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INDUSTRIAL AUTOMATION

TRAINER GUIDE

National Vocational Certificate Level 4

Version 1 - September, 2019

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Introduction

Competence-based training helps to bridge the gap between what is taught in training and what tasks will be performed on the job. Training trainees to perform actual job functions helps to ensure that future front-line workers have the skills, knowledge and abilities required to perform their jobs properly, safely and effectively. In addition to competence-based training, assessment based on the performance of actual work competencies helps to ensure that:

- trainees are performing their work tasks as safely as possible
- performance gaps are recognized prior to serious incidents
- training can be implemented to improve competence.

There are significant benefits to competence-based training:

1. **Cost effectiveness**

   Since training activities and assessments in a competence-based approach are goal-oriented, trainers focus on clearly defined areas of skills, knowledge and understanding that their own industry has defined in the competence standards. At the same time, trainees are more motivated to learn when they realize the benefits of improved performance.

2. **Efficiency**

   The transfer gap between the training environment and working on the job is reduced substantially in a competence-based approach. This is because training and assessment are relevant to what needs to be done on the job. As a result, it takes less time for trainees to become competent in the required areas. This, in turn, contributes to improved efficiency where training and assessment are concerned.

3. **Increased productivity**

   When trainees become competent in the competence standards that their own industry has defined, when they know what the performance expectations are and receive recognition for their abilities through successful assessments, they are likely to be more motivated and experience higher job satisfaction. The result is improved productivity for organizations. The communication and constructive feedback between future employers and employees will improve as a result of a competence-based approach, which can also increase productivity.

4. **Reduced risk**

   Using a competence-based approach to training, development, and assessment, employers are able to create project teams of people with complementary skills. A trainee's record of the skills, knowledge and understanding relating to the competence standards they have achieved can be used by a future employer to identify and provide further relevant training and assessment for new skills areas. Competence standards can shape employee development and promotional paths within an organization and give employees the opportunity to learn more competencies beyond their roles. It can also provide organizations with greater ability to scale and flex as needed, thereby reducing the risk they face.

5. **Increased customer satisfaction**

   Employees who have been trained and assessed using a competence-based approach are, by the definition of the relevant competence standards, able to perform the required tasks associated with a job. The knock-on effect is that, in service-related industries, they are able to provide high service levels, thereby increasing customer satisfaction. In production or manufacturing industries, they are able to work closely to industry standards in a more effective and efficient way.

Lesson Plans:

This manual provides a series of lesson plans that will guide delivery of each module for the Industrial Automation qualification. It is important for trainers to be flexible and be ready to adapt lesson plans to suit the context of the subject and the needs of their trainees.

Good teachers acknowledge that CBT means each and every trainee in the class learns at a different speed. The good teacher is prepared to throw aside the day's lesson plan and do something different (and unplanned) for the class even if it means 'writing' a lesson plan for each trainee to match their learning pace for that day or week.

Learning by doing is different from learning theory and then applying it. To learn to do something, trainees need someone looking over their shoulder saying 'it's not quite like that, it's like this', 'you do it like this because …', or even 'tell me why you chose to do it like this?'.

In this way, trainees learn that theoretical knowledge is meaningless if it is not seen in the context of what they are doing. In other words, if a trainee doesn't know why they do something, they will not do it competently (skills underpinned by knowledge = competent performer).

This is how an Industrial Automation learner acquires a practical grasp of the standards expected. It's not by learning it in theory, but because those standards are acquired through correction by people who show what the standards are, and correct the trainee where they do not meet those standards, and where they repeat it correction until they have internalized those standards.

Demonstration of a Skill:

Demonstration or modeling a skill is a powerful tool, which is used, in vocational training. The instructions for trainers for demonstration are as under:

a) Read the procedure mentioned in the Trainer Guide for the relevant Learning Unit before demonstration.
b) Arrange all tools, equipment and consumable material, which are required for demonstration of a skill.
c) Practice the skill before demonstration to trainees, if possible.
d) Introduce the skill to trainees clearly at the commencement of demonstration.
e) Explain how the skill relates to the skill(s) already acquired and describe the expected results or show the objects to trainees.
f) Carry out demonstration in a way that can be seen by all trainees.
g) Use the same tools and materials that the learner will be using.
h) Go through EACH of the steps involved in performing the skill.
i) Go SLOWLY - describe each step as it is completed.
j) Encourage the learners to move around and watch what you are doing from a number of different angles.
k) Identify critical or complex steps, or steps that involve safety precautions to be followed.
l) Explain theoretical knowledge where applicable and ask questions to trainees to test their understanding.
m) Try to involve the learners: Ask them questions about why they think the process may work that way.
n) Repeat critical steps in demonstration, if required.
o) Summarize the demonstration by asking questions to trainees.

Involvement in the process (actively seeing) is important at this stage. When you work on getting involved, getting people to participate, you make them a part of what is happening. Questions for clarification or explanation are important throughout the demonstration. It is up to the learners to ask questions about things they do not understand, but it is also important for trainers to seek out and elicit questions from learners. A trainer may need to do repeated demonstrations of difficult or complex skills.

Remember that the learner will learn a lot from your demonstration - and not just the demonstration itself. Learners will learn about how to perform the skills, but they will also learn from watching demonstrations how trainers treat the tools or materials and how they follow safety procedures.

After the demonstration, it is important to again seek out questions - be sure all questions are answered. The trainer should ask the learner if they are ready to try the skill. If not, there may be a need for recycling the demonstration (or part of it), and clarifying some of the information.

Overview of the program

Course: NVQ Certificate Level 4 in Industrial Automation	**Total Course Duration:** **Hours**
Course Overview:	
The Industrial Automation program is to engage young people with a program of development that will provide them with the knowledge, skills and understanding to start their career in Pakistan as Industrial Controls & Automation skilled person , technician or expert. The program has been developed to address specific issues, such as the national, regional and local cultures, the manpower availability within the country, and meeting and exceeding the needs and expectations of their customers.	

Module Title and Aim	Learning Units	Duration
Module 19: Configure AC Drives and Motors **Aim:** The aim of this module to get knowledge, skills and understanding to configure ac drives and motors	**LU1:** Operate AC Drives and Motors **LU2:** Integrate AC Drives with PLC	250
Module 20: Operate Industrial Robot **Aim:** The aim of this module to get knowledge, skills and understanding to operate industrial robot	**LU1:** Install industrial robot **LU2:** Develop programs for robotic applications **LU3:** Troubleshoot / Debug Robot	140

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Module-19

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Trainer's Guidelines

Module 19 : 071400940 Configure AC Drives and Motors

Objective of the Module: The aim of this module to get knowledge, skills and understanding to configure ac Drives and Motors.

Learning Unit	Suggested Teaching/ Learning Activities	Delivery Context	Media
LU1: Operate AC Drives and Motors	Deliver illustrated presentations which consist of following points • Tool and instrument used for AC Drives and Motors. • Basic principles of single phase and three phase induction motors. • Basic principle of servo motors. • Wiring of VFD • Wiring of servo drive. • Speed control using parameters setting of VFD • Speed control using parameters setting of servo drive • Different errors in AC drives. • Different faults in AC motors. Organize the activity in class about tool selection and instrument selection for AC drives and motors Direct the learners to perform the following operation on AC drives and motors • Perform the wiring of VFD	Classroom / Lab / Workshop	• White Board • Multimedia /Internet • Illustration of tools and equipment video lectures and animations • Learner guidance

Module 19 : 071400940 Configure AC Drives and Motors

Objective of the Module: The aim of this module to get knowledge, skills and understanding to configure ac Drives and Motors.

Learning Unit	Suggested Teaching/ Learning Activities	Delivery Context	Media
	• Perform wiring of servo drive. • Set parameters for basic operation of VFD • Set the parameters of VFD for different speeds using keypad of VFD • Set parameters for basic operation of servo drive • Set the parameters of servo drive for different speeds using keypad of servo drive. • Check the errors in servo drive and VFD • If there is an error reset the VFD and servo drive using parameter setting on default setting		
LU2: Integrate AC Drives with PLC	Deliver illustrated presentations which consist of following points • Communication protocols used for communication between AC drives and PLC. • Setting of communication between PLC and AC drives. • Working of rotary encoders and their interfacing with PLC.	Classroom / Lab / Workshop	• White Board • Multimedia /Internet • Illustration of tools and equipment video lectures and animations • Learner guidance

Module 19 : 071400940 Configure AC Drives and Motors

Objective of the Module: The aim of this module to get knowledge, skills and understanding to configure ac Drives and Motors.

Learning Unit	Suggested Teaching/ Learning Activities	Delivery Context	Media
	• Different accessories (connectors, cables, cable assemblies, and cord sets) used for encoder integration with controller. • Speed, direction and torque control of induction motor using external terminals and PLC. • Speed, direction, position and torque control of servo motor using PLC. • Online parameter setting using servo control software • Different communication faults, their causes and possible solution in AC Drives. Demonstrate the following in class • Setting of communication protocols for AC drives in PLC • Setting of communication between PLC and AC drives. • Rotary encoder function • Interfacing of rotary encoder with PLC using connectors, cables, cable assemblies, and cord sets. • Speed, direction and torque control of		

Module 19 : 071400940 Configure AC Drives and Motors

Objective of the Module: The aim of this module to get knowledge, skills and understanding to configure ac Drives and Motors.

Learning Unit	Suggested Teaching/ Learning Activities	Delivery Context	Media
	induction motor using external terminals and PLC. • Speed, direction, position and torque control of servo motor using PLC. • Online parameter setting using servo control software • Tracing of different communication faults and their remedial solutions Direct the learners to perform the following operation on AC drives and motors for controlling purposes • Set Communication protocol • Perform communication setting between PLC and AC drives. • Interface the rotary encoder with PLC and read the pulses of encoder in PLC and monitor the position of any AC motor using by reading these pulses in PLC • Perform speed monitoring of any AC motor using encoder interfaced with PLC • Perform direction monitoring of motor using encoder interfaced with PLC		

Module 19 : 071400940 Configure AC Drives and Motors

Objective of the Module: The aim of this module to get knowledge, skills and understanding to configure ac Drives and Motors.

Learning Unit	Suggested Teaching/ Learning Activities	Delivery Context	Media
	• Control speed, direction and position of induction motor using encoder attached with PLC. • Use Variable Frequency Drive and control the speed of induction motor from keypad of VFD by setting the parameter • Use Variable Frequency Drive and control the direction of induction motor from keypad of VFD by setting the parameter • Use Variable Frequency Drive and control the torque of induction motor from keypad of VFD by setting the parameter • Reset the VFD on default setting • Use external terminal of VFD and control the speed and direction of induction motor by putting the external signal on external terminals of VFD • Interface VFD with PLC and now control the speed, direction and torque of induction motor by link communication through PLC programming • Start the servo motor in jog mode by		

Module 19 : 071400940 Configure AC Drives and Motors

Objective of the Module: The aim of this module to get knowledge, skills and understanding to configure ac Drives and Motors.

Learning Unit	Suggested Teaching/ Learning Activities	Delivery Context	Media
	setting parameters of servo drive • Use Servo Drive and control the speed of servo motor from keypad of servo drive by setting the parameter • Use Servo Drive and control the direction of servo motor from keypad of servo drive by setting the parameter • Use Servo Drive and control the torque of servo motor from keypad of servo drive by setting the parameter • Use Servo Drive and control the position of servo motor from keypad of servo drive by setting the parameter • Reset the servo drive on default setting • Interface Servo Drive with PLC and now control the speed, direction, position and torque of servo motor by link communication through PLC programming • Use the servo online parameter setting software and set the parameter of servo drive • Make different process control program		

Module 19 : 071400940 Configure AC Drives and Motors

Objective of the Module: The aim of this module to get knowledge, skills and understanding to configure ac Drives and Motors.

Learning Unit	Suggested Teaching/ Learning Activities	Delivery Context	Media
	using VFD and PLC interfacing than control and monitor these program from HMI • Make different process control program using Servo Drive and PLC interfacing than control and monitor these program from HMI • Trace different communication faults and perform remedial solutions		

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Module 20 : 071400941 Operate Industrial Robot

Objective of the module: The aim of this module to get knowledge, skills and understanding to operate industrial robot.

Learning Unit	Suggested Teaching/ Learning Activities	Delivery Context	Media
LU 1: Install Industrial Robot	Deliver illustrated presentations which consist of following points : • Select tools & accessories as per requirement • Connect cables and peripheral as per requirement • Integrate pneumatic / hydraulic system with robot as per requirement • Take safety measures as per requirement • Understanding the manufacturer's instructions as per the installation manual including unpacking, mechanical assembly, electrical connections, and software installation and communication establishment. • Assembling the robot, following the installation instructions provided by the manufacturer, including proper connections of the cables and peripherals (i.e. computers, teach-pendant, etc.). • Installing the operating software on the computer with proper connections with the hardware of the robot. • Calibrating the sensors before the first run of the robot.	Robotics Lab	• White Board • Multimedia /Internet • Illustration of tools and equipment video lectures and animations • Learner Guide

Module 20 : 071400941 Operate Industrial Robot

Objective of the module: The aim of this module to get knowledge, skills and understanding to operate industrial robot.

Learning Unit	Suggested Teaching/ Learning Activities	Delivery Context	Media
	• Understanding the connections of pneumatic/hydraulic units with the robot through standard solenoid operated valve modules. • Understanding the component-level checking of the installed modules and peripherals. • Operational knowledge of the first dry run of the robot including the homing operation, reaching to a specific position, etc.		
LU2: Develop programs for robotic applications	Deliver illustrated presentations which consist of following points • Develop program using Teach Pendant (online) • Simulate Robot Program as per requirement. • Develop program using Robots Software (offline) • Understanding the programming of the robot by adding different positions using the teach-pendant. • Understanding the robot movements using the controls available on the teach-pendant both in joint-space and task-space.		• White Board • Multimedia /Internet • Illustration of tools and equipment video lectures and animations • Learner Guide

Module 20 : 071400941 Operate Industrial Robot

Objective of the module: The aim of this module to get knowledge, skills and understanding to operate industrial robot.

Learning Unit	Suggested Teaching/ Learning Activities	Delivery Context	Media
	• Configuring the robot in its programming software and then programming the robot by adding different positions using the software. Writing a basic set of movement commands in the robot's programming software and then simulating the response of the robot. Understanding the physical movement of robot using the options available in the programming software (both in joint-space and task-space) Study the concepts of robot configuration, work envelop, task-space and joint-space. Programming the robot to perform different tasks in different settings such as: • Robot-gripper movement along cartesian axis, under different speed settings • Pick and place exercise • Pick and place exercise with waypoints • Pick and place activity with obstacle avoidance • Basic assembly operation with linear movements • Assembly operation with linear traverse and twist • Disassembly operation		

Module 20 : 071400941 Operate Industrial Robot

Objective of the module: The aim of this module to get knowledge, skills and understanding to operate industrial robot.

Learning Unit	Suggested Teaching/ Learning Activities	Delivery Context	Media
LU3: Troubleshoot / Debug Robot	Deliver illustrated presentations which consist of following points • Select Tools as per requirement • Edit and debug a program using Teach Pendant /Software Troubleshoot Control Panel and Drives Understanding the different error-codes (most frequently occurring) of the robot and their corresponding causes. Understanding the maintenance manual of the robot with strong emphasis to preventive maintenance practices. Troubleshooting the hardware-related faults including, but not limited to, hardware-connection faults, communication errors, sensor noise/disconnection, limit sensing, etc. Troubleshooting the software-related faults such as faulty program-sequence, syntax errors, etc. Isolating and debugging the programs in robot-alone settings. Isolating and debugging the programs in robot-with-peripheral settings. Troubleshooting the drive interfaces with the robot. Troubleshooting the robot-program in simulation mode to fulfill all the task requirements.		• White Board • Multimedia /Internet • Illustration of tools and equipment video lectures and animations • Learner Guide

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