software
- Python Software
- Arduino Development Board
- Raspberry Pi Development Board
- SD Card

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Uploading program to microcontroller
- Displaying Results on LCD Display

Computer Integrated Manufacturing (CIM)

0714E&A94. Perform CNC Machine Operations

Overview: This competency standard covers the skills and knowledge required to Set CNC machine according to job requirements, Perform Milling Operations Using CNC Machine and Perform turning operations using CNC machine

Critical Evidence	Performance Criteria
CU1 Comply with occupational health and safety and environmentally sustainable work practices	**P1.** Follow the safety rules and work place instruction according to the provided manuals. **P2.** Report and indentify the workplace hazards and accidents **P3.** Follow and indentify the emergency procedures **P4.** Identify the current resources in connection with environmental issues. **P5.** Comply with the environmental regulations. **P6.** Seek the opportunities to improve the environmental risks and resources in order to increase the efficiency.
CU2 Set CNC machine according to job requirements	**P1.** Mount and set the cutting tool and work-piece according to procedures. **P2.** Set up and adjust the machine's parameters according to the work specification. **P3.** Report the concerned person or inchargereguarly about the uncertainties / deviations /errors which wereface / observe during the operation. . **P4.** Follow / Observe the safety and workplace instructions in order to avoid injuries and accidents.

Knowledge & Understanding

K1. Basic knowledge of CNC machine.

K2. Machine's process standards and functions.

K3. Methods and techniques for adjustment of the operating parameters of machine.

K4. Interpreting the drawnings and work specifications.

K5. Techniques for checking quality of components produced.

K6. Basic knowledge of G-Code and M-Code.

K7. Basic computer operations.

K8. Procedure for reporting the uncertainties and deviations to the person concerned for timely action.

K9. X, Y, and Z axis.

K10. Safety precautions and guidelines.

K11. Use of control panel.

K12. Quality check points with standards.

K13. Basic knowledge of machine margins and alignments.

K14. Use of the coordinate system

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Set CNC machine according to job requirements
- Match work piece data with CAD data through software simulation

Tools & Equipment

- CNC machine
- CNC Manual
- CNC machine with all accessories
- Cutting Tools
- Tool Kit
- Gauges
- Measuring Instruments
- Cutting Tools
- Tool Kit
- Gauges
- Measuring Instruments

0714E&A95. Perform CNC Lathe Operations

Overview: This competency standard covers the skills and knowledge required to mount the Job, Generate the Program, Run Simulation, Feed the Program, Perform CNC Lathe Operations

Critical Evidence	Performance Criteria
CU1. Mount the Job	**P1.** Mount the work-piece according to the working capacity of the machine along with the drawing / design of the job. job to the drawing / design **P2.** Select the appropriate work holding device(s) in order to achieve the dimensional accuracy Enter **P3.** Clamp the job firmly in the work holding device according to the standard procedure. **P4.** Attain the proper alignment of the tool / cutter and work-piece e.g. concentricity of rotating jobs as per set / standared practice **P5.** Follow / Keep the safety measures while mounting the work-piece so that the unwanted operation by machine may not be initiated
CU2. Generate the Program	**P1.** Interpret the job requirements, i.e. calculation of the offsets, errors and new reference point during the removal of materials, Define the absolute or incremental coordinates system, tool path strategies, machining features and tool compensation for generating the tool path as per standard procedure **P2.** Use the appropriate part programming credentials (Sequence, G-codes, M-codes, coordinates, feed, speed, tooling information etc.) according to the control parameters of the CNC machine **P3.** Keep the record of generated part program in soft / hard form in order to feed into a machine control unit as per standard procedures
CU3. Run Simulation	**P1.** Feed the program of the drawing for the generated part into an appropriate simulation software's platform and run the simulation for checking the tool gouge according to safety measures **P2.** Run the simulation, observe the movements of tool / cutter and verify the measurement with the defined the sequences **P3.** Identify the occurrence of errors and modify the program as per defined procedures and sequences
CU4. Feed the Program	**P1.** Ensure the proper synchronization between the machine's control unit with the program of the part's drawing as per standard operating procedures

	P2. Switch the machine in the receiving mode and feed the program of the desired part drawing / file into the machine control unit for execution as per standard operating procedures **P3.** Select the program's file for the desired part for execution as per standard operating procedures
CU5. Perform CNC Lathe Operations	**P1.** Ensure and check the safety control operation of the CNC machines as per standards before executing the program file. **P2.** Control the feeds, speeds and override of the machine before execution according to the prescribed procedures **P3.** Switch the machine to execution mode (single block or auto) and press cycle start to run the machining **P4.** Compare the block-wise movements of the machining, **P5.** Complete the job and measure / calculate the the accuries / errors according to the executed program of the drawing / design

Knowledge & Understanding

K1. Work place safety and health considerations.
K2. Use of Personal Protective Equipment
K3. Reading Drawing
K4. Mechanism of working of CNC lathe machine
K5. Use of control panel and commands
K6. Program debugging techniques
K7. Use of Simulation software
K8. Use of portable devices for CNC lathe
K9. Use of Turret / Magazine and their sequence of tool mounting
K10. Possible accidents and their counteractions
K11. Coolant types along with benefits and uses
K12. Methods of calculating Coordinates techniques
K13. G codes and M codes
K14. Feed and speed concepts in Lathe Machine
K15. Lathe operations such as Facing, Turning, Drilling, Grooving, Threading, Knurling, Boring
K16. Use of Lathe tools and their types with respect to operations and materials
K17. Feed and speed concepts in Lathe Machine

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Use appropriate part programing credentials (seence, G-Code, M-code, Coordinates, feed, speed, and tooling information etc.) according to machine control units.
- Run simulation and verify movment of tools
- Perform CNC Lath operation

Tools & Equipment

- CNC Lathe Machine or Turning Centre along with Standard Accessories
- Lathe Tooling (Assorted Range)
- CNC Programming Manual
- CAM Software with Simulation Module
- Measuring Instruments (Vernier, Inside/Outside Calipers, Micrometer, Steel Rule,
- Tri-Square, Bevel Protractor etc.)
- Work Holding Devices
- Measuring Gauges
- Tooling Catalogue
- Complete Set of Computer System with Multimedia Projector
- Personal Protective Equipment (PPE)
- CNC Manual

0714E&A96. Perform CNC Milling Operations

Overview: This competency standard covers the skills and knowledge required to Mount the job on Milling Machine, Generate the Program for CNC Milling, Run Simulation, Feed the Program into CNC Milling and Perform CNC Milling Operations

Critical Evidence	Performance Criteria
CU1. Mount the job on Milling Machine	**P1.** Mount the work-piece by considering the working capacity of machine as well as job requirement according to the drawing/design **P2.** Select appropriate work holding device(s) in order to achieve dimensional accuracy and clamp the job firmly as per standard practice **P3.** Attain proper alignment of tool/ cutter and work-piece e.g. co-axiality, concentricity of rotating jobs as per set practice **P4.** Keep safe measures while mounting the work-piece so that unwanted operation by machine may not be initiated as per safety precautions
CU2. Generate the Program for CNC Milling	**P5.** Select appropriate CAM software according to the machine control unit and import 3D model into it as per standard procedure Rewrite and edit all according to the previous **P1.** **P2.** Define reference point and apply material/stock for machining to the design/model as per job requirements **P3.** Apply machining feature(s), toolpath strategies and leads/links as per prescribed procedure **P4.** Generate part program file against the applied machining sequence according to the post processor of CNC machine **P5**. Use appropriate part programming credentials (Sequence, G-codes, M-codes, Coordinates, Feed, Speed, Tooling Information etc.) according to the CNC machine control unit **P6**. Keep record of generated part program file in order to feed into machine control unit as per standard procedure
CU3. Run Simulation	P1. Feed the generated part program into appropriate simulation platform and run simulation for checking the tool gouge according to safety measures

	P2. Run simulation and verify movements of tool/cutter to get same results as per defined sequence P3. Identify occurrence of errors and modify the program as per defined procedure
CU4. Feed the Program into CNC Milling	**P1**. Ensure proper synchronization between machine control unit and part program file as per standard operating procedure P2. Switch machine to receiving mode and feed the desired part program file into machine control unit for further execution as per standard operating procedure **P6.** P3. Select the desired part program file for execution as per standard operating procedure Rewrite and edit all according to the previous
CU5. Perform CNC Milling Operations	P1. Ensure to control the safe operation of working on CNC machines before executing part program according to the safety measures P2. Control the feeds, speeds and override of machine before operating according to the prescribed procedure P3. Switch machine to execution mode (single block or auto) and press cycle start to run the machining sequence as per prescribed method P4. Compare the block-wise movements of machining sequence thoroughly during operating of machine according to the part program file P5. Complete the job and inspect its accuracy and precision according to the drawing/design

Knowledge & Understanding

- **K1.** Work place safety and health considerations
- **K2.** Use of CAM and 3D models
- **K3.** Mechanism of working of CNC Milling Machine
- **K4.** Use of control panel and commands
- **K5.** Program debugging techniques
- **K6.** Use of Simulation Software
- **K7.** Use of portable devices for CNC Milling
    a. Use of turret / Magazine and their sequence of tool mounting
    b. Possible accidents and their counteractions
    c. Coolant types along with benefits and uses
    d. Methods of calculating Coordinates techniques

e. G codes and M codes

f. Use of Clamping devices and their types

g. Feed and speed concepts in Milling machine

K8. Milling machine such as Facing, Drilling, Grooving, threading, Boring etc.

a. Use of Milling tools and their types with respect to operations and materials

Critical Evidence

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Use appropriate part programing credentials (seence, G-Code, M-code, Coordinates, feed, speed, and tooling information etc.) according to machine control units.
- Run simulation and verify movment of tools
- Perform CNC milling operation

Tools & Equipment

- CNC Milling Machine or Machining Centre along with Standard Accessories
- Lathe Tooling (Assorted Range)
- Zero Setter, Edge Finder and Dial Indicator
- Power Vice
- CNC Programming Manual
- CAM Software with Simulation Module
- Measuring Instruments (Vernier, Inside/Outside Calipers, Micrometer, Steel Rule,
- Tri-Square, Bevel Protractor etc.)
- Work Holding Devices
- Measuring Gauges
- Tooling Catalogue
- Complete Set of Computer System with Multimedia Projector
- CNC Manual
- Personal Protective Equipment (PPEs)

Machines and Mechanism

0714E&A97. Demonstrate Simple Mechanisms

Overview: This competency standard covers the knowledge and skills related to basic mechanisms. It includes primary and secondary joints, simple and complex links, four bar and quick return mechanisms. After completing this unit student should be competent to identify different types of simple mechanisms, Draw and interpret kinematic diagrams of simple mechanisms and perform kinematic inversion of simple mechanisms.

Critical Evidence	Performance Criteria
CU1. Identify Commonly Used Links and Joints	**P1.** Recognize the pin joints. **P2.** Recognize sliding joints. **P3.** Identify cam joints. **P4.** Identify gear joints. **P5.** Differentiate the simple and complex links.
CU2. Identify simple mechanisms	**P1.** Identify the four bar mechanisms. **P2.** Identify Crank Rocker Mechanism **P3.** Identify Slider Crank Mechanism. **P4.** Identify Quick Return Mechanism.
CU3. Analyze simple mechanisms	**P1.** Draw free hand sketch of simple and complex mechanism **P2.** Draw kinematic diagram of simple mechanisms. **P3.** Interpret kinematic diagram of simple mechanisms **P4.** Identify degrees of freedom in mechanisms
CU4. Perform kinematic inversion of mechanisms	**P1.** Perform Kinematic Inversion of four bar mechanisms. Correct according to the previous suggestions **P2.** Perform Kinematic Inversion of Crank Rocker Mechanism **P3.** Perform Kinematic Inversion of Slider Crank Mechanism. **P4.** Perform Kinematic Inversion of Quick Return Mechanism.

Knowledge and Understanding:

- **K1.** Kinematics
- **K2.** Constrained Motion
- **K3.** Machine Elements
- **K4.** Simple mechanisms and their types
- **K5.** Terminology of Mechanisms

K6. Kinematic Inversion

K7. Techniques of Mechanism Analysis

K8. Kinematic Diagrams

Critical Evidence(s) Required

- Recognise primary and secondary joints.
- Identify different types of simple mechanism
- Identify degrees of freedom in motion.
- Interpret kinematic diagrams of simple mechanisms.

Tools & Equipment:

- ❖ Pin Joints, Sliding Joints, Cams, Gears
- ❖ Four Bar Mechanism Model
- ❖ Slider Crank Mechanism Model
- ❖ Crank Rocker Mechanism Model
- ❖ Quick Return Mechanism Model

0714E&A98. Perform Kinematic Analysis of Simple Mechanisms

Overview: This competency standard covers knowledge and skills required to kinematic analysis of simple mechanisms. It includes model building and simulation of simple mechanisms in working model software and calculation of liner and angular displacements and velocities.

Critical Evidence	Performance Criteria
CU1. Develop computer models of simple mechanisms	**P1.** Build Model of Slider Crank Mechanism Correct according to the previous suggestions **P2.** Simulate model of Slider Crank Mechanism **P3.** Build Model of Gear Mechanism **P4.** Simulate Gear Mechanism
CU2. Perform Displacement Analysis	**P1.** Define a position of a point in a mechanism with a position vector. **P2.** Determine Liner Displacement. **P3.** Determine Angular Displacement
CU3. Perform Velocity Analysis	**P1.** Determine Liner Velocity of a point on a link. **P2.** Determine Angular Velocity of a point on a link. **P3.** Relate Linear and Angular velocities of a point on a link.

Correct according to the previous suggestions

Knowledge and Understanding:

- **K1.** CAD Modelling
- **K2.** Working Model Software
- **K3.** Model Building in Working Model.
- **K4.** Simulation of Mechanisms in Working Model
- **K5.** Kinematic Analysis.
- **K6.** Gear Terminology
- **K7.** Techniques of Mechanism Analysis

Critical Evidence(s) Required

- Model Simple Mechanism in Working Model Software.
- Simulate Simple Mechanism in Working Model Software.
- Calculate liner and angular displacement of a point on a link.

Tools & Equipment:

- ❖ Computers
- ❖ CAD software
- ❖ Working Model Software

0714E&A99. Demonstrate Mechanical Power Transmission Elements.

Overview: This competency standard covers the various methods of mechanical power transmission methods. Covering the knowledge related to belts, gears and chain drives, this unit will enable students to select appropriate power transmission method.

Competency unit	Performance Criteria
CU1. Interpret Belt Drives	**P1.** Identify the Belt Types. **P2.** Identify the Pulley Types **P3.** Draw Belt Drives Mechanism.
CU2. Interpret Gears	**P1.** Identify the gear types **P2.** Interpret Spur Gear Terminology. **P3.** Draw spur gear diagram
CU3. Interpret Chain Drives	**P1.** Select chain types. **P2.** Sketch single start chain

Knowledge and Understanding:

- **K1.** Mechanical power transmission fundamentals.
- **K2.** Types of belt drives and pulleys
- **K3.** Belt Drives Geometry
- **K4.** Types of Gears
- **K5.** Gear Geometry
- **K6.** Types of chain Drives
- **K7.** Chain Drive Geometry.

Critical Evidence(s) Required

- Interpret various types of gears, belts and chains.
- Describe the various terms of gear geometry.

Tools & Equipment:

- ❖ Belts and Pulleys of Various Sizes
- ❖ Various types of Gears.
- ❖ Various types of Chain Drives

0714E&A100. Perform Kinematic Analysis of Mechanical Power Transmission Elements.

Overview: This competency standard covers the knowledge and skills required for kinematic analysis of mechanical power transmission elements. Covering the knowledge related to belts, gears and chain drives, this unit will enable students to perform the kinematic analysis of selected power transmission method

Critical Evidence	Performance Criteria
CU1. Belts Drives	**P1.** Select the belts size **P2.** Determine the diameter of driver and driven pulleys. **P3.** Calculate velocity ratio for belts **P4.** Calculate the belt speed.
CU2. Gears	**P1.** Determine the rotational velocities of driver and driven gears. **P2.** Calculate Velocity Ratios Gears.
CU3. Chain Drives	**P1.** Determine the Velocity Ratio for Chains. **P2.** Calculate Chain Speed

Knowledge and Understanding:

K1. Mechanical power transmission fundamentals.
K2. Belt Drives Geometry
K3. Belt Drives Kinematics
K4. Gear Geometry
K5. Gear Kinematics
K6. Chain Drive Geometry
K7. Chain Drive Kinematics

Critical Evidence(s) Required

- Calculate Velocity Ratios for Gears, Belt and Chain Drives

Tools & Equipment:

- Belts and Pulleys of Various Sizes
- Various types of Gears.
- Various types of Chain Drives
- Computers
- Working Model Software

AC & DC Machines

0714E&A101. Verify Basic Laws of Electrical Machines

Overview: This competency standard covers the skills and knowledge required to verify Faraday's law by moving permanent magnet inside the coil, verify Faraday's law by moving coil near the magnet field, verify Faraday's law using relative motion of coil and magnet, verify Faraday's Law using simple loop generator, verify EMF through induction, verify Torque induce in a current carrying loop and verify Mutual induction.

Critical Evidence	Performance Criteria
CU1. Verify Faraday's law by moving permanent magnet inside the coil.	**P1.** Construct a coil. **P2.** Connect a Galvanometer with coil. **P3.** Move permanent magnet inside the coil fast and slow. **P4.** Record the effect of movement of magnet on reading of Galvanometer. **P5.** Hold the magnet inside the coil and keep it stationary Record the effect on Galvanometer again.
CU2. Verify Faraday's law by moving coil near the magnet field.	**P1.** Construct a coil. **P2.** Connect Galvanometer with coil. **P3.** Move the coil with various speeds (i.e from slow to the fast) inside / outside the permanent magnet which is set at the stationary position. **P4.** Record the effect coilon via Galvanometer. **P5.** Hold the coil near the magnetic field and keep them stationary . **P6.** Record the effect via Galvanometer.
CU3. Verify Faraday's law using relative motion of coil and magnet.	**P1.** Construct a coil. **P2.** Connect the Galvanometer with coil. **P3.** Make relative motion of coil and magnet. **P4.** Record the effect of movement on the coil via Galvanometer.
CU4. Verify Faraday's Law using simple loop generator.	**P1.** Identify the single loop generator and its parts. **P2.** Select field winding. **P3.** Connect Galvanometer with single loop coil. **P4.** Rotate the single loop coil of generator in the field

	P5. Measure the voltage induces in the loop generator. **P6.** Record the effect via Galvanometer.
CU5. Verify Torque induce in a current carrying loop	**P1.** Construct a coil. **P2.** Apply DC voltage to the coil. **P3.** Place a current carrying loop in the coil. **P4.** Check the direction of force to verify the torque produce
CU6. Verify Mutual induction	**P1.** Construct two coils on the two different legs of the similar core. **P2.** Apply AC voltage to either one of the coil (act as primary winding). **P3.** Check the volts induce in the another coil via voltmeter.

Knowledge & Understanding:

K1. Explain first law of Faraday.

K2. Explain second law of Faraday.

K3. How can we find the direction of induced emf?

K4. Explain the role of magnetic strength in Faraday's Law?

K5. Explain the role of conductor's length or turns in Faraday's Law?

K6. Explain Lenz's Law.

K7. Explain torque.

K8. Why force produce on current carrying conductor.

K9. Explain core.

K10. Explain induction.

K11. Explain Faraday's first law of Electro-Magnetic Induction.

K12. Explain meaning of coupled coils.

K13. Why emf induced in 2nd coil, when voltage is applied to 1st coil.

K14. Explain mutual induction.

K15. Explain core.

K16. Which machine work on the principle of mutual induction

Tools & Equipment:

- Galvanometer.
- Magnet.
- Connecting leads.
- Transformer
- Rheostat
- Loop
- Voltmeter
- Coil

- ❖ DC source
- ❖ Connecting leads.

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Verify Faraday's law using any method.

0714E&A102. Analyse an Alternator

Overview: This competency standard identifies the competencies required to measure the stator winding resistance with DC test, perform no load test, perform short circuit test, measure the efficiency of an alternator, measure the effect of field current on terminal voltage, measure the effect of speed changes on alternator frequency and active power and perform parallel operation of Alternators.

Critical Evidence	Performance Criteria
CU1. Measure the stator winding resistance with DC test.	**P1.** Connect DC Ampere meter in series with armature. **P2.** Apply DC voltage to either one of the two phases. **P3.** Measure current and voltage via multimeter. **P4.** Measure the resistance per phase by ohm's law.
CU2. Perform no load test.	**P1.** Make connection according to diagram. **P2.** Run the alternator with prime mover to its rated speed. **P3.** Supply the field current to make the terminal voltage to its rated value. **P4.** Measure Iron losses from watt meter.
CU3. Perform short circuit test.	**P1.** Make connection according to diagram. **P2.** Run the alternator with prime mover to its rated speed. **P3.** Supply the field current to make the terminal voltage 10 to 15 % to its rated value. **P4.** Measure the copper loss from the watt meter.
CU4. Measure the efficiency of an alternator.	**P1.** Perform no load test to measure Iron losses. **P2.** Perform short circuit test to measure copper losses. **P3.** Apply formula to find efficiency.
CU5. Measure the effect of field current on terminal voltage.	**P1.** Run the alternator with prime mover to its rated speed. **P2.** Supply the field current to make the terminal voltage to its rated value. **P3.** Draw no load curve between field current and terminal voltage
CU6. Measure the effect of speed changes on alternator frequency and active power.	**P1.** Run the alternator with prime mover to its rated speed. **P2.** Supply the field current to make the terminal voltage to its rated value. **P3.** Apply electrical load on alternator. **P4.** Measure the effects of load on alternator speed and frequency.

	P5. Adjust the prime mover speed to its rated value. **P6.** Measure the effect of this change on alternator speed and frequency.
CU7. Perform parallel operation of Alternators.	**P1.** Run the incoming alternator to its rated speed. **P2.** Supply the field current to make the terminal voltage to its rated value. **P3.** Synchronize alternator's frequency and phase angle. **P4.** Check the phase sequence with the help of dark lamp method. **P5.** Check the voltage of bus bar and incoming machine via volt meter. **P6.** Switch on the breaker after completing parallel operation.

Knowledge & Understanding:

K1. How to connect DC source with three phase stator?
K2. How to calculate the resistance of winding by using meter reading.
K3. Which type of losses is found with no load test.
K4. Explain the effect of field current on terminal voltage.
K5. Explain iron loss.
K6. Explain copper loss.
K7. Which type of losses are found with short circuit test.
K8. Explain the effect of rheostat resistance on terminal voltage.
K9. Explain core saturation.
K10. Why the graph between field current and armature voltage is not a straight line.
K11. How to change the RPM of the generator?
K12. Explain the effects of load on alternator speed and frequency.
K13. Explain the conditions of paralleling of alternators.
K14. Explain the connect alternators in parallel.
K15. Explain the working of synchronous scope.
K16. Explain phase sequence.
K17. Explain phase angle.
K18. Explain dark lamp method.

Tools & Equipment:

- Alternator
- Ampere meter
- Voltmeter

- DC source
- Connecting wires
- Alternator
- Tachometer
- Ampere meter
- Voltmeter
- Wattmeter
- DC source
- Connecting wires
- Frequency meter
- Resistive load
- Connecting wires
- Synchronous scope
- Lamps
- Hz meter

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard

- Measure the efficiency of an alternator
- Inspect the pulley and bearing

0714E&A103. Analyse Single Phase Motors.

Overview: This competency standard identifies the competencies required to operate split phase single phase AC motor, operate capacitor start and Capacitor run single phase AC motor and operate shaded pole single phase motor.

Critical Evidence	Performance Criteria
CU1. Operate split phase single phase AC motor.	**P1.** Make the connections according to circuit diagram. **P2.** Apply rated voltage to the stator. **P3.** Measure RPM and direction of rotation. **P4.** Disconnect the auxiliary winding from centrifugal switch. **P5.** Check the effect of this change.
CU2. Operate capacitor start and Capacitor run single phase AC motor.	**P1.** Make connections according to circuit diagram. **P2.** Apply rated voltage to the stator. **P3.** Measure the RPM. **P4.** Remove the starting capacitor with centrifugal switch. **P5.** Measure the RPM again. **P6.** / Analyze / Observe the effect of starting capacitor on motor's torque.
CU3. Operate shaded pole single phase motor.	**P1.** Make connections according to circuit diagram. **P2.** Apply rated voltage to the stator. **P3.** Change the applied voltage to measure the effect on motor's speed.

Knowledge & Understanding

K1. Explain starting winding?

K2. Explain running winding?

K3. How to rotate magnetic field in single phase motor.

K4. Explain the connect capacitor with starting winding.

K5. Explain the effect of capacitor on starting torque.

K6. Explain starting winding.

K7. Explain running winding.

K8. How to rotate magnetic field in single phase motor.

K9. Explain the working of shaded pole motor.

K10. Which type of voltage applied to the stator of shaded pole motor.

Tools & Equipment:

- Single phase induction motor

- ❖ Tachometer
- ❖ Centrifugal switch
- ❖ Connecting wires
- ❖ Single phase induction motor
- ❖ Capacitor
- ❖ Shaded pole motor

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Operate single phase Motor and carry out measurements.

0714E&A104. Analyse Special Purpose Motors.

Overview: This competency standard identifies the competencies required to operate and speed control of AC series motor, operate miniature (reluctance and hysteresis) single phase AC motors, construct and operate stepper motor and construct and operate and develop control circuit with the help of servo motor.

CU1. Operate and speed control of AC series motor.	**P1.**	**Connect the armature and field winding in series.**
	P2.	**Apply rated voltage to the motor.**
	P3.	**Measure and analyze the effect on motor's speed by change in applied voltage.**
CU2. Operate miniature (reluctance and hysteresis) single phase AC motors.	**P1.**	Connect the stator of motor with single phase supply.
	P2.	Apply mechanical load by hand
	P3.	Measure the effect of load change on motor speed.
	P4.	Draw torque speed curves.
CU3. Construct and operate stepper motor.	**P1.**	Connect the stator of the motor with control circuit.
	P2.	Adjust the control voltage of control unit.
	P3.	Measure the RPM.
	P4.	Readjust the control voltage of control unit.
	P5.	Measure the RPM again.
	P6.	Analyze and distinguish the effect of Control voltage and RPM.
CU4. Construct, Operate and develop control circuit of servo motor.	**P1.**	Pair the servo motor with some encoder to provide position and speed feedback.
	P2.	Compare the measured position to external input to the controller.
	P3.	Check the effect of feedback on motor position.

Knowledge & Understanding:

K1. Explain the working of AC series motor.

K2. Explain the effect of applied voltage on speed of the motor.

K3. Explain the working of reluctance motor.

K4. Explain the working of hysteresis motor.

K5. Explain the working of stepper motor.

K6. Explain the working of control unit for stepper motor.

K7. Explain the working of servo motor.

K8. Explain the working of control unit for servo motor.

Tools & Equipment:

- AC series motor
- Tachometer
- Connecting wires
- Reluctance motor
- Hysteresis motor
- Stepper motor
- Control unit
- Servo motor
- Control circuit

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard

- Construct and operate stepper motor

0714E&A105. Analyse Three Phase Motors.

Overview: This competency standard identifies the competencies required to identify and operate 3 phase Squirrel cage motor, verify rotating magnetic field , measure the starting and running current of three phase induction motor, draw torque slip curve of three phase induction motor, determine the slip of 3 phase induction motor by stroboscope, start 3 phase Induction motor with direct on line, start 3 phase Induction motor with Auto transformer starter, start 3 phase Induction motor with Star Delta starter, make connection to reverse the direction of induction motor, determine the efficiency of three phase induction motor, control the speed of three phase induction motor by changing primary voltage, control the speed of three phase induction motor by rotor resistance control method, operate two motors in cascade, start the synchronous motor using external prime mover and identify the effect of field current on three phase synchronous motor.

Critical Evidence	Performance Criteria
CU1. Identify and operate 3 phase Squirrel cage motor.	**P1.** Identify and select three 3 phase squirrel cage motor. **P2.** Make connection as per diagram. **P3.** Connect the supply and interpret the result.
CU2. Verify rotating magnetic field	**P1.** Connect the three terminals of stator winding with each other and with ground. **P2.** Apply three phase supply to the other terminals. **P3.** Place a compass between the stator and note the direction of rotating magnetic field. **P4.** Change the two phases with each other. **P5.** Observe / Note the direction of rotating magnetic field.
CU3. Measure the starting and running current of three phase induction motor.	**P1.** Connect the stator winding in star. **P2.** Connect an ammeter in series with stator. **P3.** Note down the ammeter reading at instant of just starting. **P4.** Note down the reading of ammeter at running condition.
CU4. Draw torque slip curve of three phase induction motor	**P1.** Connect three phase induction motor with electro dynamo meter with Belt. **P2.** Start the motor and run at rated speed **P3.** Measure the RPM. **P4.** Change the torque with electro dynamo meter and note the speed **P5.** Calculate slip with given values of speed. **P6.** Draw graph between slip and torque.

CU5. Determine the slip of three 3 phase induction motor by stroboscope	**P1.** Connect the stator of three phase induction motor in star **P2.** Apply single phase AC supply to the stroboscope. **P3.** Mark dot on motor shaft with marker. **P4.** Apply three phase supply to the motor **P5.** Note the RPM of the motor with the help of stroboscope. **P6.** Calculate slip.
CU6. Start three 3 phase Induction motor with direct on line.	**P1.** Draw line diagram of direct-on three 3-phase motor Starter. **P2.** Identify and select 3 phase Induction motor. **P3.** Make Connection of motor with DOL as per diagram. **P4.** Switch on the 3 phase breaker and interpret the result.
CU7. Start 3 phase Induction motor with Auto transformer starter.	**P1.** Connect power circuit with the help of diagram. **P2.** Connect control circuit with the help of diagram. **P3.** Apply rated voltage to the motor. **P4.** Gradually reduce the taping of auto transformer with the help of control circuit.
CU8. Start 3 phase Induction motor with Star Delta starter.	P1: Draw line diagram of a starter-delta starter. P2: Identify and select 3 phase Induction motor. P3: Make Connection of motor with star –delta- starter as per diagram. P4: Switch / Power on via three 3 phase breaker and interpret the result.
CU9. Make connection to reverse the direction of induction motor.	P1: Draw line diagram to reverse the direction of induction motor P2: Identify and select 3 phase Induction motor. P3: Make Connection of motor through 3 pole 2 way switch as per diagram. P4: Move the handle of 3 Pole 2 Way switch from off position to position 1. P5: Move the handle of 3 Pole 2 Way switch from Position 1 to off position and wait until the motor is stopped P6: Move the handle of 3 Pole 2 way switch from off position to position 2 and interpret the result.
CU10. Determine the efficiency of three phase induction motor	**P1.** Connect wattmeter, ammeter with the stator of three phase induction motor. **P2.** Run the motor at rated speed. **P3.** Measure the reading of wattmeter and voltmeter.

	P4. Stop the motor **P5.** Couple three phase induction motor and electro dynamo meter with belt. **P6.** Run the motor. **P7.** Supply single phase supply to the dynamo meter. **P8.** Adjust the supply of electro dynamo meter so that the maximum current passes through the motor. **P9.** Read the meters reading. **P10.** Calculate the efficiency of the motor by using these reading.
CU11. Control the speed of three phase induction motor by changing primary voltage	**P1.** Connect the stator of the motor in star connection. **P2.** Insert rheostat in series with stator of the motor. **P3.** Set the rheostat resistance to its max value. **P4.** Run the motor **P5.** Change rheostat resistance and note the effect of speed changes.
CU12. Control the speed of three phase induction motor by rotor resistance control method	**P1.** Select wound rotor induction motor. **P2.** Connect the stator of motor in star connection. **P3.** Connect a star connected starter with motor rotor. **P4.** Set rotor resistance to its max value. **P5.** Run the motor. **P6.** Change the rotor resistance and note the effect of speed change.
CU13. Operate two motors in cascade	**P1.** Select two wound rotor induction motor. **P2.** Couple shaft of the both motors. **P3.** Connect the stator of motor 2 with the rotor of motor 1. **P4.** Connect the motor 2 rotor in star connection. **P5.** Apply three phase voltage to the stator of motor 1. **P6.** Control the speed of both motors by changing the rotor resistance of motor 2.
CU14. Start the synchronous motor using external prime mover.	**P1.** Couple the shaft of the synchronous motor with external prime mover (DC Shunt motor) **P2.** Connect the stator winding of synchronous motor in star connection. **P3.** Apply rated voltage to the stator.

	P4. Run the prime mover, which results in locking of rotor with stator magnetic field.
CU15. Identify the effect of field current on three phase synchronous motor.	**P1.** Apply rated voltage to stator. **P2.** Excite the field winding. **P3.** Change the field winding voltage and measure the effect on Armature current. **P4.** Draw the V curve between Armature Current and Field current.

Knowledge & Understanding:

K1. How many types of three phase induction motor with respect to the rotor?
K2. Explain the term rotating magnetic field.
K3. How to change the direction of rotation of motor.
K4. Explain the initially start the motor in star connection.
K5. Why motor take large current at the time of starting.
K6. Explain back EMF.
K7. How to change the mechanical load on motor?
K8. How to measure the speed of DC motor?
K9. Explain motor slip.
K10. Explain the effect of torque on motor slip.
K11. Explain the working of stroboscope.
K12. Explain motor slip.
K13. How to calculate the slip from motor speed.
K14. What in magnetic contactor.
K15. Explain relay.
K16. Explain the working of DOL.
K17. Explain auto transformer.
K18. How to change the taping of auto transformer?
K19. Explain the never start motor without load.
K20. Which type of connection is use at the starting of motor.
K21. Which type of connection is use at the running of motor.
K22. What in magnetic contactor.
K23. Explain different between control circuit and power circuit.
K24. What in magnetic contactor.
K25. How to reverse the direction of motor.
K26. Explain the connection of wattmeter.

K27. Explain the working of electro dynamo meter.

K28. Explain iron loss.

K29. Explain copper loss.

K30. Explain the find copper loss at full load.

K31. Which loss having maximum value and why.

K32. How many techniques are used to control the speed of three phase induction motor.

K33. Explain rheostat.

K34. Explain the effect of voltage changes on speed of motor.

K35. Explain the connect the stator of motor in star.

K36. How to insert the resistance in rotor circuit.

K37. Explain the insert maximum resistance in rotor circuit at the time of starting.

K38. Explain back EMF.

K39. Explain mean by cascade.

K40. Write the name of starting method of synchronous motor.

K41. Why synchronous motor is not self-starting.

K42. Which type of supply voltage is applied to the synchronous motor rotor.

K43. How to change the field excitation of synchronous motor?

K44. Explain over and under excitation.

K45. Explain V curve of synchronous motor.

Tools & Equipment:

- Three phase squirrel cage induction motor
- Connecting wires
- Three phase stator of induction motor
- Compass
- Three phase induction motor
- Electro dynamo meter
- Belt
- Tachometer
- Stroboscope
- Marker
- Tachometer
- DOL starter
- Auto transformer
- Synchronous motor
- DC shunt motor

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard

- Determine phase sequence

0714E&A106. Analyze Dc Generators

Overview: This competency standard identifies the competencies required to calculate different terms used in armature winding of DC machines, develop Single Layer Lap Winding, develop Double Layer Wave Winding, measure the resistance of field winding, armature winding and terminal polarity, identify DC shunt generator, identify DC series generator and identify DC compound generator.

Critical Evidence	Performance Criteria
CU1. Calculate different terms used in armature winding of DC machines	**P1.** Count the number of slots (S) of armature. **P2.** Calculate pole pitch (Y). **P3.** Calculate Coil span / pitch. **P4.** Calculate Back pitch (Y_b) **P5.** Calculate Front pitch (Y_f) **P6.** Calculate Resultant Pitch (Y_R) **P7.** Calculate commutator pitch (Y_c)
CU2. Develop Single Layer Lap Winding	**P1.** Count the number of slot in armature core and numbering on it. **P2.** Calculate total number of conductors (Z) **P3.** Calculate average pitch, back pitch and commutator pitch. **P4.** Start winding from slot no 1. **P5.** Add the value of back pitch in conductor. **P6.** Connect conductor 1 from back side to the added value. **P7.** Subtract the value of back pitch from the added value. **P8.** Connect added value from front side to subtracted value. **P9.** Continue this process till completion of all conductors. **P10.** Connect armature segment with armature conductor. **P11.** Insert brushes in proper position.
CU3. Develop Double Layer Wave Winding	**P1.** Count the number of slot in armature core and numbering on it. **P2.** Calculate total number of conductors (Z) **P3.** Calculate average pitch, back pitch and commutator pitch. **P4.** Start winding from slot no 1. **P5.** Add the value of back pitch in conductor.

	P6. Connect conductor 1 from back side to the added value. **P7.** Add the value of front pitch in previous added value. **P8.** Continue this process till completion of all conductors. **P9.** Connect armature segment with armature conductor. **P10.** Insert brushes in proper position.
CU4. Measure the resistance of field winding, armature winding and terminal polarity	**P1.** Open the terminal box. **P2.** Connect the ohm meter with the terminal of both winding. **P3.** Read down ohm meter reading. **P4.** Connect the probe of galvanometer with any terminal and touch other probe to other terminals one by one. **P5.** Rotate the generator slowly by hand. **P6.** Touch the probe of galvanometer with each winding. **P7.** Identify armature with the deflection of galvanometer pointer. **P8.** Mark the polarity of terminals with the deflection of galvanometer.
CU5. Identify DC shunt generator	**P1.** Measure the terminal resistance of generator with ohm meter. **P2.** Identify DC shunt generator from measured value of resistance. **P3.** Disconnect both windings. **P4.** Identify the shunt field winding of shunt generator. **P5.** Identify armature of shunt generator. **P6.** Measure the resistance of both winding separately. **P7.** Record the resistance of armature winding and field winding. **P8.** Compare the resistance of armature winding and field winding to identify the difference between them.
CU6. Identify DC series generator	**P1.** Measure the terminal resistance of generator with ohm meter. **P2.** Identify DC series generator from measured value of resistance. **P3.** Disconnect both windings. **P4.** Identify the series field winding of series generator. **P5.** Identify armature of series generator. **P6.** Measure the resistance of both winding separately. **P7.** Record the resistance of armature winding and field winding. **P8.** Compare the resistance of armature winding and field winding to identify the difference between them.

CU7. Identify DC compound generator	**P1.** Measure the terminal resistance of generator with ohm meter. **P2.** Identify DC Compound generator from measured value of resistance. **P3.** Disconnect both windings. **P4.** Identify the series field winding of generator. **P5.** Identify the shunt field winding of generator. **P6.** Identify armature of shunt generator. **P7.** Measure and record the resistance of both winding separately. **P8.** Measure and Record the resistance of armature winding. **P9.** Compare the resistance of armature winding, series field winding and shunt field winding to identify the difference between them.

Knowledge & Understanding:

K1. Explain the term armature slots.
K2. Explain pole pitch (Y).
K3. Explain coil span/pitch.
K4. Explain Back pitch (Yb)
K5. Explain Front pitch (Yf)
K6. Explain Resultant Pitch (YR)
K7. Explain commutator pitch (Yc)
K8. Explain lap winding.
K9. How many parallel paths in lap winding?
K10. Explain mean by single layer winding.
K11. Explain wave winding.
K12. How many parallel paths in wave winding.
K13. Explain mean by double layer winding.
K14. How to read the scale of galvanometer?
K15. Explain difference between field winding and armature winding?
K16. Which winding having low resistance and why?
K17. Explain the technique to identify the terminal polarity.
K18. How many winding in shunt generator?
K19. Explain different between field winding and armature winding.
K20. Which winding having low resistance and why.
K21. Explain the technique to identify the terminal polarity.
K22. How to disconnect both winding of shunt generator.

K23. How many winding in series generator?

K24. Explain different between field winding and armature winding.

K25. Which winding having low resistance and why.

K26. Explain the technique to identify the terminal polarity.

K27. How to disconnect both winding of series generator.

K28. Which conduction you follow at the time of reconnection of both winding.

K29. Study of faraday's law

K30. study of Motors and generators

K31. study of rules of generators

K32. Define the Type of DC machines

K33. Explain the principle of simple loop generator.

Tools & Equipment:

- Stator frame
- Armature
- Winding machine
- Carbon brushes
- Insolating paper
- Sleeve
- Soldering iron
- Soldering wire
- DC machine
- Galvanometer
- Ohm meter
- Connecting wires
- DC machine
- Galvanometer
- Ohm meter
- Connecting wires
- DC machine
- Galvanometer

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard

- Identify DC Generator Type
- Measure the resistance of field winding, armature winding and terminal polarity

0714E&A107. Perform Tests on DC Generators

Overview This competency standard identifies the competencies required to Plot the Open circuit characteristics of a Separately excited D.C generator, plot the Open circuit characteristics of a D.C shunt generator, plot the load characteristics of D.C shunt generator, plot the load characteristics of D.C series generator, plot the load characteristics of D.C compound generator for under, flat and over compounding, perform parallel operation of two DC shunt generators and determine copper, iron & friction losses of shunt generator by actual loading.

Critical Evidence	Performance Criteria
CU1. Plot the Open circuit characteristics of a Separately excited D.C generator	**P1.** Connect DC supply to field coil through rheostat and ampere meter. **P2.** Rotate armature at constant speed. **P3.** Connect voltmeter across armature terminal. **P4.** Decrease the resistance of rheostat in steps and measure and record the relevant output voltage of armature and field current. **P5.** Repeat the P2 to P4 till voltage of armature reach at its saturation point. **P6.** Plot the graph between field current and armature voltage from the recorded values.
CU2. Plot the Open circuit characteristics of a D.C shunt generator	**P1.** Connect DC supply to field coil through rheostat and ampere meter. **P2.** Rotate armature at constant speed. **P3.** Connect voltmeter across armature terminal. **P4.** Decrease the resistance of rheostat in steps and measure and record the relevant output voltage of armature and field current. **P5.** Repeat the P2 to P4 till voltage of armature reach at its saturation point. **P6.** Plot the graph between field current and armature voltage from the recorded values.
CU3. Plot the load characteristics of D.C shunt generator.	**P1.** Select DC shunt generator and connect variable load. **P2.** Connect ampere meter and voltmeter across the load. **P3.** Rotate armature at constant speed and note the readings of ampere meter and voltmeter.

	P4. Increase the load in steps till specific reduce in terminal voltage observed. **P5.** Plot the graph between load current and terminal voltage from the recorded values.
CU4. Plot the load characteristics of D.C series generator.	**P1.** Select DC series generator and connect variable load. **P2.** Connect ampere meter and voltmeter across the load. **P3.** Rotate armature at constant speed and note the readings of ampere meter and voltmeter. **P4.** Increase the load in steps unless specific reduction in terminal voltage will observed. **P5.** Plot the graph between load current and terminal voltage from the recorded values.
CU5. Plot the load characteristics of D.C compound generator for under, flat and over compounding	**P1.** Select DC compound generator and connect variable load. Correct as the previous **P2.** Connect ampere meter and voltmeter across the load. **P3.** Rotate armature at constant speed and note the readings of ampere meter and voltmeter. **P4.** Adjust field diverter on zero ohm. **P5.** Increase the load in steps till specific reduce in terminal voltage observed. **P6.** Plot the graph between load current and terminal voltage from the recorded values. **P7.** Such off the load. **P8.** Adjust the field diverter at such position that the terminal voltages are equal to no load voltages. **P9.** Increase the load in steps till specific reduce in terminal voltage observed. **P10.** Plot the graph between load current and terminal voltage from the recorded values. **P11.** Such off the load. **P12.** Adjust the field diverter at such position that the terminal voltages are greater than no load voltages. **P13.** Increase the load in steps till specific reduce in terminal voltage observed. **P14.** Plot the graph between load current and terminal

	voltage from the recorded values.
CU6. Perform parallel operation of two DC shunt generators.	**P1.** Connect the circuit according to the circuit diagram. **P2.** Place all switches in off position. **P3.** Run generator 1 at rated speed. **P4.** Reduce field resistance of generator 1 **P5.** Connect generator with bus bar after attaining rated voltage. **P6.** Run generator 2 with prime mover. **P7.** Reduce the field resistance of generator 2 to attain its rated voltage. **P8.** Close the switches for parallel operation. **P9.** Calculate and record the reading of voltage and current on different loads.
CU7. Determine copper, iron & friction losses of shunt generator by actual loading.	**P1.** Connect ammeter in series with both winding. **P2.** Connect voltmeter in parallel with both winding. **P3.** Apply 10-20 DC volt. **P4.** Record the readings of voltmeter and ammeter. **P5.** Calculate R_a and R_{sh}. **P6.** Run the generator at rated speed with prime mover. **P7.** Turn on the load switch and record the meter reading. **P8.** Calculate input power and output power. **P9.** Calculate total losses (Copper loss, Friction loss, Iron loss)

Knowledge & Understanding:

K1. Explain different between shunt and separately excited generator.

K2. Explain rheostat.

K3. How to use rheostat with field winding?

K4. Explain the effect of rheostat resistance on terminal voltage.

K5. Explain core saturation.

K6. Why the graph between field current and armature voltage is not a straight line.

K7. Explain different between shunt and separately excited generator.

K8. Why the graph between field current and armature voltage is not a straight line.

K9. Explain armature reaction.

K10. Explain the reason of voltage reduce due to increase in load.

K11. How to compensate armature reaction?

K12. How to connect field and armature winding?

K13. How to connect field and armature winding in compound generator?

K14. Explain under compounding.

K15. Explain flat compounding.

K16. Explain over compounding.

K17. Explain the conditions of paralleling of DC generators.

K18. How to connect field and armature winding in shunt generator?

K19. Explain the connect DC generators in parallel.

K20. Explain iron loss.

K21. Explain copper loss.

K22. Explain the find copper loss at full load.

K23. Which loss having maximum value and why.

K24. Determine the condition of maximum efficiency of DC machine

Tools & Equipment:

- Connecting wires
- DC generators
- Ampere meters
- Voltmeters
- Tachometer
- Rheostats
- Switches

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard

0714E&A108. Analyze Dc Motors.

Overview This competency standard identifies the competencies required to identify DC shunt motor, identify DC series motor and identify DC compound motor.

Critical Evidence	Performance Criteria
CU1. Identify DC shunt motor	**P1.** Measure the terminal resistance of motors with ohm meter. **P2.** Identify DC shunt motor from measured value of resistance. **P3.** Disconnect both windings. **P4.** Identify field winding of shunt motor. **P5.** Identify armature of shunt motor. **P6.** Measure the resistance of both winding separately. **P7.** Record the resistance of armature winding and field winding. **P8.** Compare the resistance of armature winding and field winding to identify the difference between them.
CU2. Identify DC series motor	**P1.** Measure the terminal resistance of DC motors with ohm meter. **P2.** Identify DC series motor from measured value of resistance. **P3.** Disconnect both windings. **P4.** Identify the series field winding of series motor. **P5.** Identify armature of series motor. **P6.** Measure the resistance of both winding separately. **P7.** Record the resistance of armature winding and field winding. **P8.** Compare the resistance of armature winding and field winding to identify the difference between them.
CU3. Identify DC compound motor	**P1.** Measure the terminal resistance of DC motor with ohm meter. **P2.** Identify DC Compound motor from measured value of resistance. **P3.** Disconnect both windings. **P4.** Identify the series field winding of motor. **P5.** Identify the shunt field winding of motor. **P6.** Identify armature of compound motor. **P7.** Measure and record the resistance of both winding separately. **P8.** Record the resistance of armature winding. **P9.** Compare the resistance of armature winding, series field

	winding and shunt field winding to identify the difference between them.

Knowledge & Understanding:

K1. How many winding in shunt motor?
K2. Explain different between field winding and armature winding.
K3. Which winding having low resistance and why.
K4. Explain the technique to identify the terminal polarity.
K5. How to disconnect both winding of shunt motor.
K6. How many winding in series motor?
K7. Explain different between field winding and armature winding.
K8. Which winding having low resistance and why.
K9. Explain the technique to identify the terminal polarity.
K10. How to disconnect both winding of series generator.
K11. Which conduction you follow at the time of reconnection of both winding.
K12. Study of faraday's law.
K13. Study of Motors and generators
K14. Study of rules of generators
K15. Define the Type of DC machines
K16. Explain the principle of simple loop generator.
K17. Define Basic DC Systems.
K18. Describe types of DC Generators.

Tools & Equipment:

- DC shunt motor
- Ohm meter
- Connecting wires
- DC series motor
- Connecting wires
- DC compound motor

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard

- Identify DC Motor Type

0714E&A109. Perform Tests On DC Motors.

Overview This competency standard identifies the competencies required to Plot the load characteristics of D.C shunt motor, plot the load characteristics of D.C series motor, plot the load characteristics of D.C compound motor, control the speed of DC series motor, control the speed of DC shunt motor, start DC shunt motor with 3 point starter, identify the effect of back EMF in DC motor, calculate BHP of motor by Brake test, calculate efficiency of the motor by Swinburne Test and perform Regenerative / Hopkinson/ Back to back Test.

Critical Evidence	Performance Criteria
CU1. Plot the load characteristics of D.C shunt motor	**P1.** Couple electro dynamo meter to the DC motor with belt **P2.** Connect shunt motor according to the diagram. **P3.** Set the dynamo meter control knob in such position to produce a minimum starting load. **P4.** Turn on the power supply **P5.** Run the motor at rated RPM. **P6.** Apply a load to DC motor by varying the dynamo meter's control knob. **P7.** Measure and calculate the current, speed and torque. **P8.** Plot the load characteristics for the DC shunt motor..
CU2. Plot the load characteristics of D.C series motor.	**P1.** Select DC series motor and achieve connection as per diagram. **P2.** Turn on DC power supply and increase the load to full value. **P3.** Record the value of speed and current on each load. **P4.** Draw the graph between load current and speed
CU3. Plot the load characteristics of D.C compound motor*	**P1.** Couple electro dynamo meter to the DC motor with belt **P2.** Connect compound motor according to the diagram. **P3.** Set the dynamo meter control knob in such position to produce a minimum starting load. **P4.** Turn on the power supply **P5.** Run the motor at rated RPM. **P6.** Apply a load to DC motor by varying the dynamo meter control knob. **P7.** Measure and calculate the current, speed and torque. **P8.** Plot the load characteristics on DC compound motor..

CU4. Control the speed of DC series motor.	**P1.** Make the connection as per circuit diagram. **P2.** Insert external resistances in series to armature and field coil. **P3.** Switch on the supply and increase the voltage gradually to its rated voltage. **P4.** Record speed at different supply voltages. **P5.** Make graph between speed and applied voltage.
CU5. Control the speed of DC shunt motor.	**P1.** Make the connection as per circuit diagram. **P2.** Switch on the supply and increase the voltage gradually to its rated voltage. **P3.** Record speed at different field current. **P4.** Make graph between speed and field current **P5.** Fixed the field current and very armature current **P6.** Record the speed at different armature current. **P7.** Make graph between speed and armature current
CU6. Start DC shunt motor with 3 point starter.	**P1.** Make the connection as per circuit diagram. **P2.** Switch on the supply and move starter handle from off position to position 1. **P3.** Move the starter arm from position 1 to position 2 and continue this process till starter arm reach at its extreme position.
CU7. Identify the effect of back EMF in DC motor.	**P1.** Select DC series motor and make connection as per diagram. **P2.** Turn on DC power supply and increase the load 0 to full value. **P3.** Record the value of speed and current on each load. **P4.** Calculate back EMF by using the recoded values and appropriate formula. **P5.** Make graph between speed and back EMF and interpret the result.
CU8. Calculate Brake Horse Power (BHP) of motor by Brake test.	**P1.** Connect the spring balance with one end of the rope. **P2.** Connect other end of rope with weight (W1). **P3.** Measure the radius of the pulley. **P4.** Hang the weight on the pulley of the motor and fix the spring balance end with earth.

	P5. Run the motor. **P6.** Measured the RPM of the motor. **P7.** Adjust the weight to pass full load current from motor. **P8.** Calculate spring balance weight and hanged weight (W1) **P9.** Calculate shaft torque. **P10.** Calculate BHP of motor by shaft torque.
CU9. Calculate efficiency of the motor by Swinburne Test	**P1.** Perform DC test to find the value armature resistance and field resistance **P2.** Run the motor at rated voltage without load. **P3.** Adjust the value of shunt regulator to attain rated speed. **P4.** Measure the Field and no load current via ampere meter. **P5.** Calculate total copper losses and iron losses. **P6.** Calculate input and output power. **P7.** Calculate efficiency from calculated power.
CU10. Perform Regenerative / Hopkinson/ Back to back Test	**P1.** Identify two shunt machines. **P2.** Couple the shafts of both machines. **P3.** Connect the machines electrically in such a way that one machine work as a motor and other as a generator. **P4.** Connect external power supply to the machines to overcome the machine losses. **P5.** Run both the machines at no load. **P6.** Reduce the field excitation of one machine which work as a motor. **P7.** Increase the field excitation of one machine which work as a generator. **P8.** Adjust the field winding in a way that voltage of generator becomes equal to the applied voltage which result the machines runs in parallel **P9.** Calculate the efficiency by using voltmeter and ammeter.

Knowledge & Understanding:

K1. How many winding in compound generator?
K2. Explain different between field winding and armature winding.
K3. Which winding having low resistance and why.
K4. Explain the technique to identify the terminal polarity.
K5. How to disconnect both winding of series generator.
K6. Which conduction you follow at the time of reconnection of both field windings.
K7. Why series winding having low turns.
K8. Explain the effect of field current on motor speed.
K9. Explain the effect of load on motor speed.
K10. Explain thenever start DC series motor without load.
K11. Why series winding having low turns and shunt winding having high number of turns.
K12. Explain the different between shunt, series and compound motor load characteristics.
K13. Explain speed control of DC motor with applied voltage.
K14. Explain the control the speed of DC motor.
K15. How many techniques to control the speed of DC shunt motor.
K16. Explain the effect of field current changes on motor speed.
K17. Explain 3-point starter.
K18. Explain thenever start DC shunt motor without starter.
K19. Explain back EMF.
K20. Explain generator action in motor.
K21. Explain the effect of motor speed on back EMF.
K22. How to measure the RPM of the motor?
K23. Explain shaft torque.
K24. How to calculate BHP from shaft torque?
K25. Explain iron loss.
K26. Explain copper loss.
K27. Explain the find copper loss at full load.
K28. Which loss having maximum value and why.
K29. Explain the connect external source with motor generator set.
K30. Explain mean by field excitation.
K31. Explain the term efficiency.

Tools & Equipment:

- DC shunt motor
- Electro dynamo meter
- Belt
- Ohm meter

- Tachometer
- Ammeter
- Connecting wires
- DC series motor
- DC compound motor
- Resistor
- Voltmeter
- Rope

Critical Evidence(s) Required

- Perform Brake Test
- Perform Swinburne Test
- Perform back to back Test

Digital Electronics

0714E&A110. Verify Truth Tables of Digital Gates

Overview: This competency standard covers the skills and knowledge required to Verify the truth table of AND gate, Verify the truth table of OR gate, Verify the truth table of NOT gate, Verify the truth table of NAND gate, Verify the truth table of NOR gate, Verify the truth table of XOR gate and Verify the truth table of XNOR gate Verify the truth table of AND gate, OR gate, NOT gate, NAND gate, NOR gate, XOR gate and XNOR gate.

Critical Evidence	Performance Criteria
CU1. Verify the truth table of AND gate	**P1.** Identify the symbol of logic gate, IC & logic function. **P2.** Place (AND gate IC) on bread board. **P3.** Identify the input, output, Vcc and ground pin. **P4.** Connect LED to the output pin of IC and apply different logics ant input pins. **P5.** Record & verify the output result against each given input.
CU2. Verify the truth table of OR gate	**P1.** Identify the symbol of logic gate, IC & logic function. **P2.** Place (OR gate IC) on bread board. **P3.** Identify the input, output, Vcc and ground pin. **P4.** Connect LED to the output pin of IC and apply different logics ant input pins. **P5.** Record & verify the output result against each given input.
CU3. Verify the truth table of NOT gate	**P1.** Identify the symbol of logic gate, IC & logic function. **P2.** Place (NOT gate IC) on bread board.

	P3. Identify the input, output, Vcc and ground pin. **P4.** Connect LED to the output pin of IC and apply different logics ant input pins. **P5.** Record & verify the output result against each given input.
CU4. Verify the truth table of NAND gate	**P1.** Identify the symbol of logic gate, IC & logic function. **P2.** Place (NAND gate IC) on bread board. **P3.** Identify the input, output, Vcc and ground pin. **P4.** Connect LED to the output pin of IC and apply different logics ant input pins. **P5.** Record & verify the output result against each given input.
CU5. Verify the truth table of NOR gate	**P1.** Identify the symbol of logic gate, IC & logic function. **P2.** Place (NOR gate IC) on bread board. **P3.** Identify the input, output, Vcc and ground pin. **P4.** Connect LED to the output pin of IC and apply different logics ant input pins. **P5.** Record & verify the output result against each given input.
CU6. Verify the truth table of XOR gate	**P1.** Identify the symbol of logic gate, IC & logic function. **P2.** Place (XOR gate IC) on bread board. **P3.** Identify the input, output, Vcc and ground pin. **P4.** Connect LED to the output pin of IC and apply different logics ant input pins. **P5.** Record & verify the output result against each given input.
CU7. Verify the truth table of XNOR gate	**P1.** Identify the symbol of logic gate, IC & logic function. **P2.** Place (NOR gate IC) on bread board. **P3.** Identify the input, output, Vcc and ground pin. **P4.** Connect LED to the output pin of IC and apply different logics ant input pins. **P5.** Record & verify the output result against each given input.

Knowledge & Understanding:

K1. Study logic gates Logic gates. AND, OR, NAND, NOR, NOT, XOR and XNOR.

K2. Study the Boolean expression of AND, OR, NAND, NOR, NOT, XOR and XNOR, gate and its equivalent electrical circuit

Tools & Equipment:

- Define Universal gate and enlist its types.
- AND gate (7408 2-input Quad)
- OR gate (7432 2-input Quad)
- NOT gate (7404 Hex)
- NAND gate (7400 2-input Quad)
- NOR gate (7402 2-input Quad)
- X-OR gate (7486 2-input Quad)
- X-NOR gate (74266 2-input Quad)
- Bread board
- LED
- DC supply (5 V)
- Connecting leads

Critical Evidence(s) Required

The candidates need to produce following **Critical Evidence**(s) in order to be competent in this competency standard

- Construct logic gate circuit.

0714E&A111. Construct & Verify Combinational Logic Circuit

Overview: This competency standard covers the skills and knowledge required to **.** Apply Karnaugh mapping & Boolean algebra to simplify logic expressions, Construct & verify the truth table of Half adder, Construct & verify the truth table of Full adder, Construct & verify the truth table of Half Subtraction, Operate seven segment display with seven segment decoder, Construct & verify the truth table of Full Subtraction, Verify Encoder, Verify Encoder and Verify multiplexer and DE- multiplexer Construct & verify the truth table of Half adder, full adder and Half Subtraction.

Critical Evidence	Performance Criteria
CU1. Apply Karnaugh mapping & Boolean algebra to simplify logic expressions	**P1.** Identify the SOP & POS **P2.** Apply Boolean algebra & Karnaugh mapping to simplify SOP & POS. **P3.** Construct logic circuits with simplified SOP & POS.
CU2. Construct & verify the truth table of Half adder	**P1.** Place (AND gate IC) & (XOR gate IC) on bread board. **P2.** Identify the input, output, Vcc and ground pin. **P3.** Connect LED to the output pin of IC and apply different logics at input pins. **P4.** Record & verify the output result against each given input **P5.** Design, Construct, and test a half-adder circuit using one XOR gate and two NAND gates.
CU3. Construct & verify the truth table of Full adder	**P1.** Place (AND gate IC) & (XOR gate IC) on bread board. **P2.** Identify the input, output, Vcc and ground pin. **P3.** Connect LED to the output pin of IC and apply different logics at input pins. **P4.** Record & verify the output result against each given input **P5.** Design, Construct, and test a full-adder circuit using two ICS 7486 and & 7400.

CU4. Construct & verify the truth table of Half Subtraction	**P1.** Place (AND, NOT&XOR gate IC) on bread board. **P2.** Identify the input, output, Vcc and ground pin. **P3.** Connect LED to the output pin of IC and apply different logics at input pins. **P4.** Record & verify the output result against each given input
CU5. Construct & verify the truth table of Full Subtraction	**P1.** Place (AND, NOT&XOR gate IC) on bread board. **P2.** Identify the input, output, Vcc and ground pin. **P3.** Connect LED to the output pin of IC and apply different logics at input pins. **P4.** Record & verify the output result against each given input.
CU6. Verify Decoder	**P1.** Place (Decoder IC) on bread board. **P2.** Identify the input, output, Vcc and ground pin. **P3.** Connect LED to the output pin of IC and apply different logics at input pins. **P4.** Record & verify the output result against each given input.
CU7. Operate seven segment display with seven segment decoder.	**P1.** Insert (7 segment decoder IC) and 7 segment display on bread board. **P2.** Identify the input, output, Vcc and ground pin. **P3.** Connect segment display with seven segment decoder input output pins. **P4.** Record & verify the output result against each given input.
CU8. Verify Encoder	**P5.** Place (Encoder IC) on bread board. **P6.** Identify the input, output, Vcc and ground pin. **P7.** Connect LED to the output pin of IC and apply different logics at input pins. **P8.** Record & verify the output result against each given input.
CU9. Verify multiplexer and DE-multiplexer	**P9.** Implement following function with multiplexer F(ABC)=∑ (0,2,3,4,5,6): **P10.** Implement 4-to-1 mux and one 2-to-1 mux.

P11. Implement 1-to-4 dmux using 1-to-2 dmux.

Knowledge & Understanding:

K1. Describe the laws and rules of Boolean algebra.

K2. Understanding of commutative. • and distributive expiration. That is, A • (B + C) = (A • B) + (A • C) and A + (B • C) = (A + B) • (A + C).

K3. Study the combinational logic circuit. (Half adder, Full adder, Half subtraction, Full subtraction, Binary Multiplier, Magnitude Comparator)

K4. Study the Product-of-Sums& SOP Simplification

K5. Knowledge of Don't-Care Conditions

K6. Understanding of Karnaugh Map of four Variables.

K7. Understanding of Decoders & Encoders& Multiplexers.

K8. Knowledge of Pin configuration of iCs

K9. Knowledge of7 segment display.

K10. Explain pin 7 segment display and common cathode 7 segment display.

K11. Define limiting resistor.

K12. Understanding how to implement functions using multiplexers.

K13. To study DE multiplexer

Tools & Equipment:

- X-OR gate (7486 2-input Quad)
- AND gate (7408 2-input Quad)
- OR gate (7432 2-input Quad)
- NOT gate (7404 Hex not gate)
- Bread board
- LED
- DC supply (5 V)
- Connecting leads
- 74LS139 IC
- 74LS47 IC
- Seven segment display
- Resistances (1K ohm)
- Mux KL-33006 block e
- Mux KL-33006 block f

Critical Evidence(s) Required

The candidates need to produce following **Critical Evidence**(s) in order to be competent in this competency standard.

- Verification of Boolean expression with help of logic gates and circuits.
- Construct adder & subtraction.

0714E&A112. Construct and Verify Function of Flip Flops

Overview: This competency standard covers the skill and knowledge required to Construct and verify the truth table of RS latch using NAND gate, Construct and verify the truth table of clocked RS latch using NAND gate, verify function of D flip flop, verify function of JK/T flip flop construct and verify the truth table of RS latch using NAND gate, clocked RS latch using NAND gate, D flip flop and JK flip flop.

Critical Evidence	Performance Criteria
CU1. Construct and verify the truth table of RS latch using NAND gate	**P1.** Place the NAND gate IC on bread board. **P2.** Identify the input, output, Vcc and ground pin. **P3.** Connect LEDs to the outputs pins. **P4.** Apply various logic inputs to Record & verify the output result against each given input.
CU2. Construct and verify the truth table of clocked RS latch using NAND gate	**P1.** Place the NAND gate IC) on bread board. **P2.** Identify the input, output, Vcc and ground pin. **P3.** Connect LEDs to outputs pins. **P4.** Apply various logic inputs to Record & verify the output result against each given input.
CU3. Verify function of D flip flop.	**P1.** Insert the D flip flop IC on bread board. **P2.** Identify the input, output, Vcc and ground pin. **P3.** Connect LEDs\ Scope to the outputs pins. **P4.** Apply various logic inputs to Record & verify the output result against each given input.
CU4. Verify function of JK/T flip flop	**P1.** Insert 74112 (JK flip flop) IC on bread board. **P2.** Identify the input, output, Vcc and ground pin. **P3.** Connect LEDs\ Scope to outputs pins. **P4.** Apply various logic inputs to Record & verify the output result against each given input.

Knowledge & Understanding:

- **K1.** Define Latch
- **K2.** How many inputs are given to SR Latch?
- **K3.** Which IC is used for NAND and NOR gate?
- **K4.** Explain clocked RS flip flop.
- **K5.** Explain difference between Latch and flip flop.
- **K6.** Symbols for Combinational Elements (Symbols for Flip-Flops.)

K7. Define D flip flop.

K8. Define clock pulse.

K9. Explain difference between synchronous & asynchronous input.

K10. Define JK/T flip flop.

K11. Draw the symbol of JK flip flop

K12. Which IC is used for JK flip flop?

Tools & Equipment:

- NOR gate (7402 IC)
- NAND gate (7400 IC)
- Digital clock
- Bread board
- LED
- DC supply (5 V)
- Connecting leads
- D Type Flip Flop (7474 Dual IC)

Critical Evidence(s) Required

The candidates need to produce following **Critical Evidence**(s) in order to be competent in this competency standard.

- Construction of JK Flip Flop with help of logic gate circuits.
- Construction of D Flip Flop with help of logic gate circuits.

0714E&A113. Construct Multivibrator with 555 IC

Overview: This competency standard covers the skills and knowledge required to. Construct 555 IC as Actable Multivibrator, Construct 555 IC as Mono-stable Multivibrator, Construct 555 IC as Bi-stable Multivibrator and verify its set and reset conduction. Construct 555 IC as A-stable, mono-stable &bi-stable Multivibrator and observe their outputs.

Critical Evidence	Performance Criteria
CU1. Construct 555 IC as Actable Multivibrator	**P1.** Draw circuit diagram for Actable Multivibrator **P2.** Place 555 IC on bread board / trainer **P3.** Make connection as per diagram. **P4.** Apply voltage to circuit. **P5.** Recode the output signal wave shape from oscilloscope.
CU2. Construct 555 IC as Mono-stable Multivibrator	**P1.** Draw circuit diagram for Mono-stable Multivibrator **P2.** Place 555 IC on bread board/trainer. **P3.** Make connection as per diagram. **P4.** Apply voltage to circuit and give triggering pulse at input pin. **P5.** Recode the output signal wave shape from oscilloscope.
CU3. Construct 555 IC as Bi-stable Multivibrator and verify its set and reset conduction	**P1.** Draw circuit diagram for Bi-stable Multivibrator **P2.** Place 555 IC on bread board/trainer. **P3.** Make connection as per diagram. **P4.** Apply voltage to circuit and give triggering pulse at input pin. **P5.** Recode the output signal wave shape from oscilloscope.

Knowledge & Understanding:

- Describe basic elements of 555 timer IC.
- Name pins of 555 timer IC.
- Explain function of voltage control input.
- Explain A stable Multivibrator.
- Explain mono-stable Multivibrator.
- Explain bi-stable Multivibrator.

Tools & Equipment:

- 555 Timer IC

- Dual trace Oscilloscope 0-20MHZ
- Resistors 10 KΩ
- Capacitor 0.1µF
- Capacitor 0.01µF
- Bread board
- DC supply (5 V)
- Connecting leads

Critical Evidence(s) Required

The candidates need to produce following **Critical Evidence**(s) in order to be competent in this competency standard.

- Construct of A-stable circuit.
- Construct a Mono-stable circuit.
- Construct a Bi-stable.

0714E&A114. Construct Shift Registers and Counters with the Help of Flip Flops

Overview: This competency standard covers the skills and knowledge required to Construct a 4-bit shift register by Using Flip Flops, Construct a 4-bit binary counter Using Flip Flops, Construct 4-bit synchronous Counter with D flip-Flops and Repair & Troubleshoot combinational logic circuits

Critical Evidence	Performance Criteria
CU1. Construct a 4 bit shift register by Using Flip Flops	**P1.** Draw circuit diagram 4-bit register. **P2.** Make connection of D-Flip Flop as per diagram to construct 4-bit shift register. **P3.** Apply data at the input of register and give clock pulse **P4.** Recode the output according to the input.
CU2. Construct a4-bit binary counter Using Flip Flops	**P1.** Draw circuit diagram counter. **P2.** Make connection of JK-Flip Flop as per diagram to construct 4-bit binary counter. **P3.** Connect LEDs to the outputs pins. **P4.** Apply the clock pulse and record the output.
CU3. Construct 4-bitsynchronous Counter with D flip-Flops	**P1**. Draw circuit diagram synchronous counter. **P2**. Make connection of JK-Flip Flop as per diagram to construct 4-bit synchronous counter. **P3**. Connect LEDs to the output pins. **P4**. Apply the clock pulse and record the output.
CU4. Repair & Troubleshoot combinational logic circuits	**P1.** Identify principles and operations of types of logic gates **P2.** Locate drawing and diagrams. **P3.** Check the grounding system in electronic equipment. **P4.** Locate external and internal digital IC faults

Knowledge & Understanding:

- **K1.** Symbols for Combinational Elements (Symbols for Registers, Counters, RAM.)
- **K2.** Understand the function of registers, and counters in digital circuits
- **K3.** Knowledge of basic computer memories and its types.
- **K4.** Explain precautions when handling components.
- **K5.** Demonstrate proper use of ESD equipment.
- **K6.** Explain how to distinguish hardware from software issues
- **K7.** Show how pulsars are used for digital signal tracing and how logic probes are used to verify states in digital equipment.
- **K8.** Software Simulator and IDE's.

Tools & Equipment:

- DLD trainer
- IC's and Components
- Multimeter
- Logic tester

Critical Evidence(s) Required

The candidates need to produce following **Critical Evidence**(s) in order to be competent in this competency standard.

- Construct shift register.
- Construct binary counter.

Sensors and Actuators

0714E&A115. Test Sensors and Transducers

Overview: This competency standard covers the skills and knowledge required to Identify Various types of Sensors, Identify Various types of Transducers, Identify Mode of Various Sensors and Transducers, Operate Oscilloscope for testing sensors and transducers, Test sensor / transducer with Oscilloscope, Test Temperature Sensor and Test the IR sensor

Critical Evidence	Performance Criteria
CU1. Identify Various types of Sensors	P1. Identify temperature sensors. P2. Identify sound sensors. P3. Identify proximity sensors. P4. Identify pressure sensors. P5. Identify light sensors. P6. Identify position sensors. P7. Identify voltage sensors. P8. Identify current sensors. P9. Identify the vision sensors. P11. Identigy infrared (IR) sensors. P12. Identify power requirement for each sensor.shift down in last
CU2. Identify Various types of Transducers	P1. Identify Temperature transducers P2. Identify Displacement transducers P3. Identify Motion transducers (Speed, Velocity, Acceleration)

	P4. Identify Force/ Torque transducer P5. Identify Strain transducer P6. Identify Vibration transducer P7. Identify Sound transducer P8. Identify Flow rate transducer P9. Identify Flow transducer P10. Identify Level transducer P11. Identify Pressure transducer P12. Identify Light transducer P13. Identify Humidity transducer P14. Identify Power requirement for each transducer
CU3. Identify Mode of Various Sensors and Transducers	P1. Identify energy mode (Active / Passive) P2. Identify Signal mode (Analog /Digital) P3. Identify contact / non-contact mode P4. Identify Null / deflection mode
CU4. Operate Oscilloscope for testing sensors and transducers	P1. Identify components of oscilloscope, i.e. Display, power supply, etc P2. Identify Basic controls and functions of oscilloscope P3. Measure voltage and frequency of signal. P4. Identify signals in oscilloscope P5. Measure time dependent electrical signals from sensors and transducers.
CU5. Test sensor / transducer with Oscilloscope	P1. Identify the pins (Power, Signal) of sensor/transducer P2. Apply required Power to transducer/sensor power pins. P3. Connect signal pin with oscilloscope. P4. Write down the obtained data. P5. Compare the data with transducer/sensor datasheet.
CU6. Test Temperature Sensor	P1. Open Arduino IDE. P2. Connect the Arduino board to PC using USB cable. P3. Program the Arduino board with given code P4. Connect the LM35 sensor to output pin of Arduino P5. Power ON the oscilloscope P6. Connect the Channel 1 probe of the oscilloscope to output pin of Arduino P7. Acquire the signal(s) from circuit on oscilloscope Measure the

	RMS voltage at different temperatures (25, 26, 27, 28, 29, 30, 31, 32). P8. Tabulate the Temperature versus measured RMS voltage. P9. Plot to verify linear relationship between Temperature and RMS voltage.
CU7. Test the IR sensor	P1. Open Arduino IDE. P2. Connect the Arduino board to PC using USB cable. P3. Program the Arduino board with given code P4. Connect the IR sensor to output pin of Arduino P5. Power ON the oscilloscope P5. Connect the Channel 1 probe of the oscilloscope to output pin of Arduino P6. Acquire the signal(s) from circuit on oscilloscope P7. Keep a white body at a distance of 5 cm from the sensor. P8 Keep moving the object away from the sensor by 1cm and note the MAXIMUM measured voltage P9. Vary the distance between object and IR sensor (5 to 40 cms with the step of 2 cms) and measure the voltage P10. Tabulate the distance versus measured MAXIMUM voltage. P11. Plot the voltage V/S distance graph and check its validation with the datasheet and sensor specification.

Knowledge and understanding

K1. Describe the Transducer and its types
K2. Describe the Sensor and its types
K3. Describe the Range, Span, error, resolution, linearity of sensor
K4. Describe solenoids as actuator
K5. Describe torque of motors.
K6. Describe contactors, relays and timers.
K7. Describe phototransistor (converts light energy into electric energy)
K8. Describe signal conditioning method of phototransistor
K9. Describe RTD and Thermocouple
K10. Describe signal conditioning circuits of RTD and Thermocouple
K11. Describe LVDT transducer
K12. Describe Tacho-generator Transducer
K13. Describe Photoelectric Speed transducer
K14. Describe LM35 temperature sensors,
K15. Describe PIR Motion detector module
K16. Describe Proximity Sensor (Magnetic, Inductive, Capacitive, Optical)
K17. Describe the Program languages

K18. Describe the syntax and semantics.
K19. Differentiate Programs and Algorithms.
K20. Oscilloscope functions and control

Equipment and Tools

- Analog and Digital Oscilloscope
- Arduino Development board.
- Voltage probe (provided with oscilloscope) / BNC cables.
- Jumpers / wires.
- LM35 Temperature Sensor.
- Sharp IR proximity sensor
- Proximity Sensor (Inductive)

Critical Evidence(s) Required

- The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:
  - Operation of oscilloscope
  - Testing of sensors and transducers

0714E&A116 Calibrate Sensors and Transducers

Overview: This competency standard covers the skills and knowledge required to Calibrate Capacitive Transducer for Displacement measurement, Calibrate Linear Variable Differential Transformer (LVDT) Transducer for Displacement measurement, Calibrate Resistance Temperature Detector (RTD) for Temperature measurement, Calibrate Thermocouple for Temperature Measurement, Calibrate thermistor for temperature measurements, Calibrate Pressure cell for pressure Measurements, Calibrate strain gauge for temperature measurement, Calibrate Stroboscope for Speed Measurement and Calibrate rotometer for flow measurement

Critical Evidence	Performance Criteria
CU1 Calibrate Capacitive Transducer for Displacement measurement	P1. Check connection made to the instrument P2. Allow the instrument in ON position for 10 minutes for initial warm up P3. Pull the top plate to Zero position P4. Adjust the ZERO potentiometer so that the display reads '000' P5 Move the plate in step of 5 to 10 mm and note down the reading in the tabular column till 50mm.
CU2 Calibrate LVDT Transducer for Displacement measurement	P1. Connect the power supply chord at the rear panel to the 230V 50Hz supply. P2. Switch on the instrument by pressing down the toggle switch. The

	display glows to indicate the instrument is ON. P3. Allow the instrument in ON position for 10 minutes for initial warm-up. P4. Rotate the micrometer untill it shows "20.0". P5. Adjust the CAL potentiometer at the front panel so that the display reads "10.0" P6. Rotate the core of micrometer untill the micrometer shows reads "10.0" and adjust the ZERO potentiometer till the display reads "00.0". P7. Rotate back the micrometer core upto 20.0 and adjust once again CAL Potentiometer till the display read (Now the instrument is calibrated for +/- 10.0 mm range. As the core of LVDT moves the display reads the displacement in mm.) P8. Rotate the core of the micrometer in steps of 1 or 2 mm and tabulate the readings. The micrometer will show the exact displacement given to the LVDT core the display will read the displacement sensed by the LVDT. P9. Tabulate the readings and Plot the graph Actual V/s indicator readings.
CU3. Calibrate RTD for Temperature measurement	P1. Check connection made and Switch ON the instrument by rocker switch at the front panel (The display glows to indicate the instrument is ON.) P2. Allow the instrument in ON Position for 10 minutes for initial warm-up. P3. Pore around 3/4th full of water to the kettle and place sensors and thermometer inside the kettle. P4. Note down the Initial water temperature from the thermometer. P5. Select the sensor on which the experiment to be conducted through selection switch on the front panel. P6. Adjust the Initial set Potentiometer in the front panel till the display shows / reads initial water temperature. P7. Switch the power and wait untill the water boils, note down the reading in the thermometer till the display reads boiling water temperature. P8. Remove the sensor from the boiling and immerse it in cold water. Set the cold water temperature using initial set potentiometer. Repeat the process till the display reads exact boiling water and cold water temperature.

	P9. Change the water in the kettle with and re heat the water. Now the display starts showing exact temperature raise in the kettle. P10 Experiment can be repeated for all the three sensors. P11. Temperature in the thermometer and the indicator readings in steps of 10^{o} C can be tabulated
CU4. Calibrate Thermocouple for Temperature Measurement	P1. Check connection made and Switch ON the instrument by rocker switch at the front panel. P2. The display glows to indicate the instrument is ON. P3. Allow the instrument in ON Position for 10 minutes for initial warm-up. P4. Pore around 3/4^{th} full of water to the kettle and place sensors and thermometer inside the kettle. P5. Note down the Initial water temperature from the thermometer. P6. Select the sensor on which the experiment to be conducted through selection switch on the front panel. P7. Adjust the Initial set Potentiometer in the front panel till the display reads initial water temperature. P8. Switch on the kept and wait till the water boils note down the reading in the thermometer and set Final set potentiometer till the display reads boiling water temperature. P9. Remove the sensor from the boiling water immerse it in the cold water. Repeat the corrections as above P10. Set the cold-water temperature using initial set potentiometer. P11. Repeat the process till the display reads exact boiling water and cold-water temperature. P12. Change the water in the kettle with and re heat the water. Now the display starts showing exact temperature raise in the kettle. P13. Experiment can be repeated for all the three sensors. P14. Temperature in the thermometer and the indicator readings in steps of 100 C can be tabulated.
CU4. Calibrate thermistor for temperature measurements	P1. Check connection made and Switch ON the instrument by rocker switch at the front panel. Repeat the corrections as above P2. The display glows to indicate the instrument is ON. P3. Allow the instrument in ON Position for 10 minutes for initial warm-up. P4. Pore around 3/4th full of water to the kettle and place sensors and thermometer inside the kettle.

	P5. Note down the Initial water temperature from the thermometer. P6. Select the sensor on which the experiment to be conducted through selection switch on the front panel. P7. Adjust the Initial set Potentiometer in the front panel till the display reads initial water temperature. P8. Switch on the kept and wait till the water boils note down the reading in the thermometer and set Final set potentiometer till the display reads boiling water temperature. P9. Remove the sensor from the boiling water immerse it I the cold water. Set the cold-water temperature using initial set potentiometer. P10. Repeat the process till the display reads exact boiling water and cold-water temperature. Change the water in the kettle with and re heat the water. Now the display starts showing exact temperature raise in the kettle. P11. Experiment can be repeated for all the three sensors. Temperature in the thermometer and the indicator readings in steps of 10^{o} C can be tabulated.
CU5. Calibrate Pressure cell for pressure Measurements	P1. Check connection made and switch ON the instrument by rocker switch at the front panel. The display glows to indicate the instrument is ON. Repeat the corrections as above P2. Allow the instrument in ON Position for 10 minutes for initial warm-up. P3. Adjust the Potentiometer in the front panel till the display reads “000” P4. Apply pressure on the sensor using the loading arrangement provided. P5. The instrument reads the pressure coming on the sensor and display through LED. P6. Readings the data. P7. Tabulate the data and % error of the instrument, linearity can be calculated.
CU6. Calibrate strain gauge for temperature measurement.	P1. Check connection made and Switch ON the instrument by toggle switch at the back of the box. Repeat the corrections as above P2. The display glows to indicate the instrument is ON. P3. Allow the instrument in ON Position for 10 minutes for initial warm-up. P4. Adjust the ZERO Potentiometer on the panel till the display roads ‘ OOP’.

	P5. Apply load on the sensor using the loading arrangement provided in steps of 100g upto 1 Kg. P6. The instrument display exact micro-strain strained by the cantilever beam. P7. Note down the readings in the tabular column. Percentage error in the readings. P8. Hysteresic and Accuracy of the instrument can be calculated by comparing with the theoretical values.
CU7. Calibrate Stroboscope for Speed Measurement	P1. Check the connections of the equipment. Repeat the corrections as above P2. Select the mode of operation on Xenon flash lamp (Hi/lo). P3. Make a mark on the rotating wheel. P4. Now switch on the Xenon flash lamp and adjust that the light exactly projected on the rotating wheel. P5. Adjust the speed of the motor such that ONE STATIONARY mark is visible on the wheel. Note down the reading in the tabular column. P6. Now adjust the sped of the motor such that Two Stationary marks are visible and note the readings. P7. Similarly for Three and more marks and note the readings.
CU8. Calibrate rotometer for flow measurement	P1. Connect the turbine flow sensor with indicator marked as flow sensor input. Repeat the corrections as above P2. Connect the two pin of the motor to the instrument. P3. Vary the flow control potentiometer to any required set level. P4. Compare the Rotameter reading and digital reading with set reading. P5. Take reading for different set of flows rate. P6. Plot the graph of Rotameter Reading with Digital Indicator Reading.

Knowledge and understanding

K1. Describe the calibration of Transducer and Sensor

K2. Describe the Calibration Curves.

K3. Describe validation of results

K4. Describe Noise.

K5. Describe Hysteresis.

K6. Describe Offset

K7. Describe Gain

K8. Describe Linearization

K9. Describe unit scaling

K10. Describe Errors in Sensor Measurement.

K11. Describe Calibration Process

K12. Describe Error due to Improper Zero Reference

K13. Describe Error due to Mechanical Wear or Damage

Equipment and Tools

- Oscilloscope
- Arduino Development board.
- Voltage probe (provided with oscilloscope) / BNC cables.
- Jumpers / wires.
- LM35 Temperature Sensor.
- Sharp IR proximity sensor
- Proximity Sensor (Inductive)
- Strain gauge
- Stroboscope
- Rotometer

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Calibration of sensor and transducer

0714E&A117 Interface the Sensor & Transducers

Overview: This competency standard covers the skills and knowledge required to Interface LVDT with microcontroller for sensing linear displacement, Interface temperature transducer with microcontroller for sensing temperature, Interface rotary flow transducer with microcontroller for sensing flow rate, nterface Proximity sensor to sense the speed of DC Motor and Interface MQ135 Gas Sensor with Arduino

Critical Evidence	Performance Criteria
CU1. Interface LVDT with microcontroller for sensing linear displacement	P1. Open Arduino IDE. P2. Connect the Arduino board to PC using USB cable. P3. Program the Arduino board with given code P4. Connect the LVDT to Arduino P5. Acquire the data (voltages) form LVDT due to change in

	resistance. P5. Convert the data (voltages) to linear displacement by equation.
CU2. Interface temperature transducer with microcontroller for sensing temperature.	P1. Open Arduino IDE. P2. Connect the Arduino board to PC using USB cable. P3. Program the Arduino board with given code P4. Connect the temperature transducer (LM35) to Arduino P5. Acquire the data (voltages) form LM35 due to change in resistance. P5. Convert the data (voltages) to temperature by equation.
CU3. Interface rotary flow transducer with microcontroller for sensing flow rate	P1. Open Arduino IDE. P2. Connect the Arduino board to PC using USB cable. P3. Program the Arduino board with given code P4. Connect the rotary flow transducer to Arduino P5. Acquire the data (rpm) form rotary flow transducer due to flow. P5. Convert the data (rpm) to linear displacement by equation.
CU4. Interface Proximity sensor to sense the speed of DC Motor	P1. Open Arduino IDE. P2. Connect the Arduino board to PC using USB cable. P3. Program the Arduino board with given code P4. Connect the DC Motor to Arduino P5. Attach a rotating (hollow) wheel to DC Motor shaft. P5. Connect the inductive proximity sensor to Arduino P5. Attach proximity sensor near rotating wheel of DC motor P6. Acquire the data form sensor
CU5. Interface MQ135 Gas Sensor with Arduino	P1. Identify pin configurations P2. Open Arduino IDE software. P3. Connect MQ135 gas sensor to desired Pin. P4. Make a source code / sketch to sense the gas. P5. Compile and Debug P6. Run Program. P7. Acquire the data form sensor P8. Assign a task on sensor data.

Knowledge and understanding

K1. Describe the Transducer

K2. Describe the Sensor
K3. Describe the Range, Span, error, resolution, linearity of sensor
K4. Describe solenoids as actuator
K5. Describe torque of motors.
K6. Describe contactors, ralays and timers.
K7. Describe phototransistor (converts light energy into electric energy)
K8. Describe signal conditioning method of phototransistor
K9. Describe RTD and Thermocouple
K10. Describe signal conditioning circuits of RTD and Thermocouple
K11. Describe LVDT transducer
K12. Describe Tacho-generator Transducer
K13. Describe Photoelectric Speed transducer
K14. Describe LM35 temperature sensors,
K15. Describe PIR Motion detector module
K16. Describe Proximity Sensor (Magnetic, Inductive, Capacitive, Optical)
K17. Describe the Program languages
K18. Describe the syntax and semantics.
K19. Differentiate Programs and Algorithms.

Equipment and Tools

- Oscilloscope
- Arduino Development board.
- Voltage probe (provided with oscilloscope) / BNC cables.
- Jumpers / wires.
- LM35 Temperature Sensor.
- Sharp IR proximity sensor
- Proximity Sensor (Inductive)
- LVDT
- MQ135 Gas Sensor
- Flow sensor
- DC Motor

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Interfacing of sensor and transducer.
- Data acquisition

0714E&A118 Test Actuators

Overview: This competency standard covers the skills and knowledge required to Identify various types of Actuators, Leak test for Pneumatic actuators/tubes, Leak test Hydraulic actuators/tubes, Force/Power test and Piezoelectric actuator test

Critical Evidence	Performance Criteria
CU1. Identify various types of Actuators	P1. Identify Mechanical Actuators (Spring, Gear) P2. Identify Electrical Actuators P3. Identify Hydraulic Actuators P4. Identify Pneumatic Actuators. P5. Identify Electromechanical Actuators P6. Identify Electromagnetic Actuators P7. Identify Manual Actuators P8. Identify power sources of actuators
CU2. Leak test for Pneumatic actuators/tubes	P1. Select test type. (Bubble leak test, Chemical Reactivity test, Pressure drop) P2. Apply high pressure in actuator/tubes for bubble leak test. P3. Make soap water P4. Apply soap water on joints and seals. P5. Mark the places of bubbles. P6. Make a report and suggest maintenance or repairing.
CU3. Leak test Hydraulic actuators/tubes	P1. Select test type. (Bubble leak test, Chemical Reactivity test, Pressure drop) P2. Attach pressure gauges to actuator for pressure drop test. P3. Apply high pressure in actuator/tubes and seal it. P4. Note down the pressure and time. P5. Note down the pressure after each 5 minutes. P6. Make a report and suggest maintenance or repairing.
CU4. Force/Power test	P1. Select actuator type. (Pneumatic, Hydraulic) P2. Attach a load cell with actuator as given. P3. Apply controlled pressure in actuator. P4. Note down the reading on load cell. P5. Increase the pressure step by step of 5 psi and take data. P6. Tabulate the data.
CU5. Piezoelectric actuator test	P1. Select a piezoelectric actuator. P2. Identify power range for piezoelectric actuator.

P3. Select displacement sensor.
P4. Install displacement sensor.
P5. Apply the voltage of step 0.1 volts from 0 to maximum range.
P6. Take the results from displacement sensor at step of 0.1 volts
P7. Tabulate the data.

Knowledge and understanding

K1. Describe the Actuators types.
K2. Describe the Pneumatic actuators
K3. Describe the Hydraulic actuators
K4. Describe the types of leak tests (Bubble leak test, Chemical Reactivity test, Pressure drop)
K5. Describe solenoids as actuator
K6. Describe piezoelectric actuators.
K7. Describe torque of motors.
K8. Describe contactors, relays and timers.
K9. Describe the Pneumatic actuators components.
K10. Describe the Hydraulic actuators components.

Equipment and Tools

- Air Compressor
- Pneumatic Actuators.
- Pneumatic valves and accessories.
- Pressure gauges
- Hydraulic pump
- Hydraulic Actuators.
- Hydraulic valves and accessories.
- Load cell

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Testing of pneumatic and hydraulic actuators and lines.

0714E&A119 Interface and control Actuator with sensors

Overview: This competency standard covers the skills and knowledge required to Identify motion of Actuators, Control extension length of pneumatic actuator, Control the room temperature with relay (actuator) and Control angle of Servomotor with potentiometer.

Critical Evidence	Performance Criteria
CU1. Identify motion of Actuators	P1. Identify Linear Actuators P2. Identify Rotary Actuators P3. Identify Binary Actuators P4. Identify Continues Actuators
CU2. Control extension length of pneumatic actuator	P1. Select pneumatic actuator P2. Select displacement sensor P3. Select a solenoid valve with relay to actuate pneumatic cylinder P4. Select controller (Arduino) P5. Make a wiring diagram for connection of sensor, relay and controller. P6. Open Arduino IDE. P7. Connect the Arduino board to PC using USB cable. P8. Program the Arduino board to ON/OFF the relay for minimum and maximum extension of actuating rod. P9. Perform reciprocating motion of rod.
CU3. Control the room temperature with relay (actuator)	P1. Select temperature sensor P2. Select heater or air conditioner P3. Select a relay (actuator) for operating heater or air conditioner P4. Select controller (Arduino). P5. Make a wiring diagram for connection of heater or air conditioner, sensor, relay and controller. P6. Open Arduino IDE. P7. Connect the Arduino board to PC using USB cable. P8. Program the Arduino board to ON/OFF the relay to maintain temperature.
CU4. Control angle of Servomotor with potentiometer.	P1. Identify potentiometer (manual actuator) to detect the resistance/angle. P2. Identify servomotor (rotary actuator) to position the

system.

P3. Identify the Input and Output pins.

P4. Identify the Digital, Analog and PMW pins.

P5. Make a layout and connect components

P6. Write, compile, debug and upload a program to microcontroller.

P7. RUN and Get results (Angle depends on Potentiometer)

Knowledge and understanding

K1. Describe the types of actuator motion.

K2. Describe the Pressure force relationship

K3. Describe the Control of system

K4. Describe open loop systems

K5. Describe close loop systems.

K6. Describe potentiometer as manual rotary actuator.

K7. Describe relay as binary actuator.

K8. Describe DC motor as rotary actuator

K9. Describe Servo motor as rotary actuator

K10. Describe pneumatic actuator as linear actuator

Equipment and Tools

- Oscilloscope
- Arduino Development board.
- Voltage probe (provided with oscilloscope) / BNC cables.
- Jumpers / wires.
- LM35 Temperature Sensor.
- Sharp IR proximity sensor
- Proximity Sensor (Inductive)
- LVDT
- Servomotor
- Pneumatic actuator

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Control of a system

Programmable Logic Controllers (PLCS)

0714E&A120 Install PLC software and Simulator

Overview: This competency standard covers the skills and knowledge required to install PLC software and Simulator, Program a PLC using simulator and analyze user requirements and specifications.

Critical Evidence	Performance Criteria
CU1. Install PLC software and Simulator	P1. Install the PLC Programming software / firmware, as per PLC manufacturer such as Rs Logic 5000 and Rs links classic etc. P3. Select the best and most frequently used Simulator for programming P4. Select the module P5. Input the generic value as per universal settings (check from internet/helped) P6. Start the Simulator. P7. Open PLC programming software. P8. Install the HMI software as per manufacturer such as Winccflexible and Easybuilder etc.
CU2. Program a PLC using simulator	P1. Open the programming software as per PLC manufacturer P2. Ensure that the Simulator is connected and is in ON condition P3. Create a basic ladder logic program for the ON/OFF of a bulb using utility swith, i.e. Examine ON and Examine OFF P4. Create a basic ladder logic program for Simple Start/Stop Ladder Logic Relay P5. Create a basic ladder logic program for Single Push Button On/Off Ladder Logic P6. Create a basic ladder logic program with On Delay Timer P7. Create a basic ladder logic program for with Off Delay Timer P8. Create a basic ladder logic program for Up Counter P9. Create a basic ladder logic program for Down Counter P10. Create a basic ladder logic program for Motor Control

	P11. Create a basic ladder logic program for Traffic signal lights P12. Create a basic ladder logic program for Elevator Control.
CU3. Analyze user requirements and specifications	P1. Draw the general value chain of the end user industry P2. Highlight the set of activities that a typical firm operating in the specific industry performs in the value chain drawing P3. Check out and list the equipment/gauges/sensors/actuators/transducers used in various stages of the process P4. Identify critical stages in the process P5. Identify the safety aspect required in the critical stages of the process P6. Analyze the possible automation in the existing processes and global trends in automation P7. Analyse the client requirement at broad level from the proposal P8. Generate a report on the various industrial processes running in some typical industries in Pakistan P9. Collect the required specification of the equipments (if already prepared by the user) and clarify the technical specification.
CU4. Identify error codes and functionality testing	P1. Use error codes to identify programming errors P2. Determine program scan time in milliseconds P3. Use a force function to verify an input P4. Use a force function to verify an output P5. Perform measurement of status/values at IOs and variables used for logical operation ? using programming software
CU5. Identify HMI Software and programming.	P1. Open the software. P2. Make a program of graphical representation of tasks on CU2 (P3 – P12). P3. Program the HMI software in order to communicate with PLC. P4. Download and RUN the software on HMI .
CU6. Identification and configuration of SCADA Systems.	P1. Create the connection between two units of PLCs. P2. Define the programming. P3. Identify the communications between two units..

P4. Convey the data of both units on HMI.

Knowledge and understanding

K1. Describe the advantages of the PLC
K2. Describe the major components and
K3. Describe the applications of PLC.
K4. Describe the types of input and output signals.
K5. Define Piping and instrumentation diagram/drawing (P&ID)
K6. List down the PLC
K7. DCS programming software
K8. List Down the SCADA, HMI development software
K9. Knowledge of Relevant documents and documentation procedures
K10. Define Ladder Logic
K11. Explain the Examine ON and Examine OFF switch
K12. How to use ladder logic to create basic programs?
K13. What is push button?
K14. Define the types of Timers.
K15. What is the working of traffic light?
K16. Describe the working of an elevator.
K17. Define the term 'value chain' of industry.
K18. Define human machine interface (HMI)
K19. Define the Standard operating procedure (SOP) of the organization for control panel development process.
K20. How to prepare a General arrangement drawing?
K21. Define IEC standards

Equipment and Tools

- PLC Software and hardware
- Protective gear such as helmets, goggles, gloves, rubber shoes, etc
- Psychometric Charts and Tables
- Calculator
- Calculation Sheet
- Clipboard
- Site Visit
- Pen
- Reference Material

- Helping Manual
- User guide
- Simulator
- Page
- HMI software and hardware
- Communication modules

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

0714E&A121 Interface PLC with system

Overview: After this competency standard the student will be able to implement, troubleshoot and perform maintenance and diagnostics of variety of control system components in various industries.

Critical Evidence	Performance Criteria
CU1. Differentiate Modules of control systems	P1. Identify the standalone / module P2. Demonstrate its functions & capabilities P3. Extract information from device part number
CU2. Install / Modify PLC and its components	P1. Implement hardware configuration as per given design P2. Perform post installation test P3. Disassemble the hardware in accordance user's manual
CU3. Install field instruments	P1. Identify field instruments P2. Install the wiring from Module to instrument location P3. Install the instrument P4. Perform field testing and calibration (if required) P5. Generate the field-testing reports

Knowledge and understanding

K1. Explain modular and Standalone design

K2. Describe different functions & importance of modules

K3. Explain the module on basis of their specification

K4. Describe the correlation of modules

K5. Explain design and part selection as per the requirement of machine.

K6. Explain communication topology and their application

K7. Explain hardware configuration

K8. Explain the importance of hardware testing (monitoring, diagnose real time data/faults)

K9. Explain different instruments and their wiring.

K10. Describe the safe wiring and layout procedure

K11. Explain the data sheets of instruments

K12. Explain offline/online testing procedures

Equipment and Tools

- Datasheets
- Part Manuals
- PLC Trainer
- Multimeter
- Pliers
- Spanner set
- Screw driver set
- Electrical Tester
- Jumper wire set
- Mili-Amp Source
- Special Tools
- Trainer
- Power supply
- Datasheets

Critical Evidence(s) Required

The student needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

Evidence of the following is essential:

- Perform field testing and calibration
- Generate field testing report

0714E&A122 Program PLC using Ladder Logic

Overview: This competency standard covers the skills and knowledge required to install, run, simulate and use in real world application.

Critical Evidence	Performance Criteria
CU1. Installation of PLC programming software	P1. Identify PLC languages 1) Instructions List (IL) i) Structured Text (ST) 2) Graphical language i) Ladder Diagrams (LD) ii) Function Block Diagram (FBD) iii) Sequential Function Chart (SFC) P2. Download and open setup file for software installation on windows PC. P3. Configure installation setup. P4. Install all parts of software. P5. Complete installation and restart the PC
CU2. Design Basic logic program on Ladder logic.	P1. Open GUI of the software . P2. Design basic logical ON/OFF operation in Ladder logic programming. P3. Run thr simulator software to verify program. P4. Upload that program on PLC hardware.
CU3. Apply timers on ladder logic program Apply counters on Ladder logic program.	P1. Open software GUI. P2. Design program and insert timers. P3. Configure timer block according to requirement. P4. Run simulator software to verify this program. P5. Upload this program and run on PLC.
CU4. Apply counters on Ladder logic program.	P1. Open software GUI. P2. Design program and insert counters. P3. Configure counter block according to requirement. P4. Run simulator software to verify this program. P5. Upload this program and run on PLC

Knowledge and understanding

K1. Explain modular and Standalone design

K2. Describe different functions & importance of modules

K3. Explain the module on basis of their specification

K4. Describe the correlation of modules

K5. Explain design and part selection as per the requirement of machine.

K6. Explain communication topology and their application

K7. Explain hardware configuration

K8. Explain the importance of hardware testing (monitoring, diagnose real time data/faults)

K9. Explain different instruments and their wiring.

Equipment and Tools

- Programming logic controller
- Computer
- Programming software.
- Simulation software
- Communication cable.
- Power Adaptor

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Identify PLC program languages.
- Installation of PLC software.
- Design ladder logic program.

0714E&A123 Design and Test the PLC

Overview: This competency standard covers the skills and knowledge required to Prepare work plan, design and program PLC and Test the PLC.

Critical Evidence	Performance Criteria
CU1. Prepare work plan	P1. Suggest globally practiced and accepted automation systems if ?the user is not aware of the technical specifications P2. List down the sub systems that are involved in the process P3. List down sensors and actuators requirement. P4. Collect information on process logic P5. Collect information for operator station screens P6. Decide on whether the system can be developed as per the user requirement P7. Support the project manager in calculating the time required for each stage to ensure completion of project P8. Assist in preparing the work plan with deliverables and timelines P9. Explain the expected output to the user P10. Calculate the number of days needed for commissioning of the panel at site P11. Summarize the user requirement.
CU2. Design and program PLC.	P1. Develop PLC application as per user requirement by following the standard operating procedure (SOP) of the organization P2. Apply approved engineering concepts, processes and principles in developing the PLC application P3. Install organization approved software (system and application software) to develop the system P4. Identify the requirement of indications, switchgears and accessories P5. Develop the control circuit drawing P6. Prepare wiring plans P7. Integrate the main process system with the sub-systems as per the user requirement (e.g., using communication protocol)

	P8. Ensure that safety aspect of the process is captured in the design plan P9. Program PLC as per FDF Program SCADA Application P10. PLC-SCADA Communication P11. Create backup copies of all designs developed for control panel and store in a secure location P12. Prepare a product manual and store them for future references
CU3. Installation and Commissioning	P1. Check availability of panel and tools required for installation P2. Check the internal panel wiring and ensure that it is in accordance with the design drawing P3. Carry out insulation check of internal panel wiring and devices within the panel P4. Check if batteries and chargers have been assembled in accordance with the manufacturers recommended procedures P5. Identify the conductors size and capacity for installation P6. Ensure that the panel is positioned as prescribed, following safety norms P7. Make connections to socket outlets, switches and protective conductors P8. Perform settings as per customer requirements on the equipment in each of the panels P9. Test all control system interlocks P10. Check each digital control point by comparing the command at the control panel and status of the device that it controls P11. Ensure that fuses, switches and other protective devices are labelled correctly P12. Follow the grounding and earthling procedures while commissioning P13. Put danger and warning notices, (if necessary) P14. Test continuity, insulation resistance, functions of all devices, etc., after completion of installation

CU4. Test the PLC	P1. Locate field devices and their interface to PLC P2. Test the system in off line mode using simulator P3. Test the gauges independently for integration of main system with the sub-systems (if applicable) P4. Verify that the system conforms with all the user specifications during testing P5. Rework if there are any issues found and fix them P6. Send the test report for review to the customer P7. Perform Factory Acceptance Test (FAT) P8. Perform site acceptance test plan

Knowledge and understanding

K1. Knowledge of Relevant documents and documentation procedures used in the process
K2. Define formula for Electrical load calculations
K3. Explain the Piping and instrumentation diagram/drawing (P&ID)
K4. Describe the Safety aspects to be inbuilt in the control system as per the process requirement
K5. Describe the advantages of the PLC
K6. Describe the major components and
K7. Describe the applications of PLC.
K8. Describe the types of input and output signals.
K9. How to prepare wiring diagram
K10. List down the PLC, DCS programming software
K11. List Down the SCADA, HMI development software
K12. Knowledge of Relevant documents and documentation procedures used in the process
K13. What are the Testing process and parameters involved in the testing
K14. Define the use of Emulator(Simulator)
K15. What are the Relevant regulations, standards and codes of practice and their implications on the panel

Equipment and Tools

- PLC Software
- Protective gear such as helmets, goggles, gloves, rubber shoes, etc.
- Psychometric Charts and Tables
- Calculator
- Calculation Sheet
- Clipboard

- ❖ Site Visit
- ❖ Pen
- ❖ Reference Material
- ❖ Helping Manual
- ❖ User guide
- ❖ Simulator
- ❖ Page
- ❖ Reference Material
- ❖ Psychometric Charts and Tables

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Identify components.
- Installation of PLC software.
- Design ladder logic program.
- Interface sensors and actuators with PLC.

0714E&A124 Carry out Industrial Automation on PLC

Overview: After this competency standard the student will be able to identify variety of relays and switches and their usage in industry.

Critical Evidence	Performance Criteria
CU1. Implement industrial application using instruments and communication system.	P1. Sketch the process of application (Flowchart, Pseudo code) P2. Identify process data and communication protocols and their specification P3. Implement the open and close loop motor control system P3. Implement a communication BUS system to monitor remote data
CU2. Analyze user requirements and specifications.	P1. Draw the general value chain of the end user industry P2. Highlight the set of activities for a typical firm / industry in the according to the available resources and performs in the value chain drawing P3. Enlist the equipment/gauges/sensors/actuators/transducers which can be used in various stages of the process P4. Identify critical stages in the process P5. Identify the safety aspect required in the critical stages of the process P6. Analyse the possible automation in the existing processes according to the existing global trends and solutionsP7. Analyse the client requirements from broader level of their requirements / quotations along with their additional possible needs which may drastically improve their process and production and its flexibilities for future expansion and upscalling. P8. Generate a report of various industrial processes involved in industry P9. Collect the required specification of the equipment (if already prepared by the user) and clarify the technical specification.
CU3. Implement DC Motor control with PLC, Proximity and	P1.Enlist the required hardware and tool used in different stages of the process.

Limit Switches.	P2. Draw a circuit connection diagram P3. Draw control strategy of system P4. Make physical connection of PLC, DC motor, Proximity switch and limit switch as per drawing. P5. Powerup the circuit. P6. Write and upload the code P7. Write report
CU4. Maintenance and Troubleshooting	P1. Identify status of LEDs on Power Supply, CPU, I/O Cards P2. Match status LEDs within troubleshooting tables defined in manufacturer manual P3. Monitoring of Input and Output status using Programming interface P3. Carry out replacement of faulty cards as per manufacturer instructions P4. Perform replacement of faulty back up battery of the PLC P5. Identify problems in control circuit for I/O by loop testing, contact resistance, signal electrical parameters.

Knowledge and understanding

K1. Define the term 'value chain' of industry.

K2. Define human machine interface (HMI)

K3. Define the Standard operating procedure (SOP) of the organization for control panel development process.

K4. How to prepare a General arrangement drawing?

K5. Define IEC standards

K6. Knowledge of Relevant documents and documentation procedures used in the process

K7. Define formula for Electrical load calculations

K8. Explain the Piping and instrumentation diagram/drawing (P&ID)

K9. Describe the Safety aspects to be inbuilt n the control system as per the process requirement

K10. Describe the advantages of the PLC

K11. Describe the major components and

K12. Describe the applications of PLC.

K13. Describe the types of input and output signals.

K14. Define Piping and instrumentation diagram/drawing (P&ID)

K15. How to prepare wiring diagram

K16. DCS programming software

K17. List Down the SCADA, HMI development software

K18. Knowledge of Relevant documents and documentation procedures used in the process

K19. What are the Testing process and parameters involved in the testing?

K20. Define the use of Emulator (Simulator) Panel?

K21. How to troubleshoot frequently occurring errors.

K22. Describe the Safety aspects to be inbuilt in the control panel system as per the process requirement.Define Relevant regulations, standards and codes of practice and their implications on the panel

K23. What are the safety norms in handling electrical/electronic components?

K24. Describe the Operation of PLCs, relays, contactors, circuit breakers, solenoids, actuators, controllers etc.

K25. Describe the various tools used during the installation process

K26. How to troubleshoot Frequently occurring errors, causes and preventive measures repairing/replacement of various components in a PLC

K27. What are safety precautions while working in an electronic assembly unit

Equipment and Tools

- ❖ PLC Software
- ❖ DC Motor
- ❖ Proximity Switches
- ❖ Limit Switches
- ❖ Simulator
- ❖ Helping Manual
- ❖ User guide
- ❖ Wiring and Connectors

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Evidence of the following is essential:
  - Draw circuit diagram of limit switch
  - Working Physical System

Designing of Mechanical Members

0714E&A125 Calculate Stresses in Machine Parts

Overview: This competency standard covers the skills and knowledge required to Calculate Tensile Loads, Calculate Compressive load and Calculate Shear load

Critical Evidence	Performance Criteria
CU1. **Calculate Tensile loads**	**P1.** Select the attachments for tensile load. **P2.** Select the specimen as per machine manual description and capacity. **P3.** Calculate Dimensions of the specimen. **P4**. Mount specimen properly. **P5**. Perform tensile load test. **P6**. Prepare the dimensions table with loaded and unloaded part. **P7**. Calculate the Stresses, strain, modulus of elasticity, %percentage elongation, % percentage reduction in the area and factor of safety.
CU2. **Calculate Compressive load**	**P1**. Select the attachments for compressive load. **P2.** Select specimen as per machine manual description and capacity. **P3.** Calculate Dimensions of the specimen. **P4**. Mount specimen properly. **P5**. Perform compressive load test. **P6**. Prepare dimensions table with loaded and unloaded part. **P7**. Calculate Stresses, strain, modulus of elasticity, % percentage age elongation, % percentage reduction in area and factor of safety.
CU3. **Calculate Shear load**	**P1**. Select attachments for shear load. **P2.** Select specimen as per machine manual description and capacity. **P3.** Calculate Dimensions of the specimen. **P4**. Mount specimen properly. **P5**. Perform shear load test. **P6**. Prepare dimensions table. **P7**. Calculate Stresses, strain, modulus of elasticity, %age elongation, %age reduction in area and factor of safety.

Knowledge & Understanding

- **K1.** Understanding of stress and strain,
- **K2.** Calculate modulus of elasticity,
- **K3.** Derive relationship of %age elongation,
- **K4.** Derive relationship of %age reduction in area,

K5. Calculate factor of safety for simple machine parts.

K6. Knowing about Stress-Strain Diagram

Tool and Equipment

- UTM
- Specimen for tensile load
- Micrometre Screw gauge
- Vernier-Caliper

0714E&A126 Calculate diameter of cylinder for hoop and longitudinal stresses

Overview: This competency standard covers the skills and knowledge required to Differentiate between thin and thick shells, Identify Hoop and longitudinal stress in cylindrical shells and Calculate Transverse and longitudinal failure of pressure vessel

Critical Evidence	Performance Criteria
CU1. **Differentiate between thin and thick shells.**	**P1**. Select the work-piece **P2**. Calculate thickness and diameter **P3.** Apply the criteria of thin and thick .
CU2. **Identify Hoop and longitudinal stress in cylindrical shells**	**P1.** Select thin wall pressure vessel **P2.** Apply air testing **P3.** Calculate the hoop and logitudinal stresses
CU3. **Calculate Transverse and longitudinal failure of pressure vessel**	**P1**. Select thin wall pressure vessel **P2.** Apply air testing **P3.** Calculate the hoop and logitudinal **P4.** Apply failure criteria

Knowledge & Understanding

- **K1.** Understanding of cylindrical part.
- **K2.** Describe basic measurements
- **K3.** Know thin and thick cylinders relationships.
- **K4.** Understanding of hoop and longitudinal stress analysis
- **K5.** Relationship of hoop and longitudinal stresses
- **K6.** Know about strain gauges and pressure gauges
- **K7.** Proper knowledge to use air compressor.
- **K8.** Apply relationship of failure criteria for pressure vessel

Tool and Equipment

- Micrometre Screw gauge
- Vernier-Calliper
- Measuring Gauges
- Pressure Gauges
- Air compressor with safety valve
- Strain Gauges (for hoop and longitudinal strains and stresses)

0714E&A127 Calculate thickness and diameter of spherical shell for circumferential stresses

Overview: This competency standard covers the skills and knowledge required to Calculate Lame's equations for brittle materials and Calculate Different cases of thickness of thick shells of brittle material, Measure thickness of spherical shell for circumferential stresses and Measure diameter of spherical shell for circumferential stresses

Critical Evidence	Performance Criteria
CU1. Calculate Lame's equations for brittle materials	**P1**. Select the thick wall pressure vessel **P2.** Apply air testing **P3.** Calculate the hoop and logitudinal **P4.** Apply failure criteria
CU2. Calculate Different cases of thickness of thick shells of brittle material	**P1.** Select pressure vessel part **P2.** Choose measurement tool **P3.** Measure dimensions of the cylindrical part **P4.** Solve the distributed load profiles.
CU3. Measure thickness of spherical shell for circumferential stresses	**P1**. Identify thick wall pressure vessel **P2.** Measure thickness of spherical part **P3.** Calculate Stresses on thick spherical shells
CU4. Measure diameter of spherical shell for circumferential stresses	**P1**. Identify thick wall pressure vessel **P2.** Measure diameter of spherical part **P3.** Calculate Stresses on inner side of spherical shells

Knowledge & Understanding

K1. Thick cylinder derivations

K2. Measuring techniques

K3. Basic knowledge of stresses inside the thick wall

K4. Understanding about Lame's equation

K5. Knowledge of geometric

K6. Analyze Stresses in thick wall cylinder

Tool and Equipment

- Measuring tools (Micrometre Screw gauge, Vernier-Calliper Measuring Gauges)
- Cylindrical part of thick cylinder of the brittle materials
- Thick cylinder catalogues
- Basic measuring tools
- Formulae catalogues

0714E&A128 Design welded joints for transverse and parallel fillet under static and fatigue loading

Overview: This competency standard covers the skills and knowledge required to Produce transverse fillet weld, Produce parallel fillet weld, Calculate Tensile stresses in transverse fillet weld, Calculate Shear stresses in transverse fillet weld, Calculate Tensile stresses in parallel fillet weld, Calculate Shear stresses in parallel fillet weld, Calculate Transverse fillet weld under static loadings, Calculate Parallel fillet weld under fatigue loading, Calculate Parallel fillet weld under static loadings and Calculate Parallel fillet weld under fatigue loadings

Critical Evidence	Performance Criteria
CU1. Produce Transverse fillet weld	**P1**.Identify the weld types **P2.** Select Electrode and weld machine as per material requirement **P3.** Perform transverse fillet Weld **P4.** Observe tensile and shear stresses in the transverse fillet weld.
CU2. **Produce Parallel fillet weld**	**P1**. Identify weld types correct as the above **P2.** Select Electrode, weld machine as per material requirement **P3.** Perform parallel fillet Weld **P4.** Observe tensile and shear stresses in transverse fillet weld.
CU3. **Calculate Tensile stresses in transverse fillet weld.**	**P1**. Identify weld types correct as the above **P2.** Select Electrode, weld machine as per material requirement **P3.** Perform transverse fillet Weld **P4.** Analyze tensile and transverse fillet weld.
CU4. **Calculate Shear stresses in transverse fillet weld.**	**P1**. Identify weld types correct as the above **P2.** Select Electrode, weld machine as per material requirement **P3.** Perform transverse fillet Weld **P4.** Analyze shear stresses in transverse fillet weld.
CU5. **Calculate Tensile stresses in parallel fillet weld.**	**P1**. Identify weld types **P2.** Select Electrode, weld machine as per material requirement **P3.** Perform parallel fillet Weld **P4.** Observe tensile stresses in parallel fillet weld.
CU6. **Calculate Shear stresses in parallel fillet weld.**	**P1.** Identify weld types **P2.** Select Electrode, weld machine as per material requirement **P3.** Perform parallel fillet Weld

	P4. Observe shear stresses in parallel fillet weld.
CU7. **Calculate transverse fillet weld under static loadings**	**P1.** Identify weld types correct as the above **P2.** Select Electrode, weld machine as per material requirement **P3.** Perform transverse fillet Weld **P4.** Identify load types **P5**. Observe transverse fillet weld under static loadings.
CU8. **Calculate parallel fillet weld under fatigue loading**	**P1.** Identify weld types correct as the above **P2.** Select Electrode, weld machine as per material requirement **P3.** Perform parallel fillet Weld **P4.** Identify load types **P5**. Observe parallel fillet weld under fatigue loading
CU0714E&A **Calculate parallel fillet weld under static loadings**	**P1.** Identify weld types correct as the above **P2.** Select Electrode, weld machine as per material requirement **P3.** Perform transverse fillet Weld **P4.** Identify load types **P5**. Observe parallel fillet weld under static loadings
CU10. **Calculate parallel fillet weld under fatigue loadings**	**P1.** Identify weld types correct as the above **P2.** Select Electrode, weld machine as per material requirement **P3.** Perform transverse fillet Weld **P4.** Identify load types **P5**. Observe parallel fillet weld under fatigue loadings

Knowledge & Understanding

K1. Understanding of various welding types

K2. Recognize material types as per requirements.

K3. Know about the current and voltage knowledge of welding transformers.

K4.Familiar with the types of loads.

Tools and Equipment

- Welding transformers
- Welding Table and accessories
- Fixture and hand vice

- Welding Safety Equipment
- Chipping hammer
- Power supply
- Measuring Tools as per requirement.
- Cutting equipment and accessories
- Grinding equipment and accessories

0714E&A129 Calculate stresses due to initial tightening and external load on screws

Overview: this competency standard covers the skills and knowledge required to measure stress area of a screw, develop relation with core diameter and nominal diameter of a screw thread, perform initial tightening and its specific values and calculate different cases of external load raised by different bolts

Critical Evidence	Performance Criteria
CU1. Measure Stress area of a screw	**P1**. Choose the bolt **P2.** Select bolt types w.r.t. threads categories **P3.** Compare the of Nut with bolt thread **P4.** Calculate stresses on the threaded part by using mathematical relationships **P5.** Compare stresses with as per given standards in tables.
CU2. Develop relation with core dia. and nominal dia. of a screw thread	**P1**. Choose bolt correct as the above **P2.** Select bolt types w.r.t. threads categories **P3.** Measure core and nominal diameters of the bolt. **P4.** Develop mathematical relationships between the diameters. **P5.** Compare stresses with given standard tables.
CU3. Perform Initial tightening and its specific values	**P1**. Measure tensile stresses due to stretching of the bolt correct as the above **P2.** Calculate torsional shear stress due to frictional resistance at the threads. **P3.** Identify shear stress across threads **P4.** Identify compressive or crushing stress on the threads **P5.** Identify bending stress
CU4. Calculate different cases of external load raised by different bolts	**P1**. Measure stresses due to stretching of the bolt correct as the above **P2.** Calculate torsional shear stress due to frictional resistance at the threads. **P3.** Identify shear stress across threads **P4.** Identify compressive or crushing stress on the threads **P5.** Identify bending stress **P6.** Perform same procedure for different cases.

Knowledge & Understanding

- **K1.** Difference between nut and bolts
- **K2.** Know about the thread types

K3. Calculations of the stresses inside the bolts

K4. Knowledge of the failure criteria of the screw

K5. Differentiate between the weak areas of the screw

K6. Measurements of the diameters core and nominal

K7. Knowledge of the failure criteria of the screw w.r.t. diameters

K8. Knowledge of the various types of loads

K9. Analyze the stresses

K10. Understanding of torque theory and calibration

K11. Knowledge of tables and graphs for the specific values

K12. Understanding about different cases of external load

K13. Knowledge of bolts

K14. Recognize material of bolts

Tools & Equipment

- Measuring tools (Scales, Micrometer Screw Gauges)
- Thread pitch gauge
- Safety gloves
- Nut bolt assembly
- Torque wrench

0714E&A130 Design dimension of square and rectangular keys

Overview: This competency standard covers the skills and knowledge required to Recognise all types of sunk keys, Understand sizes of keys proportional to the shaft diameter, Select length of a sunk key for same material with shaft and equal strength with shaft, Check torque transmitted by rectangular and square keys against shearing as well as crushing and Calculate length of a sunk key when torque transmitted dia. of shaft, stress (shear & compressive) and width of key is given,

Critical Evidence	Performance Criteria
CU1. Recognise all types of sunk keys	**P1.** Select any key **P2.** Measure thickness of the key **P3.** Measure width of the key **P4.**Identify the type of the key
CU2. Understand sizes of keys proportional to the shaft diameter	**P1.** Select shaft and key according to the shaft requirement **P2.** Identify the type of the key **P3.** Perform shaft and key integration
CU3. Select length of a sunk key for same material with shaft and equal strength with shaft	**P1.** Select sunk key **P2.** Measure thickness of the key **P3.** Measure width of the key **P4.** Measure width of the key-way inside the shaft **P5.** Measure Length of the key-way inside the shaft **P6.** Measure the depth of the key-way inside the shaft
CU4. Check torque transmitted by rectangular and square keys against shearing as well as crushing	**P1.** Select rectangular key **P2.** Measure thickness of the key **P3.** Measure width of the key **P4.** Measure width of the key-way inside the shaft **P5.** Measure Length of the key-way inside the shaft **P6.** Measure the depth of the key-way inside the shaft **P7.** Apply torque as per given condition **P8.** Analyze the stresses at various different condition **P9.** Perform the same procedure for square key

CU5. Calculate length of a sunk key when torque transmitted dia. of shaft, stress (shear & compressive) and width of key is given	**P1.** Select sunk key correct as the above **P2.** Measure thickness of the key **P3.** Measure width of the key **P4.** Measure width of the key-way inside the shaft **P5.** Measure Length of the key-way inside the shaft **P6.** Measure depth of the key-way inside the shaft **P7.** Apply torque as per given condition **P8.** Analyze the stresses on different condition **P9.** Calculate tangential forces inside the key **P10.** Apply failure criteria to find out the torsional, shear and compression stresses.

Knowledge & Understanding

Understanding of the key theory

Measurement techniques

Know about the categories of the keys

Measure key dimensions

Measure shaft slot dimension

Assemble both parts properly.

Understand the coupling mechanism

Measure shaft key-way dimension

Assemble both parts properly.

Knowing about the material strength

Understand the torque transmission

Calculate the shearing, torsional and crushing stresses

Tools and Equipment

- Various types of sunk keys
- Measuring instruments
- Various slotted shafts
- Various type of keys
- Measuring tools

0714E&A131 Design shafts subjected to twisting moment only

Overview: This competency standard covers the skills and knowledge required to understand twisting and bending moment on solid shaft, Perform torsion and bending equation for strength of shaft, calculate diameters of shaft under torsion when torque to be transmitted and torsional shear stress is given, calculate diameter of shafts subjected to combine bending and twisting moments Understand twisting moment and bending moment on hollow shaft, Know torsion and bending equation and Calculate dia. of hollow shaft (inside & outside dia.) when bending moment, twisting moment and stresses are given

Critical Evidence	Performance Criteria
CU1. **Perform twisting and bending moment on solid shaft**	**P1**. Select the required solid shaft **P2**. Measure dimensions of the shaft **P3**. Recognize the reaction forces which produce bending moment and twisting.
CU2. **Perform torsion and bending equation for strength of shaft**	**P1**. Select required solid shaft **P2**. Measure dimensions of the shaft **P3**. Measure the force to produce moment along the dia. **P4**. Calculate the reaction forces which produce bending moment. **P5.** Calculate the moment of inertia of shaft **P6.** Produce the relationship to find-out the strength of the shaft
CU3. **Calculate diameters of shaft under torsion when torque to be transmitted and torsional shear stress is given**	**P1**. Select required solid shaft **P2.** Identify the type of shaft **P3**. Measure dimensions of the shaft **P4**. Apply torque to produce torsion along the dia. **P5**. Calculate the reaction forces which produce shear moment. **P6.** Calculate the moment of inertia of the shaft **P7.** Produce the relationship to find-out the diameter of the shaft under torsional loading
CU4. **Calculate diameter of shafts subjected to combine bending and twisting moments**	**P1.** Identify the type of shaft **P2**. Measure dimensions of the shaft **P3**. Apply torque to produce torsion along the dia. **P4**. Calculate the reaction forces which produce bending moment. **P5.** Calculate the reaction forces which produce twisting moment. **P6.** Calculate the moment of inertia of the shaft **P7.** Produce the relationship to find-out the diameter of the shaft under

	torsional loading **P8.** Calculate the max. normal stress in the shaft **P9.** Calculate Min. normal stress in the shaft **P10.** Bending stress induce in the shaft in the bending moment **P11.** Calculate the shear stress induced in the shaft due to twisting moment **P12.** Calculate the equivalent bending moment **P13.** Calculate the max. shear stress
CU 5. **Understand twisting moment and bending moment on hollow shaft**	**P1**. Select required hollow shaft **P2**. Measure dimensions of the shaft **P3**. Observe bending and twisting moment of the hollow shaft
CU 6. **Know torsion and bending equation**	**P1.** Select required hollow shaft **P2**. Measure dimensions of the shaft **P3**. Observe bending and twisting moment of the hollow shaft
CU 7. **Calculate dia. of hollow shaft (inside & outside dia.) when bending moment, twisting moment and stresses are given**	**P1**. Select required hollow shaft **P2**. Measure dimensions of the shaft **P3**. Observe bending and twisting moment of the hollow shaft

Knowledge and Understanding

- **K1.** Measure the diameter and length of the solid shaft
- **K2.** Knowing about the moment types.
- **K3.** Differentiate between the twisting moment and bending moment.
- **K4.** Understanding twisting behavior of the shaft
- **K5.** Identify the bending moment of the shaft
- **K6.** Knowledge to deal with stiffness of the solid shaft
- **K7.** Knowledge to deal with the modulus of the elasticity of the solid shaft
- **K8.** Identify the shearing moment of the shaft
- **K9.** Understanding to measure the diameters (Inner, outer or thickness.)
- **K10.** Able to recognize twisting and bending.

Tools and Equipment

- Solid shaft
- Measuring instruments
- Safety equipment

0714E&A132 Design flange coupling for specific torque

Overview: This competency standard covers the skills and knowledge required to un-protected flange coupling, know empirical size of flange coupling and design assembly (hub, keys, flange and bolts) of unprotected type flange coupling

Critical Evidence	Performance Criteria
CU1. **Un protected flange coupling**	**P1**.Identify the flange from the different machine parts like Hub, keys. Flywheel, bolts etc. **P2.** Differentiate various type of the flanges from Marine, Unprotected and Protected flange coupling
CU2. **Know empirical size of flange coupling**	**P1**. Choose the flange coupling **P2**. Measure diameter of the shaft **P3**. Measure outside diameter of the shaft **P4.** Measure Length of hub/ Effective length of key **P5.** Measure Thickness of output flange **P6.** Measure Pitch circular diameter **P7.** Measure Thickness of Protective rim **P8.** Measure Diameter of pin **P9.** Measure Number of pins
CU3. **Design assembly (hub, keys, flange and bolts) of unprotected type flange coupling**	**P1.** Measure and select hub as per requirement **P2.** Identify keys and measure dimensions for required unprotected type flange coupling **P3.** Identify un-protected flange type **P4.** Select the bolts as per requirements **P5.** Assemble shaft inside the flange **P6.** Insert key and check fitting **P7.** Assemble bolt and tight nuts **P8.** Check the torque of the nut bolt assembly

Knowledge and Understanding

- **K1.** Understanding of the machine parts
- **K2.** Measurement techniques
- **K3.** Knowledge about the sizes of flange
- **K4.** Measurement techniques
- **K5.** Knowledge about all the parts of the flange assembly

K6. Knowing about the unprotected flange application.

K7. Able to check the errors in fitting.

Tools and Equipment

- Flange
- Bolts
- Keys
- Hubs
- Flywheels
- Measuring instruments
- Leveling instruments

Industrial Process Control & Instrumentation

0714E&A133 Design & Implement a process control

Overview: After completing this competency standard, the student will be able to understand the functions, uses and design process control.

Critical Evidence	Performance Criteria
CU1. Design an Open loop Process Control circuit	P1. Specify the open loop system which is to be analysed. P2. Select the type of the "Process variable" need to be measured, , such as, pressure, temperature, level, flow, velocity, etc. P3. Specify the input to the system. P4. Select type of instrument which is required to measure the Process variable . P5. Construct the open-loop process control circuit. P6. Generate and display the output reading.
CU2. Design a Closed Loop Process control circuit	P1. Specify the close loop system which is to be analysed. Repeat the same correction as above P2. Select the type of process variable for the measurement, such as, pressure, temperature, level, flow, velocity, etc. P3. Specify the input to the system. P4. Select type of instrument for process variable measurement. P5. Construct the closed-loop process control circuit. P6. Generate and display the output reading.
CU3. Implement the ON/OFF Control Mode	P1. Specify the ON/OFF type of control mode to be installed Repeat the same correction as above P2. Select the appropriate type of control mode P3. Install the desired control mode type as per the installation instructions P4. Perform a test run on the ON/OFF control mode P5. Generate the Output reading
CU4. Implement the PID Control Mode	P1. Specify the closed loop system which is to be analysed. Repeat the same correction as above P2. Select the type of process variable for the measurement, such as, pressure, temperature, level, flow, velocity, etc.

P3. Select the appropriate type of control mode
P4. Install the desired control mode type as per the installation instructions
P5. Perform a test run on the P control mode
P6. Perform a test run on the PI control mode
P7. Perform a test run on the PID control mode
P8. Generate the Output report

Knowledge and understanding

K1. Define process control, its working principles and uses in industry.
K2. Explain the basic drawing skills
K3. Explain process variable to be measure or controlled.
K4. Explain different types of sensors for the instrumentation.
K5. Explain the process variable measuring instruments.
K6. Explain the purpose of an amplifier for the instrumentation.
K7. Explain the function of analogue to digital conversion and vice versa.
K8. Describe the Industrial control phenomenon.
K9. Define process control, its working principles and uses in industry.
K10. Explain the ON/OFF control mode
K11. Describe the method of ON/OFF control mode
K12. Describe the advantages and disadvantages of ON/OFF control mode
K13. Explain the PID control or manual mode
K14. Describe the importance and method of PID control mode
K15. Describe the advantages of PID control mode.
K16. Explain the types of controllers used in process as well as manufacturing industries.

Equipment and Tools

- PID controller
- Tool kit
- Multi-meter
- IP Valves
- Pneumatic valves and supply
- 4-20 m amps devices
- SSR
- SCR

- Sketch Board
- Plotting Paper
- Soldering iron, Rods
- Transistors, MOSFET
- Indicators

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

Evidence of the following is essential:

- Differentiate various application of closed loop and open loop control system
- Identify different pin configuration of PID controller using data sheet

0714E&A134 Install Transducer & Transmitters used in Industrial Applications

Overview: After completion of this competency standard the student will be able to grasp the uses, basic concepts and installation of transducers and industrial Transmitters

Critical Evidence	Performance Criteria
CU1. Apply the P/I and I/P Transducers.	P1. Specify the type of transducer to be installed P2. Install the desired type of transducer as per the installations manual P3. Perform the post installation measures P4. Generate an output report for the transducer.
CU2. Install the Differential Pressure Transmitters.	P1. Analyze the type of DP Transmitter to be installed P2. Locate the point of installation for DP transmitter P3. Install the DP Transmitter as per the installations manual. P4. Perform Post Installation measures. P5. Generate an output report for the transmitter
CU3. Install the Pneumatic Transmitter in Industry	P1. Analyze the type of Pneumatic Transmitter to be installed P2. Locate the point of installation for Pneumatic transmitter P3. Install the Pneumatic Transmitter as per the installations manual. P4. Perform Post Installation measures. P5. Generate an output report for the transmitter

Knowledge and understanding

K1. Describe the working principles of P/I (pressure to current) & I/P (current ot pressure) Transducers.

K2. Explain the applications of P/I & I/P transducers in industry

K3. Explain the criteria of installation and calibration of P/I ,I/P transducers

K4. Explain the differential pressure (DP) transmitter and its types.

K5. Describe the working principle of DP transmitter.

K6. Explain the Installation & calibration procedures of DP transmitter

K7. Explain the Pneumatic transmitter and its types.

K8. Describe the working principle of Pneumatic transmitter.

K9. Explain the Installation & calibration procedures of Pneumatic transmitter

Equipment and Tools

- I/P AND P/I Transducers

- Multi-meter
- Calibrator
- Calibrator probes
- Differential pressure (DP) Transmitter
- Multi-meter
- Pneumatic Transmitter
- Multi-meter
- Compressor

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Differentiate various type of transducers
- Pin diagram and connectivity of pressure transmitter

0714E&A135 Install the process Regulators

Overview: After completion of this competency standard the student will be able to grasp the uses, basic concepts and installation of regulator and actuators.

Critical Evidence	Performance Criteria
CU1. Install the regulator in application	P1. Specify the type of regulator to be installed P2. Select the appropriate type of regulator P3. Install the desired regulator type as per the installation instructions P4. Perform a test run on the installed regulator P5. Generate the Output report
CU2. Install the Flow Control Actuators in application	P1. Specify the type of Actuator to be installed P2. Select the appropriate type of Actuator P3. Install the desired Actuator type as per the installation instructions P4. Perform a test run on the Actuator installed P5. Generate the Output report
CU3. Analyze the Power Controlling Devices	P1. Specify the type of Power Controlling Device to be installed P2. Select the appropriate type of Power Controlling Device P3. Install the desired Power Controlling Device type as per the installation instructions P4. Perform a test run on the Power Controlling Device P5. Generate the Output report
CU4. Install the Motor in Application	P1. Specify the type of motor to be installed P2. Select the appropriate type of motor P3. Install the desired motor type as per the installation manual P4. Perform a test run on the motor P5. Generate the Output report

Knowledge and understanding

K1. Explain the Actuator, Its Types and working principles

K2. Describe the installation and calibration criteria of Actuator

K3. Explain the Power Controlling Device , Its Types and working principles

K4. Describe the installation and calibration criteria of Power Controlling Device

K5. Explain the Motor, Its Types and working principles

K6. Describe the installation and calibration criteria of motor

Equipment and Tools

- Multimeter
- Spring-regulator
- Weight Regulator
- Pressure controlled Regulator
- Product manual
- Globe Valve
- Butterfly Valve
- Differential Valve
- Rotary Plug Valve
- Calibrator
- Flow meter
- Product manual
- Silicon Controlled Rectifier (SCR) Module also known as Thyristor
- Triod for Alternating Current (TRIAC) Module
- Integrated Gate Bipolar Transistor (IGBT) Module
- MOS controlled thyristor Module
- Switching relays
- Multimeter
- Spring-regulator
- DC motor

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Identify power control devices
- Pin diagram and connectivity of flow control sensor

0714E&A136 Install the Variable Frequency Drive (VFD)

Overview: After completion of this competency standard the student will be able to grasp the uses, basic concepts and installation of VFD.

Critical Evidence	Performance Criteria
CU1. Install the Variable Frequency Drive	P1. Select / Specify the type of VFD to be installed P2. Select the appropriate type of VFD P3. Install the desired VFD type as per the installation instructions P4. Perform a test run on the VFD P5. Generate the Output report
CU2. Perform the Parameterization process	P1. Specify the required parameter, such as current, voltage, rpm. P2. Select the appropriate parameter P3. Perform parameter downloading P4. Tune the selected parameters with test run to adjust the output P5. Generate the output report

Knowledge and understanding

- **K1.** Explain the VFD, Its Types and working principles
- **K2.** Describe the installation and commissioning of VFD
- **K3.** Explain the VFD parameter procedure
- **K4.** Describe the importance of Parameterization
- **K5.** Describe the speed control procedure by VFD

Equipment and Tools

- Servo-VFD
- Induction Motor
- Servo Motor
- Multi-meter
- Tool kit
- Product manual
- Servo-VFD
- Induction Motor
- Servo Motor
- Keypad

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Control Speed by VFD
- Working principle of servo VFD induction motor

0714E&A137 Install Pneumatic & Hydraulic systems

Overview: After completion of this competency standard the student will be able to grasp the uses, basic concepts and installation of pneumatic and hydraulic system.

Critical Evidence	Performance Criteria
CU1. Install Hydraulic Equipment	P1. Specify the type of hydraulic system to be installed, such as jack, press, pump, etc. P2. Select the appropriate type of hydraulic system. P3. Install or mount the desired hydraulic type as per the installation instructions P4. Perform a test run on the hydraulic equipment P7. Generate the Output report
CU2. Perform equipment maintenance	P1. Analyze the type of hydraulic maintenance required P2. Select the appropriate procedure of hydraulic maintenance P3. Inspect the Pressure Seal, Spring, Piston and oil level P4. Service the equipment as per the servicing manual
CU3. Install Pneumatic Equipment	P1. Specify the type of pneumatic system to be installed, such as valve, jack, cylinder, etc. P2. Select the appropriate type of Pneumatic P3. Install the desired Pneumatic type equipment as per the installation instructions P4. Perform a test run on the Pneumatic equipment P7. Generate the Output report

Knowledge and understanding

K1. Explain the hydraulic system, types and working principle

K2. Describe the importance and requirement of hydraulic system

K3. Describe the advantages of hydraulic system

K4. Explain the hydraulic maintenance procedures

K5. Describe the method of checking pressure.

K6. Describe the method of Cleaning and oil level

K7. Explain the Pneumatic system, types and working principle

K8. Describe the importance and requirement of Pneumatic

K9. Describe the advantages of Pneumatic system

Equipment and Tools

- Hydraulic Pumps

- ❖ Hydraulic Relays
- ❖ Hydraulic Regulator
- ❖ Calibrator
- ❖ Pressure tester
- ❖ Valves
- ❖ Sensors
- ❖ Seal,
- ❖ Spring
- ❖ Piston
- ❖ Pneumatic Valves
- ❖ Magnetic coil
- ❖ Compressor

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

Evidence of the following is essential:

- Working principle of Pneumatic system
- Perform a test run on the hydraulic equipment

Robotics

0714E&A138 Identify Various Parts of Robots

Overview: This competency standard covers the skills and knowledge required to Identify Various types of Sensors, Identify Various Controllers/ Microprocessors and Identify Designing and Development Software.

Critical Evidence	Performance Criteria
CU1. Identify Various types of Sensors	P1. Identify temperature sensors. P2. Identify sound sensors. P3. Identify proximity sensors. P4. Identify pressure sensors. P5. Identify light sensors. P6. Identify position sensors. P7. Identify voltage sensors. P8. Identify current sensors. P9. Identify the vision sensors. P10. Identify power supply of each sensor
CU2. Identify Various Controllers/ Microprocessors	P1. Identify the open loop controllers. P2. Identify the closed loop controllers. P3. Recognize the algorithms for both controllers. P4. Recognize the components of both controllers. P5. Draw circuit diagram for controllers. P6. Draw the block diagram and flow charts of both controllers. P7. Recognize the power supply for controllers.
CU3. Identify Designing and Development Software.	P1. Identify the programming languages. P2. Identify the program development architecture for the robot. P3. Identify the software tools for the different types of controllers.

Knowledge and understanding

- **K1.** Describe Robot
- **K2.** Diffrentiate Machine and robot
- **K3.** Describe Parts of robots
- **K4.** Define function of temperature sensors.

K5. Define function of sound sensors.
K6. Define function of proximity sensors.
K7. Define function of pressure sensors.
K8. Define function of light sensors.
K9. Define function of position sensors.
K10. Define function of voltage sensors.
K11. Define function of current sensors.
K12. Define function of vision sensors.
K13. Defina open and close loop systems.
K14. Explain algorithms for open and close loop systems.
K15. Draw diagram for open and close loop systems.
K16. Explain Robot programing languages
K17. Define program development architecture
K18. Explain Robot software tools

Equipment and Tools

- Manipulator links and joints
- Measuring tool kit
- Robotic fastening tool kit.
- Trainer
- Manipulator links and joints
- End Effectors
- Mounting accessories
- Actuators
- Multimeter
- Computer System
- Software
- Sensors
- Base for the manipulator
- Electrical Wiring

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Identify the major parts and main body of the Robot.

0714E&A139 Identify Various Parts of Robot Arm

Overview: This competency standard covers the skills and knowledge required to Assemble the different types of Manipulators or Rovers, Set up Various Types of End Effectors with the Robot and Assemble Various Actuators / Drives with the Robot.

Critical Evidence	Performance Criteria
CU1. Assemble the different types of Manipulators or Rovers.	P1. Identify parts and main body and of the manipulator. P2. Identify the links and joints. P3. Assemble links, joints and overall assembly of the manipulator. P4. Identify the kinematics (movement) of a manipulator.
CU2. Set up Various Types of End Effectors with the Robot.	P1. Identify the types of End Effectors. P2. Select the End Effectors as given per requirements. P3. Assemble the End Effectors with the manipulator. P4. Identify Drives for the End Effector. P5. Identify the kinematics (movement) of the end effectors.
CU3. Assemble Various Actuators / Drives with the Robot.	P1. Identify Hydraulic Actuators. P2. Identify Electrical Actuators. P3. Identify Pneumatic Actuators. P4. Identify Mechanical Actuators. P5. Identify Power Drives. P6. Identify the input power for each actuator. P7. Assemble actuators with manipulators and end effectors

Knowledge and understanding

K1. Describe Robot arm

K2. Describe degrees of freedom

K3. Describe links of robot arm

K4. Describe joints of robot arm (linear, rotary, both)

K5. Describe assembly

K6. Draw kinematic diagram of manipulator

K7. Explain end effector and its types.

K8. Differentiate between manipulator and end effector

K9. Describe endeffector drives

K10. Describe actuator.

K11. Describe Hydraulic Actuators.

K12. Describe Electrical Actuators.

K13. Describe Pneumatic Actuators.

K14. Describe Mechanical Actuators.

K15. Define the power drives

Equipment and Tools

- Manipulator links and joints
- Measuring tool kit
- Robotic fastening tool kit.
- Trainer
- Manipulator links and joints
- End Effectors
- Mounting accessories
- Actuators
- Multimeter
- Computer System
- Software
- Sensors
- Base for the manipulator
- Electrical Wiring

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Assemble/integrate the parts and the main body of the Robot.

0714E&A140 Develop Robot program

Overview: This competency standard covers the skills and knowledge required to Develop program to interface temperature sensor LM35 with Arduino, Develop program to operate DC motor with PWM based speed control, Develop program to operate SONAR and measure distance with Arduino

Critical Evidence	Performance Criteria
CU1. Develop program to interface temperature sensor LM35 with Arduino.	P1. Identify the pin configuration of Arduino and LM 35 temperature sensor P2. Make connection of power, ground and analog pin of LM 35 with Arduino P3. Connect Arduino with computer(PC) and open Arduino IDE and select port and Devices P4. Write and upload the code of LM35 into Arduino P5. Observe the value of temperature in serial monitor Screen in PC P6. Measure the temperature of ice and calibrate reading by tuning in programming.
CU2. Develop program to operate DC motor with PWM based speed control	P1. Identify the components and connection of circuits P2. Connect the potentiometer to analog pin and connect the MOSFET to digital Pin of Arduino P3. Connect the DC motor with separate Power Supply unit with MOSFET as switch P4. Write code to take value of voltage and make switch case statements to generate PWM signal of multiple Duty cycle P5. Upload the code and run DC motor
CU3. Develop program to operate SONAR and measure distance with Arduino	P1. Identify the Pin configuration of Sonar and Arduino P2. Make connection according to circuit diagram P3. Connect Arduino with PC and open Arduino IDE P4. Write and upload the code in Arduino P5. Run the code and measure value at serial monitor P6. Calibrate measure value of distance with Scale

Knowledge and understanding

K1. Explain Robot program

K2. Explain hardware required for Robot program

K3. Define interfacing

K4. Define configuration

K5. Define controller.

K6. Define pins (Analog and logical)

K7. Explain LM39,

K8. Describe code

K9. What is PWM signal

Equipment and Tools

- Trainer
- Computer system
- CAD software
- Measuring tool kit
- Basic Robotic components
- Complete design of the Robot
- Robotic fastening tool kit

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Identify and Assemble parts of robot.
- Describe the programing Algorithm and Operation Logic with various sensors

0714E&A141 Develop robotic arm structure

Overview: This competency standard covers the skills and knowledge required to Design the Robotic Armm and Develop the structure of Robotic Arm

Critical Evidence	Performance Criteria
CU1. Design the Robotic Arm.	P1. Identify the types of robotic arms. P2. Select the links and joints type for robotic arm. P3. Plan the axes of motion (rotation and straight line movement) of robotic arm. P4. Specify the degrees of freedom for end effector. P5. Specify the reach envelope for robotic arm. P6. Identify the speed and payload for robotic arm. P7. Design the model of links, joints and overall assembly of the manipulator.
CU2. Develop the structure of Robotic Arm	P1. Assembly of the parts of manipulators. P2. Assembly of the End Effectors with the manipulator. P3. Assemble actuators with manipulators and end effectors. P4. Assemble Controller with actuators and power supply.

Knowledge and understanding

K1. Describe Robotic arm
K2. Explain types of Robotic arm.
K3. Define plan axes of motion
K4. Define links and joints
K5. Define degrees of freedom
K6. Describe reach envelope of robotic arm
K7. Draw flow chart of manipulator assembly
K8. Define manipulators components.
K9. Diffrentiate End Effectors with the manipulator
K10. Define power distribution
K11. Define forward kinematics
K12. Define inverse kinematics.

Equipment and Tools

- Manipulator links and joints
- Measuring tool kit
- Robotic fastening tool kit.

- Trainer
- Manipulator links and joints
- Computer system
- Mounting accessories
- Complete design of the sensor assembly

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Integrate part to form structure of Robot

0714E&A142 Test the Robot

Overview: This competency standard covers the skills and knowledge required to Configure the Robotic Arm and Test the Robotic Arm

Critical Evidence	Performance Criteria
CU1. Configure the Robotic Arm	P1. Identify of Working space. P2. Identify of Controller. P3. Identify of Manipulator. P4. Identify of End Effector. P5. Identify of Actuators. P6. Identify of Joints. P7. Identify of Software. P8. Identify of power supply. P9. Identify of connecting wiring. P10. Identify the components (Resistor, Capacitor and Potentiometer). P11. Draw the circuit diagram. P12. Develop the algorithm flowchart to implement on controller. P13. Identify the power distribution.
CU2. Test the Robotic Arm	P1. Identify movement of robotic arm. P2. Perform the arm movement detection test P3. Check the robotic arm System feasibility and manipulability for end effectors. P4. Check of Robotic arm operating conditions. P5. Check all the connections of the components. P6. Recognize the program algorithm for the robotic arm.

Knowledge and understanding

K1. Explain work space.
K2. Define robot controller
K3. Define Manipulator
K4. Define end effector
K5. Define actuator
K6. Define Joints
K7. Define Software
K8. Define power supply

K9. Explain wiring diagram

K10. Define flow chart

K11. Define power distribution

K12. Define forward kinematics

K13. Define inverse kinematics

K14. Explain movement detection test

K15. Define robotic arm System feasibility

K16. Define manipulability for end effectors

Equipment and Tools

- Manipulator links and joints
- Measuring tool kit
- Robotic fastening tool kit.
- Trainer
- Manipulator links and joints
- Computer system
- Mounting accessories
- Complete design of the sensor assembly

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence**(s) in order to be competent in this competency standard:

- Configure and test Robotic arm.

Mechatronic Projects

Overview: This module is designed to introduce the student to the some application of robotics in industry. This module covers operating principles of a manipulator and describes types of actuators found in industry. The development of computer aided design (CAD) model of robots is also outlined, and the main components associated with robotic systems are explored.

0714E&A143 Access Control System using RFID Reader RC522

Overview: This Project is designed to introduce the student to some application of robotics in industry.

Performance Criteria

P1. Identify Components of system.
P2. Identify Components ratings.
P3. Identify the reader to read the RFID (Radio Fredquency Idendification)
P4. Sketch the model and overall assembly of the system.
P5. Select the Controller
P6. Recognize the power supply distribution for controller and components.
P7. Assemble the parts of system
P8. Draw the circuit diagram
P9. Electric wiring of sensors, switches and controller
P10. Design the algorithm flowchart to implement on controller.
P11. Program the controller to read a key from RFID to Allow or Block the Access.
P12. Upload code/Program to controller.
P13. RUN the controller to read key from RFID.

0714E&A144 Finger print Sensor Based Biometric Attendance System

Overview: This Project is designed to introduce the student to some application of robotics in industry.

Performance Criteria

P1. Identify Components of system.
P2. Identify Components ratings.
P3. Sketch the model and overall assembly of the system.
P4. Select the Controller

P5.	Recognize the power supply distribution for controller and components.
P6.	Assemble the parts of system
P7.	Draw the circuit diagram
P8.	Connect the sensors, switches and controller
P9.	Design the algorithm flowchart to implement on controller.
P10.	Program the controller to scan the fingerprints and save in satabase.
P11.	Upload code/Program to controller.
P12.	RUN the controller to scan the fingerprints.

0714E&A145 Humidity and Temperature Monitoring System.

Overview: This Project is designed to introduce the student to some application of robotics in industry

Performance Criteria	
P1.	Identify Components of system.
P2.	Identify Components ratings.
P3.	Identify Sensors and their ratings.
P4.	Sketch the model and overall assembly of the system.
P5.	Select the Controller
P6.	Recognize the power supply distribution for controller, components and sensors.
P7.	Assemble the parts of system
P8.	Draw the circuit diagram
P9.	Connect the sensors, switches and controller
P10.	Design the algorithm flowchart to implement on controller.
P11.	Program the controller to read the values form sensors.
P12.	Upload code/Program to controller.
P13.	RUN the controller to read the values.

0714E&A146 Smart Stick for Blinds

Overview: This Project is designed to introduce the student to some application of robotics in industry

Performance Criteria	
P1.	Identify Components of system.
P2.	Identify Components ratings.
P3.	Sketch the model and overall assembly of the system.

P4.	Select the Controller
P5.	Recognize the power supply distribution for controller, components and sensors.
P6.	Assemble the parts of system
P7.	Draw the circuit diagram
P8.	Connect the sensors, switches and controller
P9.	Design the algorithm flowchart to implement on controller.
P10.	Program the controller to read the values form sensors.
P11.	Upload code/Program to controller.
P12.	RUN the controller to read the values.

0714E&A147 Perform Line Following Robot

Overview: This Project is designed to introduce the student to some application of robotics in industry

Performance Criteria	
P1.	Specify the types of line following robot.
P2.	Identify mobile base of line following robot.
P3.	Identify the actuators for of line following robot.
P4.	Select the components for line following robot.
P5.	Identify the sensors to detect the path.
P6.	Design the model and overall assembly of the line following robot.
P7.	Assembly of the parts of line following robot
P8.	Select the Controller
P9.	Draw the circuit diagram
P10.	Electric wiring of sensors, actuator and controller
P11.	Design the algorithm flowchart to implement on controller.
P12.	Recognize the power supply distribution for controller and actuator.
P13.	Recognize the program algorithm for the line following robot
P14.	Program the controller to change direction of robot according to the receive signal.
P15.	Identification of movement of the line following robot.
P16.	Preform the robot movement detection test
P17.	Check the line following robot feasibility and manipulability.
P18.	Check of line following robot operating conditions
P19.	Check the condition of each component and overall assembly of the line following robot.
P20.	Check all the connections of the components.

0714E&A148 Perform Smart Phone Control Robot Using Bluetooth

Overview: This Project is designed to introduce the student to some application of robotics in industry

Performance Criteria
P1. Specify the types of Smart Phone Control Robot Using Bluetooth.
P2. Identify mobile base.
P3. Identify the actuators.
P4. Select the components.
P5. Identify the sensors to detect the Bluetooth signals.
P6. Design the model and overall assembly of the robot.
P7. Assembly of the parts
P8. Select the Controller
P9. Draw the circuit diagram
P10. Electric wiring of sensors, actuator and controller.
P11. Design the algorithm flowchart to implement on controller.
P12. Recognize the power supply distribution for controller and actuator.
P13. Recognize the program algorithm for the Smart Phone Control Robot Using Bluetooth.
P14. Program the controller to change direction of robot according to the receive signal from smart phone android application via Bluetooth.
P15. Download and Install the android application on smartphone.
P16. Connect the Bluetooth with Bluetooth module on controller.
P17. Identification of movement of the Smart Phone Control Robot Using Bluetooth.
P18. Preform the robot movement detection test
P19. Check the robot feasibility and manipulability.
P20. Check the robot all possible operating conditions.
P21. Check the Bluetooth range and its connectivity.
P22. Check the condition of each component and overall assembly of the robot.
P23. Check all the connections of the components.

0714E&A149 Perform IoT Controlled based home automation system

Overview: This Project is designed to introduce the student to some application of robotics in industry

Performance Criteria	
P1.	Specify the types of IoT Controlled based home automation system.
P2.	Identify the specification of home appliances and things to automate.
P3.	Select the components for each part of the automation system.
P4.	Identify the sensors to detect light, movement, temperature and other.
P5.	Perform the Internet module connection with controller.
P6.	Connect the LCD display with controller.
P7.	Design the model and overall assembly on single control unit.
P8.	Select the Controller
P9.	Draw the circuit diagram
P10.	Electric wiring of sensors, actuator and controller.
P11.	Design the algorithm flowchart to implement on controller for each sensor.
P12.	Recognize the power supply distribution for sensors, controller and actuator.
P13.	Recognize the program algorithm for each sensor.
P14.	Setup the cloud for getting the sensors data on cloud.
P15.	Program the controller to automate the door, turn light on/off from smart phone, control the Fan from smart phone and display the temperature and humidity on screen.
P16.	Download and Install the android application on smartphone.
P17.	Connect the Internet with Internet module on controller.
P18.	Check the robot feasibility.
P19.	Check of line robot operating conditions
P20.	Check the data acquisition accuracy

0714E&A150 Perform Smart Phone Control Door Lock System

Overview: This Project is designed to introduce the student to some application of robotics in industry

Performance Criteria	
P1.	Specify the types Of Smart Phone Control Door Lock System.
P2.	Identify the specification of door lock.
P3.	Select the components.
P4.	Identify the actuators.
P5.	Identify the module to detect the Bluetooth signals.
P6.	Perform the Bluetooth module connection with controller.
P7.	Connect the LCD display with controller.
P8.	Design the model and overall assembly on single control unit.
P9.	Select the Controller
P10.	Draw the circuit diagram.
P11.	Electric wiring of sensors, actuator and controller.
P12.	Design the algorithm flowchart to implement on controller.
P13.	Recognize the power supply distribution for sensors, controller and actuator.
P14.	Program the Algorithm to controller to unlock the door according to the received signals.
P15.	Download and Install the android application on smartphone.
P16.	Connect the Bluetooth with Bluetooth module on controller.
P17.	Identification of door activity according to pin code provide to unlock the door.
P18.	Preform the Door Lock System error detection test.
P19.	Check the robot feasibility and manipulability.
P20.	Check the Door Lock System all possible operating conditions.
P21.	Check the Bluetooth range and its connectivity.
P22.	Check the condition of each component.
P23.	Check all the connections and wiring of the components.

0714E&A151 Perform Security System Using Motion Detection

Overview: This Project is designed to introduce the student to some application of robotics in industry

Performance Criteria	
P1.	Specify the types Of Security System Using Motion Detection.
P2.	Identify the specification of Security System.

P3.	Select the components.
P4.	Identify the actuators.
P5.	Identify the sensor to detect the Motion.
P6.	Select the Controller.
P7.	Design the model and overall assembly on single control unit.
P8.	Draw the circuit diagram.
P9.	Electric wiring of sensors, actuator and controller.
P10.	Design the algorithm flowchart to implement on controller.
P11.	Recognize the power supply distribution for sensors, controller and actuator.
P12.	Program the Algorithm to detect the unwanted motion and ring buzzer when detected.
P13.	Preform the movement detection test on the Security System .
P14.	Check the robot feasibility and manipulability.
P15.	Check the Security System for all possible operating conditions.
P16.	Check the buzzer range.
P17.	Check the condition of each component.
P18.	Check all the connections and wiring of the components

0714E&A152 Perform Water-level Detection in Tank

Overview: This Project is designed to introduce the student to some application of robotics in industry

Performance Criteria	
P1.	Specify the types of Water-level Detection in Tank.
P2.	Identify the specification of Water-level Detection Tank.
P3.	Select the components.
P4.	Identify the actuators.
P5.	Identify the sensor to detect the Water-level.
P6.	Select the Controller.
P7.	Design the model and overall assembly on single control unit.
P8.	Draw the circuit diagram.
P9.	Electric wiring of sensors, actuator and controller.
P10.	Design the algorithm flowchart to implement on controller.
P11.	Recognize the power supply distribution for sensors, controller and actuator.
P12.	Program the Algorithm to detect the Water-level in tank and display reading on the LCD.
P13.	Preform the Water-level Detection test on different ranges of sensor with varying the level of

water.

P14. Check the Water-level Detection System feasibility and manipulability.

P15. Check the Water-level Detection System for all possible operating conditions.

P16. Check the sensor range.

P17. Check the condition of each component.

P18. Check all the connections and wiring of the components

0714E&A153 Perform Mini CNC 2D Plotter

Overview: This Project is designed to introduce the student to some application of robotics in industry

Performance Criteria	
P1.	Specify the types of 2D CNC Plotter.
P2.	Identify static base of 2D CNC Plotter.
P3.	Identify the actuators.
P4.	Select the components.
P5.	Identify the sensors.
P6.	Design the model and overall assembly of the robot.
P7.	Assemble the parts
P8.	Select the Controller
P9.	Draw the circuit diagram
P10.	Electric wiring of sensors, actuator and controller
P11.	Design the algorithm flowchart to implement on controller.
P12.	Recognize the power supply distribution for controller and actuator.
P13.	Recognize the program algorithm for the 2D CNC Plotter.
P14.	Program the controller to trace the input image on the page.
P15.	Identification of movement of the 2D CNC Plotter.
P16.	Preform the robot movement detection test
P17.	Check the 2D CNC Plotter feasibility and manipulability.
P18.	Check of 2D CNC Plotter operating conditions.
P19.	Check the condition of each component and overall assembly of the 2D CNC Plotter.
P20.	Check all the connections of the components.

0714E&A154 Perform Voice Controlled Robot

Overview: This Project is designed to introduce the student to some application of robotics in industry

Performance Criteria
P1. Specify the types of Voice Controlled Robot.
P1. Identify mobile base of robot.
P2. Identify the actuators for the robot.
P3. Select the components for robot.
P4. Identify the sensors to recognize the voice instructions.
P5. Design the model and overall assembly of the robot.
P6. Assemble of the parts of line following robot
P7. Select the Controller
P8. Draw the circuit diagram
P9. Electric wiring of sensors, actuator and controller
P10. Design the algorithm flowchart to implement on controller.
P11. Recognize the power supply distribution for controller and actuator.
P12. Recognize the program algorithm for the Voice Controlled Robot.
P13. Program the controller to change direction of robot according to the voice command.
P14. Identification of movement of the Voice Controlled Robot.
P15. Preform the robot movement detection test
P16. Check the robot feasibility and manipulability.
P17. Check of line robot operating conditions
P18. Check the condition of each component and overall assembly of the robot.
P19. Check all the connections of the components.

Tools and Equipment:

The tools and equipment required for this competency standard are given below:

- Manipulator links and joints
- Measuring tool kit
- Robotic fastening tool kit.
- Trainer
- Manipulator links and joints
- Computer system
- Mounting accessories

- ❖ Complete design of the sensor assembly
- ❖ Basic ROV components
- ❖ Complete design of the ROV
- ❖ Software
- ❖ Sensors
- ❖ Wiring and accessories

Hydraulic and Pneumatics

0714E&A155 Operate Hydraulic Bench and Its Functions

Overview: This competency standard covers the skills and knowledge required to provide knowledge for observing Hydraulic Bench, identify various standard parts of Hydraulic Bench and its main functions.

Competency Unit	Performance Criteria
CU-1: Identify parts of hydraulic bench	**P-1.** Enlist all parts of a Hydraulic Bench **P-2.** Identify the Control valve, Drain valve and Dump valve. **P-3.** Identify the Sump Tank and Volumetric Tank. **P-4.** Identify the Open Channel and Vertical Pipe. **P-5.** Identify the Centrifugal Pump **P-6.** Identify the Actuators
CU2:Identify/perform Various Functions of/on Hydraulic Bench	**P-1.** Ensure the pump is switched off. **P-2.** Set up the device to be tested. **P-3.** Attach a water supply for the open channel flow or a close conduct device to the water inlet. **P-4.** Ensure that all connections are secure. **P-5.** Ensure that supply valve is closed, and dump valve is open. **P-6.** Turn ON the power of the pump . **P-7.** Open the valve slowly to allow the water to circulate the bench. **P-8.** Make an appropriate measurement for the testing device for the recommended setting of the supply valve, e.g. pressure reading, water depth etc. **P-0714E&A** Close the supply of the valve after completion of the test. **P-10.** Turn off the valve.

P-11. Disconnect the device which was used for testing.

Knowledge and Understanding

K-1. Describe the purpose of a Hydraulic Bench

K-2. Explain the working of a hydraulic bench with help of circuit diagram.

K-3. Describe the importance of Centrifugal pump in a Hydraulic Bench.

K-4. Describe the function of Main Tank and of Sump Tank.

K-5. Explain the purpose and working of Control valve, Drain Valve and Dump Valve.

K-1. Describe centrifugal pump

K-2. Differentiate between sump tank and volumetric tank

K-3. Differentiate control valve, drain valve and dump valve

K-4. Differentiate main channel and side channels

K-5. Describe water level indicator

K-6. Describe stilling baffle

K-7. Differentiate between overflow and starter

K-8. Read a Schematic Diagram of Hydraulic Bench

Apparatus

- Hydraulic bench
- Control Valve
- Centrifugal pump
- Sump tank
- Vertical pipe
- Channel

- Drain valve
- Volumetric tank
- Water Level Indicator
- Dump valve
- Actuators

0714E&A156 Calibrate Bourdon Tube and Diaphragm Pressure Gauge

Overview: This competency standard covers the skills and knowledge required to record the working principle of mechanical Pressure gauges and incorporate the Calibration Methods for Mechanical Gauges.

Critical Evidence	Performance Criteria
CU-1: Caliberate Bourdon Tube using dead wight Pressure gauge and master gauge Caliberator	**P-1.** Connect the Bourdon Tube with the dead weight pressure gauge. **P-2.** Fill the cylinder of dead weight pressure gauge with water. **P-3.** Place a known weight on the plunger of the dead weight pressure gauge. **P-4.** Note the pressure reading of the gauge to be calibrated. **P-5.** Add more weights of the known values and note corresponding pressure readings. **P-6.** Compare the readings with the values provided in the table. **P-7.** compare the dead weight gauge with the master gauge.
CU-2: Caliberate Diaphragm Pressure Gauge using dead wight pressure gauge and master gauge Caliberator	**P-1.** Connect the Diaphragm Pressure Gauge with the dead weight pressure gauge. **P-2.** Fill the cylinder of dead weight pressure gauge with water. **P-3.** Place a known weight on the plunger of the dead weight pressure gauge. **P-4.** Note the pressure reading of the gauge which is needed to be calibrated. **P-5.** Add more weights of known values and note corresponding pressure readings. **P-6.** Compare these readings with the values provided in the table . **P-7.** compare the dead weight gauge with the master gauge.

Knowledge & Understanding

K-1. Define a pressure gauge

K-2. Describe basic types of pressure gauges

K-3. Describe Bourdon tube gauge

K-4. Differentiate between measuring gauge and calibration gauge

K-5. Describe dead weight pressure gauge

K-6. Describe Pascal's Law

K-1. Describe Diaphragm pressure gauge.

K-2. Describe master gauge calibrator

K-3. Describe calibration Method and Frequency

K-4. Describe Pascal's Law

Apparatus

Deadweight gauge Tester

Weights

Master Gauge Calibrator

Bourdon Tube

Deadweight gauge Tester

Weights

Master Gauge Calibrator

Diaphragm Pressure Gauge

0714E&A157 Operate Hydraulic Press

Overview: This competency standard covers the skills and knowledge required to operate a hydraulic press and observe power required to drive it.

Competency Unit	**Performance Criteria**
CU-1: Operate hydraulic press	P-1. Prepare the work piece as per size requirement. P-2. Ensure / Inspect the press for oil level and other necessary elements. P-3. Turn on the hydraulic press and select the load according to the thickness of the material. P-4. Place the work piece between the die and bench. P-5. Exert a force on the work piece with the help of punch. This would prepare the work piece to fit in the die. P-6. Turn off the hydraulic press and note the observations and calculate the power required to drive the hydraulic press.
CU-2: Obseve the power requirement to drive a Hydraulic press	P-1. Prepare the work piece as per size requirement.correct as the provious P-2. Inspect the press for oil level and other necessary elements. P-3. Turn on the hydraulic press and select the load according to the thickness of the material. P-4. Place the work piece between the die and bench. P-5. Exert a force on the work piece with the using the punch of the press. This would prepare the work piece to fit in the die. P-6. Turn off the hydraulic press and note all observations. P-7. Enter values of Area of Ram, Area of Plunger, length of the stroke of the Plunger, loaded arm and weight lifted by the arm in the Formula to calculate the power required.

Knowledge and Understanding

K-1. Define a hydraulic press

K-2. Describe construction of a hydraulic press

K-3. Describe working principle of a hydraulic press.

K-4. Describe Pascal's Law.

K-1. Enlist all the parameters involved in Formula.

K-2. Explain Mechanical Advantage of a machine.

Apparatus

- Plunger
- Ram
- Chamber
- Weight
- Plunger
- Ram
- Chamber
- Weight

0714E&A158 Verify Bernoulli's Equation

Overview: This competency standard covers the skills and knowledge required to verify Velocity Head, Pressure head and Datum Head as well as Law of Conservation of Energy by measuring pressure and velocity at various points.

Competency Unit	Performance Measure
CU-1: Verification of Velocity Head, Pressure Head and Datum Head	**P-1.** Open inlet valve of hydraulic bench supply tank to allow the water to flow out of the tank. Correct according to the previous suggestions **P-2.** Adjust the valves to obtain continuous flow at inlet and outlet valve. **P-3.** Ensure continuous pressure head in the piezometer tube and note the reading. **P-4.** Determine the water quantity collected in the measuring tank during the time noted by stop watch. **P-5.** Determine the cross-sectional area of piezometer tube. **P-6.** Calculate the velocity head and pressure head. **P-7.** Change input and output supply and note the readings.
CU-2: Observe the performance of friction pipe apparatus	**P-1.** Select a pipe of suitable size as per available equipment for the experiment. Correct according to the previous suggestions **P-2.** Start the flow of water in the pipe with the help of hydraulic bench. **P-3.** Observe the change in mercury level of U-tube manometer due to water flow in the pipe. **P-4.** Note h1 and h2. **P-5.** Note the time from stop watch to fill the water in the tank up to the height of 5 cm. **P-6.** Change the flow and repeat the procedure. **P-7.** Calculate coefficient of discharge.
CU-3: Examine loss of head due to sudden enlargement, Contraction and entrance in a pipe	**P-1.** Note the length and diameter of the pipe present between hydraulic bench and pressure tank. Correct according to the previous suggestions **P-2.** Keep the pressure tank, end of the, pipe open and the other end closed. **P3.** Turn on the power supply of the hydraulic bench. **P-4.** Start the flow water in the circuit. **P-5.** Adjust the flow up to maximum level. **P-6.** Determine the total discharge in the circuit with the help of left and right limbs of U-tube manometer.

	P-7. Keep the pressure tank, end of the, pipe close and the other end opened. **P-8.** Repeat the process.

Knowledge and Understanding

- **K1.** Describe Bernoulli's theorem
- **K2.** Describe piezometer tube
- **K3.** Define velocity head
- **K4.** Define pressure head
- **K5.** Define Datum head
- **K6.** Describe the friction pipe apparatus
- **K7.** Describe the effects of friction on fluid flow
- **K8.** Describe Differential type U-tube Manometer
- **K9.** Define coefficient of discharge
- **K10.** Explain Darey's friction factor
- **K11.** Describe loss of head
- **K12.** Describe co-efficient of loss
- **K13.** Describe G.I. Pipes

Apparatus

- Hydraulic Bench
- Tapered inclined pipe fitted with number of piezometer tube points
- Measuring tank
- Scale
- Stop watch
- Pipe provided with inlet and outlet and pressure tapping
- Differential U-tube manometer
- Hydraulic bench
- Piezometer tube
- Stop watch
- Flow circuit of G.I. Pipes of different fittings via Large bend, Small bend
- Sudden enlargement from 25 mm to 50 mm diameter
- Sudden contraction from 50 mm to 25 mm diameter.
- U-tube differential manometer
- Hydraulic bench

0714E&A159 Analyse the performance of Pumps

Overview: This competency standard covers the skills and knowledge required to observe and analyse centrifugal pump as well as reciprocating pump.

Critical Evidence	Performance
CU-1: Analyze the performance of Centrifugal Pump	**P-1.** Prime the pump **P-2.** Open the gate valve 1 or 2 rotations **P-3.** Start the motor and set the vacuum gauge reading to the required head **P-4.** Note down the following readings • Pressure gauge reading G • Vacuum Gauge Reading V • Time taken for 10 revolutions in the energy meter T • Time taken to fill up 200 cm rise in the collecting tank, t • The difference in the levels of the pressure and vacuum gauges, x **P-5.** Set the vacuum gauge reading to the other heads **P-6.** Note down the readings from the above step G, V, T, and t **P-7.** Take at least 5 sets of readings by varying the head through delivery valve and note down the readings
CU-2: Analyse the performance of Reciprocating Pump	**P-1.** Prime the pump Correct according to the previous suggestions **P-2.** Open the gate valve 1 or 2 rotations **P-3.** Start the motor and set the vacuum gauge reading to the required head **P-4.** Note down the following readings • Pressure gauge reading G • Vacuum Gauge Reading V • Time taken for 10 revolutions in the energy meter T • Time taken to fill up 200 cm rise in the collecting tank, t • The difference in the levels of the pressure and vacuum gauges, x **P-5.** And then set the vacuum gauge reading to the other heads **P-6.** Note down the above readings G, V, T, and t **P-7.** Take at least 5 sets of readings by varying the head through delivery valve and note down the readings.

Knowledge and Understanding

K-1. Describe centrifugal pump working principle

K-2. Describe pump casing

K-3. Describe impeller

K-4. Describe suction pipe and delivery pipe

K-1. Describe reciprocating pump

K-2. Describe suction valve and delivery valve

K-3. Describe crank and connecting rod mechanism

K-4. Describe suction and delivery pipe

K-5. Describe function of Piston

K-6. Differentiate between centrifugal and reciprocating pump.

Apparatus

- Centrifugal Pump
- Test Bench
- Pipe Hoses
- Voltmeter
- Ammeter
- Reciprocating Pump
- Tachometer
- Stop watch
- Pressure gauge
- Energy meter

0714E&A160 Construct circuit for Double Acting Hydraulic Cylinder

Overview: This competency standard covers the skills and knowledge required to actuate a double acting hydraulic cylinder by a switch, speed regulation through throttle valve and flow control valves. It also explains actuation of double acting hydraulic cylinder by one-way throttle valve.

Competency Unit	Performance Criteria
CU-1: Actuate double acting hydraulic cylinder by switch and draw a circuit diagram	**P-1.** Complete all connections of hydraulic circuit as per drawing **P-2.** Turn on the push button switch to start the supply of fluid with which double acting cylinder will start moving **P-3.** Move the piston to initiate the supply from forward stroke **P-4.** Turn on the second push button switch after the piston reaches top dead center. This will start supply in the opposite direction **P-5.** Observe the functions from control valve by varying its speed after the completion of supply in the circuit **P-6.** Note all observations.
CU-2: Actuate double acting hydraulic cylinder by oneway throttle valve	**P-1.** Prepare the hydraulic circuit as per drawing **P-2.** Turn on the circuit power supply and ensure that all accessories are working properly **P-3.** Ensure the throttle valve on return line of the circuit works properly. **P-4.** Open the valve and ensure extra supply of oil to observe quick return of cylinder. **P-5.** Observe the cylinder speed at various positions of the valve. **P-6.** Note all the observations

Knowledge and Understanding

K-1. Describe types of hydraulic cylinder

K-2. Describe Double acting hydraulic circuit

K-3. Describe direction control valve

K-4. Describe function of push button

K-1. Describe throttle valve function

K-2. Describe one way throttle valve

K-3. Explain role of cylinder speed

Apparatus

- Hydraulic bench
- Double acting cylinder
- Pipe hoses And fittings
- Pressure gauges
- Flow control valve
- Direction control valve
- Push button
- Hydraulic bench
- Double acting cylinder
- Pipe hoses and fittings
- Pressure gauges
- One-way Throttle valve
- Direction control valve

0714E&A161 Setup a Pressure Device and Hold Specific Load on a Double Acting Cylinder

Overview: This competency standard covers the skills and knowledge required to use pressure reducing valve on double acting cylinder and holding load on double acting cylinder.

Competency Unit	Performance Criteria
CU-1: Set-up pressure device on a double acting cylinder using pressure reducing valve	**P-1.** Complete the hydraulic circuit as per given drawing **P-2.** Turn on the circuit supply and check if all devices are working properly **P-3.** Ensure the Fluid starts flowing and the initially adjusted pressure is passed on to the circuit while passing through the relief valve. **P-4.** Observe and note the pressure reading at various pressure gauges. **P-5.** Change direction with the help of DCV and ensure control of double acting cylinder according to this direction. **P-6.** Re-observe and re-note the readings on all the pressure gauges.
CU-2: Hold specific load using double acting cylinder	**P-1.** Complete the hydraulic circuit as per given drawings. **P-2.** Turn on the circuit supply and check if all devices are working properly **P-3.** Adjust pressure according to desired/required load. **P-4.** Ensure fluid flow from port A. This would uplift the load. **P-5.** Now change the position of DCV and ensure fluid entrance from port B. **P-6.** Observe the downward motion of loaded ram. **P-7.** Record / Take the pressure reading and observe the cylinder return.

Knowledge and Understanding

- **K1.** Describe pressure reducing valve
- **K2.** Describe purpose of double acting cylinder as a pressure device
- **K3.** Describe applications of double acting cylinder with the pressure pipe
- **K4.** Describe function of pilot operated check valve
- **K5.** Describe DCV
- **K6.** Describe the role of RAM

Apparatus

- Hydraulic Bench
- Double ACTING Cylinder
- Pressure reading valve
- DCV pipe hoses

- Hydraulic bench
- Double acting cylinder
- Pilot operated check valve
- Direction control valve
- Various loads
- Pipe hoses
- Pressure gauges

0714E&A162 Construct Circuit of Double Acting Hydraulic Cylinder for Mechanical Interlocking

Overview: This competency standard covers the skills and knowledge required to construct a hydraulic cylinder for mechanical interlocking and use of push buttons, limit switch and stored energy in double acting hydraulic cylinder

Competency Unit	Performance Criteria
CU-1: Construct a hydraulic circuit for double acting hydraulic cyclinder for mechanical interlocking with switch	**P-1.** Complete the hydraulic circuit as per drawings. Correct according to the previous suggestions **P-2**. Turn on the circuit supply and check if all devices are working properly **P-3.** Operate hydraulic circuit **P-4.** Try lift some weight **P-5.** Drop the pressure using pressure gauge before the piston starts moving **P-6.** Construct Hydraulic Circuit Diagram **P-7.** Construct electric circuit diagram
CU-2: Construct circuit to control double acting Hydraulic Cylinder using 2 push buttons and canceling with limit switch	**P-1.** Prepare simulation circuit of double acting cylinder as per drawing Correct according to the previous suggestions **P-2.** Fix the push button and limit switch at their designated place as per drawing **P-3.** Turn on the circuit power supply and ensure proper working of all equipment. **P-4.** Press the push button to start fluid supply and will enable the cylinder for forward stroke supply. **P-5.** Observe that as the push rod touches limit switch the supply of coil would disconnect and the piston would stop. **P-6.** Press the second push button to complete backward stroke of piston, this will enable the supply of side coil and the backward stroke of piston would be completed and as it enters the surroundings of limit switches the supply would be disconnected. **P-7.** Change 5/2 DCV and complete the opposite circuit. **P-8.** Observe this changed circuit and note down all the observations.
CU-3: Construct hydraulic circuit using Accumulator stored Energy by DAC	**P-1.** Complete the hydraulic circuit as per drawing. Correct according to the previous suggestions **P-2.** Turn on the motor power supply and ensure proper working of all devises and equipment. **P-3.** Use flow control valve to ensure fluid flow.

	P-4. Observe the movement of piston rod. **P-5.** When the circuit is burnt/completed the turn off the power supply. **P-6.** Observe that due to accumulator the double acting cylinder completes its stroke and doesn't stop immediately after the burning of circuit.
CU4: Measure pressure at various connections in hydraulic circuits	**P-1.** prepare the hydraulic circuit as per drawing Correct according to the previous suggestions **P-2.** install pressure gauges on the points where pressure is to be noted **P-3.** Turn on the hydraulic circuit **P-4.** Ensure fluid flow through the whole circuit **P-5.** Complete the circuit and note the readings of all gauges **P-6.** Enter all readings in observation table

Knowledge and Understanding

K1. Describe mechanical interlocking function
K2. Describe the function of hydraulic circuit
K3. Describe double acting hydraulic cylinder
K4. Describe 3/2 push buttons
K5. Describe 5/2 double acting side pilot operated DCV
K6. Describe function of connecting tubes
K7. Describe function of limit switches
K8. Describe the role of accumulator
K9. Describe mechanism of energy storage in accumulator
K10. Describe working of hydraulic accumulator
K11. Describe fluid port
K12. Describe construction of hydraulic actuator
K13. Describe function of actuators
K14. Describe coupling
K15. Describe functioning of chillers
K16. Describe proximity switch or limit switch
K17. Describe purpose of hydraulic circuit
K18. Draw analogy between hydraulic and electrical circuit
K19. Describe function of pressure control valve
K20. Describe flow control valve

Apparatus

- Hydraulic bench

- Mechanical interlocking
- Double acting cylinder
- Fluid control valve
- DC pressure Gauges
- Double acting cylinder
- 3/2 push button
- 5/2 double acting side pilot operated DCV
- Contacting tubes
- Hydraulic bench
- Push button
- Limit switch
- Pressure gauges
- Hydraulic Bench
- Double Acting Cylinder
- Accumulator Flow Control
- Valve
- DCV
- Pipe Hoses
- Pressure Gauges
- Hydraulic bench
- Pressure control valve
- Flow control valve
- Hydraulic pump hoses

0714E&A163 Set Speed and Direction of Hydraulic Motor

Overview: This competency standard covers the skills and knowledge required to set-up a hydraulic motor using flow control valve and setting-up direction using direction control valve.

Competency Unit	Performance Criteria
CU-1: Set hydraulic motor R.P.M using flow control valve	**P-1.** Complete the hydraulic circuit as per drawing. Correct according to the previous suggestions **P-2.** Turn on the motor power supply and ensure proper working of all devises and equipment. **P-3.** Fix the tachometer with the rotor to note motor RPM **P-4.** Use flow control valve to control the flow, this would also control the motor RPM. **P-5.** Observe the speed during this process. **P-6**. Note RPM at different flow rates and analyze them.
CU-2: Set hydraulic motor direction by using direction control valve	**P-1.** Complete the hydraulic circuit as per drawing. **P-2.** Turn on the motor power supply and ensure proper working of all devises and equipment. **P-3.** Use DCV to rotor the motor Clockwise and Anti Clockwise. **P-4.** Observe the direction during this process. **P-5.** Repeat the process.

Knowledge and Understanding

K-1. Describe hydraulic motor

K-2. Describe operating principle of hydraulic motor

K-3. Describe tachometer

K-4. Describe flow control valve

K-5. Describe DCV

Apparatus

- Hydraulic bench
- Hydraulic motors
- Tachometer
- Flow control valve
- Direction control valve
- Pipe hoses
- Pressure gauges

0714E&A164 Operate Pressure Measuring Instruments

Overview: This competency standard covers the skills and knowledge required to identify, and explain the construction and working of various pressure measuring devices.

Competency Unit	Performance Criteria
CU-1: U Tube Manometer	**P-1.** Set up the equipment. **P-**2 Connect one leg of manometer to the inlet port and the other leg to the outlet port. **P-**3 Initiate the flow of fluid through the test pipe. P-4. Compute the pressure difference between the pipe inlet and outlet. P-5. Repeat the experiment for various flow rates of fluid through the test pipe.
CU-2: Inclined manometer	P-5. Set up the equipment. Connect one leg of inclined manometer to the inlet port and the other leg to the outlet port. Initiate the flow of fluid through the test pipe. Correct according to the previous suggestions P-6. Observe the difference in head between the two legs of the manometer and record. P-7. Compute the pressure difference between the pipe inlet and outlet. P-8. Repeat the experiment for various flow rates of fluid through the test pipe.
Cu-3: Micro Manometer	P-1. Observe the enlarged ends of both tubes of the manometer P-2. Adjust the instrument initially as p1 = p2. P-3. Record / Note down the reading of the micrometer P-4. Apply the unknown pressure difference P-5. Observe the meniscus to move off the hairline, which can be restored to the initial position by raising or lowering the well (mercury sump). P-6. Note down the difference in the initial and final micrometer readings P-7. Note down the height of the mercury column and hence the pressure.
CU-4: Pressure measurement in The Mercury Barometer	P-1. Take a reservoir and fill it with any fluid P-2. Put a glass tube in the reservoir in the inverted state P-3. Make the top portion of glass tube as air tight while the internal surface as complete vacuum P-4. When the glass tube is dipped in the tank, an improper balanced pressure is created P-5. Observe the water from the tank rises in the tube

	P-6. Note that the water would ? rise to particular height/ limit P-7. Note down the point where the water will stop lifting up P-8. This pressure noted directly from the scale of the tube would give us the exact atmospheric/ air pressure
CU-5: Borden Tube	P-1. Observe the device consisting of a metallic tube of elliptical section closed at one end A P-2. Note the other end B being fitted to the gauge point where the pressure is to be measured. P-3. Enter the fluid in the tube P-4. Observe the tube tending to straighten. P-5. Observe a pinion-sector arrangement pivoted with the pointer needle and already calibrated markings P-6. Note the small elastic deformation of the tube is communicated to a pointer over a graduated dial. P-7. Calibrate the device by subjecting it to various known pressures.
CU-6: Piezo Metric Tube	P-1. Close all the valves of the tubes manifold . P-2. Fill the tank until the lower part of the piezo metric tube is in contact with water. P-3. Connect the pump to the upper plug of the tank with the non-return valve in the correct direction and pressurize the tank. P-4. Observe if the water head in the piezo metric tube rises. P-5. Observe the level whether it is constant or not, when the is stopped.
CU-7: Elastic Diaphragms	P-1. Observe the diaphragm is fixed in a tubular member. P-2. Observe the initial pressure on a diaphragm P-3. Apply the unknown pressure from one side. P-4. Observe a direct connection between diaphragm and pinion-sector P-5. Observe a pinion-sector arrangement pivoted with the pointer needle and already graduated markings on the dial P-6. Note that the small elastic deformation of the diaphragm is communicating with the pointer over the graduated dial.

Knowledge and Understanding

K1. Differentiate between absolute pressure and gauge pressure

K2. Differentiate between u tube inclined and differential manometer

K3. Pressures as low as 0.025 mm water column can be measured.

K4. What is a barometer

K5. What is the basic function of a barometer

K6. Explain the selection process of a pressure gauge

K7. Write the types of Bourdon tubes

K8. Explain the purpose of different Bourdon tubes

K9. Explain the formula for calculating a static head

K10. Convert a pressure gauge into a level gauge

K11. Mention the units of Pressure

K12. Explain the necessity of putting the plug in the tank

K13. Explain natural frequency

Apparatus

U Tube Manometer, Hydraulic Bench (if working fluid is water), Air Compressor (if working fluid is air), Scale

Inclined Manometer, Hydraulic Bench (if working fluid is water), Air Compressor (if working fluid is air), Scale

0714E&A165 Operate Flow Regulating Devices

Overview: This competency standard covers the skills and knowledge required to identify, evaluate and explain different types of valves.

Competency Unit	Performance Criteria
CU-1: Ball Valve	P-1. Identify the various parts of the ball valve including Handle, shaft, Ball, Seats and valve body P-1. Observe a ball with a hole drilled through the center swivel mounted within the valve body P-2. Ensure the hole in the ball is orientated in the same direction as the pipe to allow flow P-3. Observe the hole in the ball is oriented away from the direction of the pipe (flowrate will be restricted and finally cut off completely when the hole is oriented at 90 degrees to the pipe direction) P-4. observe / Note that whether the hole in the ball is smaller in diameter than bore of the pipe .
CU-2: Butterfly Valve	P-1. Identify the gear box, handle, butterfly and the body of the butterfly valve P-1. Observe a circular disc in the middle of fluid pipe. P-2. Ensure that the butterfly is oriented in the same direction as the pipe in order to allow the full flow. P-3. Orient the butterfly away from the direction of the pipe, the flowrate will be restricted by the increased area of obstruction to the fluid P-4. Keep the butterfly orienting away from the fluid until 90 degrees to completely restrict the flow
CU-3: Gate valve	P-1. Identify gate and body of the gate valve Correct according to the previous suggestions P-1. Identify the gate in the valve P-2. Identify the shape of the gate with respect to the pipe diameter P-3. Identify the direction of movement of the gate P-4. Ensure the complete upward motion of the gate for full flow of the fluid P-5. Ensure compete downward motion of the gate until the opposite end for complete restriction to the fluid flow.
CU-4: Diaphragm Valve	P-1. Identify bonnet, diaphragm/ flexible sheet, seat and main body of the valve Correct according to the previous suggestions P-2. Identify whether the valve is manual or pneumatic actuated

	P-3. observe the fluid flow rates from the pipe as the diaphragm is pushed towards the seat for complete obstruction to the flow
CU-5: Non Return Valve	P-1. Identify the following parts in a non-return/ check valve: body, cover plate, disc, seats, hinge, hinge pin, nut, cotter pin, stud bolt, gasket, washer Correct according to the previous suggestions P-2. observe the fluid flow as the disk is released P-3. observe the disk being fixed as the flow direction is reversed
CU-6: Pressure Relief Valve	P-1. Identify the following parts in pressure relief valve: set pressure adjusting screw, spring, disk holder, seat disk, nozzle, bonnet, bonnet plug and body Correct according to the previous suggestions P-2. identify various types of pressure relief valve P-3. observe system pressure and spring pressure P-4. observe the valve opening as the system pressure increases then spring pressure

Knowledge and Understanding

K1. Define a valve
K2. Identify applications of Ball Valve
K3. Explain the safety precautions of ball valve
K4. explain the terminology of ‘butterfly valve’
K5. identify its industrial applications
K6. Explain the safety precautions of Butterfly Valve
K7. describe Gate/ Knife gate valve
K8. explain the isolation valves
K9. explain the precaution for knife gate valve
K10. Explain the safety precautions of Gate valve
K11. Compare diaphragm and gate valve
K12. Explain the industrial applications of diaphragm valve
K13. Explain the safety precautions of Diaphragm Valve
K14. Mention and explain various types of non-return valve
K15. Explain unidirectional valve working mechanism
K16. Identify various industrial applications of Non-return valve
K17. Explain the safety precautions of Non Return Valve
K18. Explain the safety aspects of pressure relief valve
K19. Describe industrial applications of Pressure relief valve

K20. Explain the safety precautions of Pressure Relief Valve

Apparatus

- Ball Valve
- Section view drawing of Ball Valve
- Butterfly Valve
- Section view drawing of Butterfly Valve
- Gate Valve
- Section view drawing of Gate Valve
- Diaphragm Valve
- Section view drawing of
- Non Return Valve
- Section view drawing of Non Return Valve
- Pressure Relief Valve
- Section view drawing of Pressure Relief Valve

Entrepreneurship

0714E&A166. Investigate micro business opportunities

Overview: This competency describes the performance outcomes, skills and knowledge required to develop business ideas, and to investigate market needs and factors affecting potential markets.

Competency Unit	Performance Criteria
CU-1.**Describe business ideas**	**P1.** Gather information for business ideas from appropriate sources **P2.** List details of business ideas and opportunities **P3.** Research alternative business ideas in light of the resources available **P4.** Specify and list products and services to match business ideas **P5.** .Identify and research potential customer information for business ideas **P6.** Identify and take into account financial, business and technical skills available when researching business opportunities

CU-2. **Identify market needs**	**P1.** Collect information regarding market size and potential from appropriate sources **P2.** Investigate market trends and developments to identify market needs relative to business ideas **P3.** Gather market information from primary and secondary sources to identify possible market needs in relation to business ideas **P4.** Identify ethical and cultural requirements of the market and their impact on business ideas **P5.** Identify new and emerging markets and document their features **P6.** Identify and organise information on expected market growth or decline and associated risk factors
CU-3. **Investigate factors affecting the market**	**P1.** Identify projected changes in population, economic activity and the labour force that may affect business ideas **P2.** Identify movements in prices and projected changes in availability of resources **P3.** Review trends and developments and identify their potential impact on business ideas

Knowledge and understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

K1. Define entrepreneurship.
K2. Explain the concept of entrepreneurship
K3. Explain the various types of enterprise that exist in the community
K4. Identify and interpret the terms and elements involved in the concept of enterprise
K5. Appreciate that the advancement of individual and society in general when entrepreneurship is adopted
K6. Explain various motivational factors that entrepreneurs possess and utilize.
K7. Exhibit the skills needed to assess and evaluate a risk
K8. Describe the outline of small enterprise
K9. Describe the creativity and innovation
K10. Apply the techniques for developing creative abilities

K11. Explain the resources of business idea

K12. Explain the collective and creative thinking

K13. Explain how to generate a business idea

K14. Appreciate the importance of, and possess techniques for identifying and assessing business opportunities.

K15. Identify the various entrepreneurial characteristics

K16. Access personal potential for becoming future entrepreneurs.

K17. Identify leadership qualities which are essential to the success of entrepreneurs

K18. Identify self- management skills and how they are important to be enterprising

K19. Apply a rational approach to make personal and business decisions

K20. Explain the steps for decision making and rating of decision making skills

K21. Apply the rules of negotiation for resolving business issues

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

Evidence of the following is essential:

- Thorough investigation of business opportunities and ideas
- Clearly identified products/services and customer information for each business idea
- Thorough collection and analysis of market information and associated factors relating to business ideas
- Knowledge of ethical and cultural requirements.

Instruments & Consumables

S No.	Description (Instruments)
1	Calculator
2	Ruler
3	Papers and Pencil

0714E&A167. Develop a micro business proposal

Overview: This competency describes the performance outcomes, skills and knowledge required to develop an identified business idea, to research the feasibility of the business opportunity and to present a business idea in formats that suit a range of stakeholders

Competency Unit	Performance Criteria
CU1. Evaluate business opportunities	**P1.** Identify and research key factors that influence viability of business ideas **P2.** Analyze business ideas in terms of personal or family needs and commitments **P3.** Evaluate impacts of emerging or changing technology, including e-commerce, on the business **P4.** Determine viability of business opportunity in line with perceived risks, resources available, financial returns and other outcomes sought **P5.** Assess and match personal skills/attributes against those perceived as necessary for a particular business opportunity **P6.** Identify and assess business risks according to resources available and personal preferences
CU2. Detail the business idea	**P1.** .Develop an accurate description of the business idea for key stakeholders **P2.** Develop an accurate summary of the major products and/or services required to suit personal needs and requirements
CU3. Prepare the business overview to suit different stakeholders	**P1.** Present an accurate list of key stakeholders and their information requirements **P2.** Determine an acceptable method of presentation of information for each stakeholder **P3.** Provide accurate customized information to target audiences

Knowledge and understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

K1. State and local government legislative requirements relating to business operation, especially in regard to occupational health and safety (OHS) and environmental issues,

K2. Income and expenditure costing

K3. Principles of risk assessment relevant to the business opportunity

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

Evidence of the following is essential:

- accurate and complete outline of the business idea that considers the major elements of:
  - products/services
  - customers
  - operations and processes
  - income and expenditure
  - resources
  - marketing
  - location

Instruments & Consumables

S No.	Description (Instruments)
1	Calculator
2	Ruler
3	Papers and Pencil

0714E&A168. Develop a marketing plan

Overview: This competency describes the performance outcomes, skills and knowledge required to research, develop and present a marketing plan for an entrepreneurship business

Competency Unit	Performance Criteria
CU-1. **Devise marketing strategies**	**P1.** Evaluate ***marketing opportunity options*** that address organizational objectives, and evaluate their risks and returns in the selection process **P2.** Develop ***marketing strategies*** that address strengths and opportunities within the organization's projected capabilities and resources **P3.** Develop strategies which increase resources or organizational expertise where gaps exist between current capability and marketing objectives **P4**.Develop feasible marketing strategies and communicate reasons that justifies their selection **P5**. Ensure strategies align with organization's strategic direction **P6.**Develop a ***marketing performance review strategy***, incorporating appropriate marketing metrics to review of organizational performance against marketing objectives
CU-2. **Plan marketing tactics**	**P1.** Detail tactics to implement each marketing strategy in terms of scheduling, costing, accountabilities and persons responsible **P2.** Identify coordination and monitoring mechanisms for scheduled activities **P3.** Ensure tactics are achievable within organization's projected capabilities and budget **P4.** Ensure tactics meeting ***legal and ethical requirements*** **P5.** Ensure tactics provide for ongoing review of performance against objectives and budgets, and allow marketing targets to be adjusted if necessary

CU-3. **Prepare and present a marketing plan**	**P1. Ensure marketing plan meets organizational, as well as marketing, objectives and incorporates** *marketing approaches* **and a strategic** *marketing mix* **P2. Ensure marketing plan contains a rationale for objectives and information that supports the choice of strategies and tactics** **P3. Present marketing plan for approval in the required format and timeframe** **P4. Adjust marketing plan in response to feedback from key stakeholders and disseminate for implementation within the required timeframe**

Knowledge and understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of: Culturally appropriate communication skills to relate to people from diverse backgrounds and people with diverse abilities

KI. Describe the market & marketing
K2 Differentiate between sellers and buyers' market
K3. Describe the five 'w' of market
K4. Explain the procedure for assessing the market size and demand
K5. Explain the major factors to be considered when selecting a location for a business
K6. Describe the basic types of business ownership and the limitation of each
K7. Explain the computation of initial and working capital needed to start an enterprise
K8. Identify the advantages and disadvantages of using various sources of capital to start an enterprise
K9. Explain the component of cost of product
K10. Explain the breakeven analysis for a new business
K11. Calculate the breakeven point for various new business

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Devising, documenting and presenting a marketing plan
- Detailing approaches and
- The marketing mix to achieve organizational marketing objectives.

Instruments & Consumables

1 Calculator, 2 Ruler, 3 Papers and Pencil

0714E&A169. Develop and review a business plan.

Overview: This competency standard covers the process of developing and reviewing business for a small business enterprise. It requires the application of knowledge and skills to determine the scope of the business plan, prepare a business plan, determine goals, trial systems, and document, monitor and review the business plan.

Competency Unit	Performance Criteria
CU-1. Determine scope of business	**P1.** Determine scope of the business plan and associated systems is determined in consultation with specialist personnel. **P2.** Access accurate information for inform business plan development **P3.** Account for and incorporate trends and seasonal variations into the business plan. **P4.** Account for strategic goals, targets and directions of the enterprise in the development of the business plan **P5.** Comply Legal obligations in developing the business plan.
CU-2. Prepare business plan	**P1.** Develop operational goals and targets **to meet the enterprise strategic plan.** **P2.** Identify and incorporate supply chains **into the business plan.** **P3.** Identify risk management needs **are within the business plan.** **P4.** Incorporate trial systems **in order to test budgetary impact and operational potential prior to full implementation of the business plan.** **P5.** Set clear and measureable indicators of operational

	performance **to allow for realistic analysis of performance.**
CU-3. Document and review business plan	**P1.** Include fiscal and operational systems that enhance performance management and suit enterprise requirements. **P2.** Incorporate resource considerations the business plan. **P3.** Document accurately and clearly communicate business Plan to all relevant parties. **P4.** Monitor to identify strengths, weaknesses and areas for improvement performance against the business plan **P5.** Make recommendations to improve the business plan and associated systems as required.

Knowledge and understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

K1. Appreciate the importance of business plan

K2. Explain the process of writing a business plan

K3. Develop feasibility for a business idea

K4. Realize the problem that may be encountered when starting a small business/Enterprise

K5. Develop a business plan for a small business on the standard format

K6. Evaluate the business plan in a real market satiation

K7. working knowledge of environmental, OHS, industrial relations, taxation, corporate and industry legislation as they relate to the enterprise

Critical Evidence(s) Required

The candidate needs to produce following critical evidences in order to competent in this competency standard.

Competence in develop and review a business plan requires evidence that demonstrates ability to scope the business plan and determine key objectives and targets. It also requires competence in specifying key performance targets, assessing the relevance of the business plan, and trial systems. The business plan also needs to be documented and reviewed.

The skills and knowledge required to develop and review a business plan must be **transferable** to a different work environment. For example, if competence is demonstrated in developing a business plan for a small enterprise, it must also be evident in reviewing a business plan in medium or large enterprise environment.

Instruments & Consumables

S No.	Description (Instruments)
1	Construction Lab Tools
2	Rule, tape, square, hammer, hand saw, hand plane, chisel, shovel, wheelbarrow, sledge hammer, pick, mattock and crow bar and pinch bar for given tasks.

0714E&A170. Organise finances for the micro business

Overview: This competency standard describes the performance outcomes, skills and knowledge required to investigate the financial capacity to enter into a micro business, to determine the projected cash flow, to source finances and to monitor the profitability of the business.

Competency Unit	Performance Criteria
CU-1. **Ascertain own financial position and the ability to provide capital/equity for the business**	**P1.** Realistically detail personal, family or community financial situation in terms of funds available and commitments already incurred **P2.** Determine equity finance and assets available for micro business from personal, family or community sources
CU-2. **Determine projected cash flow for the business**	**P1.** Determine the level of forecast business activity over a year and the business mix **P2.** Estimate establishment costs for the business and repayment schedule for borrowings **P3.** Calculate the monthly variable and fixed costs needed to conduct business activity over a year **P4.** Estimate personal drawings needed to be taken from the business **P5.** Estimate the monthly income generated by the business for a year based on price per unit item or hourly charge rate for labor **P6.** Develop a cash flow budget for the first year of business operation **P7.** Seek professional advice to estimate goods and services tax and operating finance required for the business

CU-3. Source the required funds to establish the business	**P1.** Estimate required funding to establish and run the business based on expected sales and activity levels, available finances and commitments **P2.** Investigate methods of accessing alternative sources of finance **P3.** Identify strategies for meeting financial obligations **P4.** Implement plans to access available funds as required
CU-4. Monitor profitability of the business	**P1.** Maintain and review monthly expenditure and income records **P2.** Compare equity at beginning and end of a year to estimate business performance **P3.** Assess the financial viability of the business after a year of operation **P4.** Seek professional advice on depreciation, insurance and tax implications of the business

Knowledge and understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

- **K1.** Basic budgeting
- **K2.** basic costing for the business
- **K3.** financial commitments and requirements
- **K4.** financial reports and terminology
- **K5.** methods and relative costs of obtaining finance
- **K6.** own financial position
- **K7.** Sources of advice and assistance.

Critical Evidence(s) Required

The candidate needs to produce following critical evidences in order to competent in this competency standard.

Evidence of the following is essential:

- investigation of own financial position and needs
- investigation of projected cash flow for the business
- estimation of the funding needed to establish and operate the business
- assessment of the financial viability of the business
- Knowledge of basic budgeting.

0714E&A171. Manage human resources

Overview: This competency standard covers the skills and knowledge required to manage human resources and to manage and develop human resources to achieve organization's operational objectives

Competency Unit	Performance Criteria
CU-1. Lead and motivate people	**P1.** Establish goals for people and teams to optimize achievement in work tasks. **P2**. Take into account the capabilities of people and teams. **P3.** Provide advice and support sensitive to the individual's needs to people in the performance of their duties. **P4.** Undertake activities to achieve commitment to common goals. **P5.** Recognize and encourage initiative and innovation **P6.** Recognize and communicate achievements within the organization.
CU-2. Undertake human resource planning	**P1. Determine human resource needs** within the anticipated operational needs and allocated budget. **P2.** Analyze alternatives to staffing levels which clearly demonstrate returns to the organization. **P3.** Develop contingency plans for staffing which meet key provisions of the human resources plan. **P4.** Compare existing competencies of staff with the needs of the work group. **P5.** Plan staffing levels and negotiate with stakeholders within the organisational framework to achieve maximum efficiency of operations.
CU-3. Develop and facilitate performance	P1. Negotiate performance criteria individuals, teams and work groups. P2. Review performance criteria as circumstances change. P3. Conduct performance appraisal based on clearly established and agreed performance criteria. P4. Identify and propose the total performance development system strategies to rectify performance shortfalls and

	recognize success. P5. Address performance problems confidentially and in a constructive and timely manner, in line with relevant organizational procedures. P6. Make selections, transfers and promotions in accordance with organization policies and supported with documented information. P7. Develop and implement mechanisms for the identification of human resource development needs within the work group taking account of the strategic plan for the organisation.
CU-4. Facilitate training, education and development opportunities	**P1.** Make information on planned training events widely available throughout the organization. **P2.** Include training, education and development plans as part of individual/team performance plans. **P3.** Facilitate individual/team access to, and participation in, training, education and development opportunities. **P4.** Contribute coaching and mentoring effectively to the training, education and development of personnel in an environment of change. **P5.** Enhance training, education and development opportunities of individual, team and organizational performance. **P6.** Create workplace environment is which facilitates training, education and development

Knowledge and understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

K1. Describe the hiring method/Procedures

K2. Describe the term & conditions of services and job description for various employments

K3. Describe the characteristics of successful sales personals

K4. Communication principles
K5. Conflict resolution principles and practice
K6. Equal Employment Opportunity
K7. Grievance procedures
K8. Interpersonal relations
K9. Leadership theory and principles
K10. Management principles and practice
K11. Occupational Health and Safety
K12. Training and education principles
K13. Training need analysis

Critical Evidence(s) Required

The candidate needs to produce following critical evidences in order to competent in this competency standard.

- It is essential that competence be demonstrated in the application of human resource management in a wide range of contexts in achieving the organisation's objectives.
- Evidence should be gathered over a period of time in a range of actual or simulated workplace environments.
- Evidence of competent performance should be obtained by observing an individual in a management role within the workplace or exercise or operational environment. Knowledge may be assessed through written assignments, project reports, debriefings and action learning projects.

0714E&A172. Market products and services

Overview: This competency standard covers the skills and knowledge required to analyze market information, Identify and evaluate factors to include in a marketing plan, Develop a marketing plan for your products and services, Determine promotional strategies, Implement marketing activities and Evaluate marketing performance.

Competency Unit	Performance Criteria
CU1. Analyze market information	**P1.** Identify, research and analyze existing or new markets for existing or new products or services using techniques to ensure reliable data **P2.** Analyze past trends and developments to determine market variability and associated risks **P3.** Develop gross margin budgets to account for market variability **P4.** Identify and evaluate competing products to determine strengths and weaknesses of own products **P5.** Monitor market environment to ensure information is current and reliable **P6.** Identify the legal, ethical and environmental constraints of the markets and their effect on the enterprise **P7.** Identify product specifications that suit market requirements and price advantage at the time **P8.** Present clear and concise information to the enterprise management team.
CU2. Identify and evaluate factors to include in a marketing plan	**P1.** Identify and evaluate production processes to ensure required product specifications are met **P2.** Identify and assess alternative selling strategies and techniques to identify marketing targets and methods **P3.** Identify and assess distribution channels and their role in your marketing strategies **P4.** Ensure the data used is reliable and the market environment and trends are substantiated **P5.** Evaluate the role of marketing professionals in providing advice
CU3. Develop a	**P1.** Establish marketing objectives based on current and potential

marketing plan for your products and services	product specifications **P2.** Select appropriate production processes to ensure product specifications are met **P3.** Select selling strategies to ensure required prices are achieved **P4.** Select appropriate distribution channel options to ensure access to target markets is achieved efficiently and appropriately **P5.** Establish time-frames for production, distribution and selling activities **P6.** Develop a gross margin budget to demonstrate the cost effectiveness of the marketing plan **P7.** Develop partial gross margin budgets to account for market variability
CU4. Determine promotional strategies	**P1.** Prepare and record detailed plans for promotional activities **P2.** Outline objectives, level of exposure and available markets **P3.** Ensure strategies take account of time management and scheduling issues, and resource constraints **P4.** Create promotional materials that enhance the product and commercial presentation **P5.** Record and communicate priorities, responsibilities, timelines and budgets for promotional activities.
CU5. Implement marketing activities	**P1.** Schedule planned marketing activities within appropriate timeframes **P2.** Develop measurable performance targets that meet business plan objectives **P3.** Organize distribution channels and ensure product and service information is accurate and readily available to clients **P4.** Implement marketing activities within budgetary constraints to meet legal, ethical and enterprise requirements
CU6. Evaluate marketing performance.	**P1.** Review the established marketing objectives to ensure they remain viable **P2.** Make an objective assessment of the marketing plan and its implementation by a comparison of valid and reliable data against the established objectives **P3.** Assess product, pricing and distribution policies in relation to

	market changes, marketing objectives and enterprise requirements **P4.** Identify areas of positive marketing performance and take corrective action to remedy poor marketing performance areas **P5.** Document and distribute information for continual analysis and effective planning management

Knowledge and understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

K1. Describe the life cycle of product
K2. Identify the various ways of selecting suppliers,
K3. Explain the inventory management of stock, raw material and finished goods etc.
K4. Appreciate the importance of financial record keeping in a small business
K5. Explain techniques to keep cost as low as possible
K6. Develop balance sheet for a small enterprise
K7. Explain the operating cycle concept
K8. Explain the income tax computation procedure for a small business
K9. Explain the basic scheme of sales tax
K10. Explain the assessment procedure for returns and filling of returns.

Critical Evidence(s) Required

The evidence required to demonstrate competency in this unit must be relevant to workplace operations and satisfy holistically all of the requirements of the performance criteria and required skills and knowledge and include achievement of the following:

- identify the marketable features of the product and potential markets
- develop a range of marketing alternatives
- collect and analyses data to assess alternatives in a marketing plan
- evaluate performance targets and recommend modifications or improvements
- implement and evaluate a marketing plan
- Plan to manage promotional activities.

0714E&A173. Monitor and review business performance

Overview: This competency standard covers the skills and knowledge required to evaluate commercial performance, Allocate and co-ordinate business resources, Identify performance requirements and Review business performance

Competency Unit	Performance Criteria
CU-1. Evaluate commercial performance	**P1.** Gather and analyze data relating to enterprise performance to identify historical and current performance. **P2.** Review and analyze operational structures to determine the suitability of organizational processes to enterprise objectives. **P3.** Evaluate enterprise strengths and weaknesses against market conditions to determine current and future capacities. **P4.** Evaluate enterprise objectives are to identify variations and scope for future development.
CU-2. Allocate and co-ordinate business resources	**P1.** Identify and communicate roles and responsibilities of personnel. **P2.** Identify resource requirements for enterprise and cost them using standard financial analysis techniques. **P3.** Calculate costs of ensuring sustainability of enterprise operations and factor into business planning for the enterprise.
CU-3. Identify performance requirements	**P1.** Develop realistic performance indicators within available timeframes and resources **P2.** Identify and minimize factors inhibiting performance against objectives. **P3.** Monitor and assess market conditions based on relevant data. **P4.** Prepare and incorporate strategies and programs to promote the sustainability of operations into enterprise procedures.
CU-4. Review business performance	**P1.** Review regularly enterprise operations to identify opportunities for improvements in performance. **P2.** Monitor and anticipate impact of natural conditions on enterprise to assess sustainability of resource use. **P3.** Compare costs and estimates with resource allocation. **P4.** Determine operational plans to determine schedule of activities

Knowledge and understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

K1. Rates of return for products and/or services
K2. Financial analysis techniques
K3. Structure and operation of small businesses relevant State/Territory Occupational Health and Safety (OHS)
K4. Legislative requirements
K5. Environmental conditions, positive environmental practices and negative impact minimization measures
K6. Human resource requirements for the enterprise
K7. Transport requirements for the enterprise
K8. Enterprise/property improvement requirements.
K9. Market performance in commodities
K10. Statutory marketing requirements

Critical Evidence(s) Required

The evidence required to demonstrate competency in this unit must be relevant to workplace operations and satisfy holistically all of the requirements of the performance criteria and required skills and knowledge and include achievement of the following:

- gather and analyze data relating to enterprise performance
- review operational structures to determine effectiveness
- identify available resources to assess capacity
- develop realistic performance indicators
- review enterprise operations against performance indicators
- Plan to improve business performance by addressing results of review.

0714E&A174. Negotiate for resolving business issues

Overview: This competency standard covers the skills and knowledge required to Develop and implement issue resolution and grievance procedures and Manage disciplinary matters

Competency Unit	Performance Criteria
CU-1. Develop and implement issue resolution and grievance procedures	**P1.** Establish problem solving/issue resolution procedures within legislative requirements and organization's guidelines. **P2.** Manage grievances and complaints are in a timely and caring way to optimize likelihood of a favorable outcome for all parties and in line with organizational objectives and procedures. **P3.** Document and communicate individual's rights and obligations under industrial awards/agreements and legislation are in a clear and concise manner and in appropriate language. **P4.** Conduct hearings, interviews and meetings within the principles of industrial democracy and participative, consultative processes. **P5.** Identify and invite all relevant industrial parties to participate in the resolution process.
CU-2. Manage disciplinary matters	**P1.** Implement disciplinary matters in accordance with organization's procedures. **P2.** Conduct investigations in a caring and confidential manner to maintain performance and morale. **P3.** Provide feedback promptly. **P4.** Institute appeals processes in accordance with organizational procedures. **P5.** Recognize and recommend deficiencies in procedures for changes made

Knowledge and understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

K1. Describe Concrete ingredients ratio

K2. Explain batching and finishing techniques

K3. Identify concrete materials

K4. Explain methods of concrete placement

K5. State curing times for concrete.

K6. Describe fresh concrete levelling techniques

K7. Describe types, characteristics, uses and limitations of plant, tools and equipment

Critical Evidence(s) Required

The candidate needs to produce following critical evidences in order to competent in this competency standard.

- Use a hand trowel and power trowel to finish a minimum of 10 square meters of concrete in foundation.

Instruments & Consumables

S No.	Description (Instruments)
1	Construction Lab Tools
2	• Chutes, Line pumps • Measuring tapes and rules, mechanized dumpers • Rakes, Screed boards, shovels, stipple devices • Trowels troweling machines • Vibrators, Wheelbarrows, kibble, pump or hopper.

Islamabad 3rd September, 2019

NOTIFICATION

No. F. 5(13)/2018-DD (TE): In pursuance of sub-section (d) of section-6" Functions of the Commission" National Vocational & Technical Training Commission (NAVTTC) Act-2011, NAVTTC is pleased to approve and notify following qualifications in seven (07) trades for Level 1-5 under National Vocational Qualification Framework (NVQF), which have been developed in compatibility with latest global trends in the fields and fulfilling requirements of competency based training and assessment (CBT&A) system. The qualifications have been developed and validated in collaboration with TEVTAs, QABs, industry and other relevant stakeholders: -

S#	National Vocational Qualifications
1.	National Qualification Level-5 diploma in **Artificial Intelligence**
2.	National Qualification Level-5 diploma in **Robotics Technology**
3.	National Qualification Level-5 diploma in **Automation & Process Control**
4.	National Qualification Level-5 diploma in **Mechatronics Technology**
5.	National Qualification Level-5 diploma in **Water Quality & Resource Management**
6.	National Qualification Level-5 diploma in **Retail and Merchandize Management**
7.	National Qualification Level-5 diploma in **Printing & Publishing Technology**

2. All the TVET related institutions / organizations are required to implement aforementioned qualifications so that a uniform and standardized TVET qualification system is established in Pakistan and efforts are made for international equivalence / recognition of these qualifications.

3. Competency Standards of the above-enlisted qualifications can be accessed at NAVTTC's website **(www.navttc.org).**

(Muqeem Islam)
Director General (Skill Standards & Curricula)
Phone: 051-9215385

Distribution:

1. Federal Secretary, Ministry of Federal Education & Professional Training, Govt of Pakistan
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5. Federal Secretary, Ministry of Commerce, Govt of Pakistan, Islamabad
6. Federal Secretary, Ministry of Railway, Govt of Pakistan, Islamabad
7. Federal Secretary, Ministry of Climate Change, Govt of Pakistan, Islamabad
8. Federal Secretary, Ministry of Religious Affairs, Govt of Pakistan, Islamabad
9. Federal Secretary, Ministry of Communication, Govt of Pakistan, Islamabad
10. Federal Secretary, Ministry of Aviation Division, Govt of Pakistan, Islamabad
11. Federal Secretary, Ministry of Science & Technology, Govt of Pakistan, Islamabad
12. Chairperson, Punjab Technical Education and Vocational Training Authority (P-TEVTA), Lahore
13. Managing Director, Khyber Pakhtunkhwa Technical Education and Vocational Training Authority (KP-TEVTA),
14. Managing Director, Sindh Technical Education and Vocational Training Authority (S-TEVTA), Karachi
15. Chairman, Azad Jammu & Kashmir, Technical Education and Vocational Training Authority (AJ&K TEVTA), Muzafarabad
16. Director TVET Cell, Gilgit Baltistan, Gilgit
17. Director General, Punjab Vocational Training Council (PVTC), Punjab
18. Managing Director, Technology Upgradation and Skill Development Company (TUSDEC) Lahore
19. Project Director, Punjab Skill Development Program (PS DP) Lahore
20. CEO, Punjab Skill Development Fund, Lahore
21. Rector, UNTECH University Islamabad
22. National Deputy Leader, GIZ Islamabad
23. PS to Minister of Federal Education & Professional Training, Govt of Pakistan
24. PS to Special Adviser to the Prime Minister on Youth Affairs, Prime Minister's Office, Islamabad
25. Chairperson, Federal of Pakistan Chamber of Commerce and Industry (FPCCI), Karachi
26. Conveyor, Sector Skills Council (Textile/ Construction/ Renewable Energy/ Hospitality and Tourism)
27. Director Technical Education and Vocational Training Authorities (TEVTA), Balochistan
28. Chairman, Pakistan Tourism Development Corporation, Lahore
29. Chairman, PCSIR Headquarters, Islamabad

30. Director General, Pakistan Forest Institute, Peshawar
31. Chairman, Wafaq ul Madaris, Multan
32. Director General, Staff Welfare, Islamabad
33. Director General, NISTE Capital Administration and Development Division, Islamabad
34. Director General, National Training Bureau, Islamabad
35. Chairmen, Provincial Technical Education Boards
36. Chairmen, Provincial Trade Testing Boards
37. Director General, Federal Directorate of Education Islamabad
38. Secretary, IBCC, Islamabad: *with the request that National qualifications of Level 5 diploma in the aforementioned trades may be considered equivalent to Diploma of Associate Engineer/HSSC after inclusion of compulsory courses in the light of IBCC general requirement.*

Copy for information to: -

1. DG (P&D)/(A&F)/ (A&C) (S&C) NAVTTC
2. Director General(s), NAVTTC Regional Office(s).
3. Sr. Technical Advisor, TSSP-GIZ
4. Staff Officer to Chairman, NAVTTC
5. PS to Executive Director, NAVTTC Islamabad
6. Concerned File/ Office Copy