

Interprovincial Program Guide

Instrumentation and Control Technician

2010

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The CCDA Executive Committee recognizes this Interprovincial Program Guide as the national curriculum for the occupation of Instrumentation and Control Technician.

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Table of Contents

Acknowledgements	2
Introduction	4
User Guide	5
IPG Glossary of Terms	7
Essential Skills Profiles	9
Profile Chart.....	10
Recommended Level Structure.....	12
2007 NOA Sub-task to IPG Unit Comparison.....	13

PROGRAM CONTENT

Level 1	19
Level 2	37
Level 3	55
Level 4	67

Introduction

Jurisdictions have long recognized the benefit of pooling resources in the development and maintenance of apprenticeship training standards. A successful example of this is the Interprovincial Standards Red Seal Program itself. Essential to the establishment of standards is the development of suitable training systems and programs which enable tradespeople to acquire certification based on these standards. While certification is the responsibility of Apprenticeship administrators throughout Canada, the development and delivery of technical training is the responsibility of jurisdictions.

In 1999, work to develop common training for apprenticeship programs within the Atlantic Provinces began. To date, 22 Curriculum Standards have been developed through the Atlantic Standards Partnership (ASP) project to assist programming staff and instructors in the design and delivery of technical training. Similarly, the Canadian Council of Directors of Apprenticeship (CCDA) embarked on a process for the development of national Interprovincial Program Guides (IPGs) for the Boilermaker, Carpenter and Sprinkler System Installer trades. At its January 2005 strategic planning session, the CCDA identified developing common training standards as one of key activities in moving towards a more cohesive apprenticeship system.

With the support of Human Resources and Skills Development Canada (HRSDC), several provinces and territories have partnered to build on the ASP and the CCDA processes to further develop IPGs to be used across the country. This partnership will create efficiencies in time and resources and promote consistency in training and apprentice mobility.

User Guide

According to the Canadian Apprenticeship Forum, the IPG is: "a list of validated technical training outcomes, based upon those sub-tasks identified as common core in the National Occupational Analysis (ANP), and validated by industry in the provinces and territories as incorporating the essential tasks, knowledge and skills associated with a given trade."

Learning outcomes contained in the IPG represent the minimum common core content for the development of jurisdictional training standards and outlines. IPGs are developed based on the ANPs and extensive industry consultation. The IPG is intended to assist program development staff in the design of jurisdictional plans of training. Each jurisdiction has the flexibility to add additional content.

The IPG was deliberately constructed for ease of use and flexibility of structure in order to adapt to all delivery requirements. It details units of training, unit outcomes and objectives. It does not impose a delivery model or teaching format.

Jurisdictions and/or training providers will select and develop delivery materials and techniques that accommodate a variety of learning styles and delivery patterns. The IPG does not dictate study materials, textbooks or learning activities to be used in delivery.

The IPG document includes a recommended leveling structure to facilitate mobility for apprentices moving from one jurisdiction to another. Because of difference in jurisdictional regulations and program durations, levels are offered as suggestions only.

Structure

The IPG is divided into units. The unit codes are used as a means of identification and are not intended to convey the order of delivery. Prerequisites have not been detailed. Each unit consists of *Learning Outcomes* and *Objectives and Content*.

The *Learning Outcomes* are the specific performances that must be evaluated. Wording of the learning outcomes, "Demonstrate knowledge of...", acknowledges the broad spectrum of ways in which knowledge can be shown. It is at the discretion of each jurisdiction to determine the manner in which learning outcomes are evaluated; theoretically, practically or a combination of both.

User Guide *(continued)*

The *Objectives and Content* for the unit details the information to be covered in order to achieve the performances specified in the *Learning Outcomes*. These objectives can be either theoretical or practical in nature, based on the requirements identified through the industry consultation process. The learning activities used to cover the objectives are at the discretion of the jurisdiction; however, practically worded objective statements have been used where industry indicated a need for the apprentices to receive exposure to performing the task or skill outlined while attending technical training. For example, this exposure could be done through instructor demonstration or individual or group performance of the skill or task. This practical training will help to reinforce the theoretical component of the technical training.

Detailed content for each objective has not been developed. Where detail is required for clarity, content has been provided. The content listed within the IPG document is **not** intended to represent an inclusive list; rather, it is included to illustrate the intended direction for the objective. Content may be added or extended in jurisdictional training plans as required.

Jurisdictions are free to deliver the IPG units one at a time or concurrently, provided that all *Learning Outcomes* are met. The IPG does not indicate the amount of time to be spent on a particular unit as the length of time required to deliver the *Learning Outcomes* successfully will depend upon the learning activities and teaching methods used.

IPG Glossary of Terms

These definitions are intended as a guide to how language is used in the IPGs.

ADJUST	To put in good working order; regulate; bring to a proper state or position.
APPLICATION	The use to which something is put and/or the circumstance in which you would use it.
CHARACTERISTIC	A feature that helps to identify, tell apart, or describe recognizably; a distinguishing mark or trait.
COMPONENT	A part that can be separated from or attached to a system; a segment or unit.
DEFINE	To state the meaning of (a word, phrase, etc.).
DESCRIBE	To give a verbal account of; tell about in detail.
DIAGNOSE	To analyze or identify a problem or malfunction.
EXPLAIN	To make plain or clear; illustrate; rationalize.
IDENTIFY	To point out or name objectives or types.
INTERPRET	To translate information from observation, charts, tables, graphs, and written material.
MAINTAIN	To keep in a condition of good repair or efficiency.
METHOD	A means or manner of doing something that has procedures attached to it.
OPERATE	How an object works; to control or direct the functioning of.
PROCEDURE	A prescribed series of steps taken to accomplish an end.

IPG Glossary of Terms *(continued)*

PURPOSE	The reason for which something exists or is done, made or used.
SERVICE	Routine inspection and replacement of worn or deteriorating parts. An act or business function provided to a customer in the course of one's profession. (e.g., haircut).
TECHNIQUE	Within a procedure, the manner in which technical skills are applied.
TEST	v. To subject to a procedure that ascertains effectiveness, value, proper function, or other quality. n. A way of examining something to determine its characteristics or properties, or to determine whether or not it is working correctly.
TROUBLESHOOT	To follow a systematic procedure to identify and locate a problem or malfunction and its cause.

Essential Skills Profiles

Essential Skills are the skills needed for work, learning and life. They provide the foundation for learning all the other skills that enable people to evolve within their jobs and adapt to workplace change.

Over the past several years, the Government of Canada has conducted research examining the skills people use at work. From this research, Essential Skills Profiles have been developed for various occupations.

For more information regarding Essential Skills and to access Essential Skills Profiles for specific occupations, visit Human Resources and Skills Development Canada's Essential Skills website at:

http://www.hrsdc.gc.ca/eng/workplaceskills/essential_skills/general/home.shtml

Profile Chart

OCCUPATIONAL SKILLS			
ICT-100 Safety	ICT-105 Tools and Equipment	ICT-115 Communication and Trade Documentation	ICT-305 Trade Related Computer Use
ICT-110 Material Handling Equipment	ICT-120 Drawings, Schematics and Specifications	ICT-200 Job Planning	ICT-160 Tubing and Piping Systems
MEASURING AND INDICATING DEVICES			
ICT-155 Introduction to Pressure Measurement and Calibration	ICT-255 Process Measurement	ICT-400 Equipment Monitoring Devices	
ANALYZERS, SAFETY SYSTEMS AND SECURITY DEVICES			
ICT-325 Process Analyzers I (Solids and Liquids)	ICT-430 Process Analyzers II (Gases)	ICT-425 Safety and Security Systems	
ENERGY SYSTEMS			
ICT-125 DC Theory	ICT-130 Series and Parallel Circuits	ICT-135 Voltage Drop and Power Loss	ICT-245 Single-Phase Theory
ICT-140 Conductors and Cables	ICT-150 Wireways, Conduit, EMT and Fittings	ICT-205 Introduction to Fluids	ICT-210 Hydraulic Supply Systems I
ICT-215 Hydraulic Supply Systems II	ICT-225 Pneumatic Supply Systems I	ICT-230 Pneumatic Supply Systems II	ICT-220 Compressors
ICT-240 Electronics (Circuits and Components)	ICT-250 Power Supplies	ICT-320 Drives and Motors	

Profile Chart *(continued)*

FINAL CONTROL ELEMENTS			
ICT-145 On-off Control Devices	ICT-235 Final Control Elements		
COMMUNICATION, NETWORKING AND SIGNAL TRANSMISSION			
ICT-405 Signal Transmission Systems	ICT-415 Supervisory Control and Data Acquisition Systems		
CONTROL SYSTEMS			
ICT-300 Basic Process Control	ICT-410 Advanced Process Control	ICT-310 Programmable Logic Controller Systems	ICT-420 Human Machine Interface Systems
ICT-315 Distributed Control Systems			

Recommended Level Structure

Level 1			Level 2		
Unit Code	Title	Page	Unit Code	Title	Page
ICT-100	Safety	20	ICT-200	Job Planning	38
ICT-105	Tools and Equipment	21	ICT-205	Introduction to Fluids	39
ICT-110	Material Handling Equipment	22	ICT-210	Hydraulic Supply Systems I	40
ICT-115	Communication and Trade Documentation	23	ICT-215	Hydraulic Supply Systems II	41
ICT-120	Drawings, Schematics and Specifications	24	ICT-220	Compressors	42
ICT-125	DC Theory	25	ICT-225	Pneumatic Supply Systems I	43
ICT-130	Series and Parallel Circuits	27	ICT-230	Pneumatic Supply Systems II	45
ICT-135	Voltage Drop and Power Loss	28	ICT-235	Final Control Elements	46
ICT-140	Conductors and Cables	29	ICT-240	Electronics (Circuits and Components)	48
ICT-145	On-off Control Devices	31	ICT-245	Single-Phase Theory	50
ICT-150	Wireways, Conduit, EMT and Fittings	32	ICT-250	Power Supplies	52
ICT-155	Introduction to Pressure Measurement and Calibration	33	ICT-255	Process Measurement	53
ICT-160	Tubing and Piping Systems	35			
Level 3			Level 4		
Unit Code	Title	Page	Unit Code	Title	Page
ICT-300	Basic Process Control	56	ICT-400	Equipment Monitoring Devices	68
ICT-305	Trade Related Computer Use	58	ICT-405	Signal Transmission Systems	70
ICT-310	Programmable Logic Controller Systems	59	ICT-410	Advanced Process Control	72
ICT-315	Distributed Control Systems	61	ICT-415	Supervisory Control and Data Acquisition Systems	73
ICT-320	Drives and Motors	62	ICT-420	Human Machine Interface Systems	75
ICT-325	Process Analyzers I (Solids and Liquids)	64	ICT-425	Safety and Security Systems	76
			ICT-430	Process Analyzers II (Gases)	78

2007 NOA Sub-task to IPG Unit Comparison

NOA Sub-task		IPG Unit	
Task 1 - Maintains tools and equipment.			
1.01	Maintains hand tools.	ICT-105	Tools and Equipment
1.02	Maintains portable power tools.	ICT-105	Tools and Equipment
1.03	Maintains stationary power tools.	ICT-105	Tools and Equipment
1.04	Maintains calibration, configuration and test equipment.	ICT-105	Tools and Equipment
1.05	Maintains personal protective equipment (PPE) and safety equipment.	ICT-100	Safety
Task 2 - Organizes work.			
2.01	Uses blueprints, schematics and drawings.	ICT-120	Drawings, Schematics and Specifications
2.02	Applies codes, standards and regulations.	ICT-115	Communication and Trade Documentation
2.03	Uses documentation.	ICT-115	Communication and Trade Documentation
2.04	Communicates with others.	ICT-115	Communication and Trade Documentation
2.05	Plans job.	ICT-200	Job Planning
2.06	Maintains parts inventory.	ICT-200	Job Planning
2.07	Maintains safe work environment.	ICT-100	Safety
Task 3 - Performs routine trade activities.			
3.01	Operates material handling equipment.	ICT-110	Material Handling Equipment
3.02	Performs lockout, tag-out and de-energizing procedures.	ICT-100	Safety
3.03	Installs mounting hardware.	ICT-105	Tools and Equipment
3.04	Installs process connections.	ICT-160	Tubing and Piping Systems
3.05	Uses specialized computer equipment and software.	ICT-305	Trade Related Computer Use
3.06	Commissions new installations.	ICT-300	Basic Process Control
3.06	Commissions new installations.	ICT-410	Advanced Process Control
Task 4 - Services pressure, temperature, level and flow measuring and indicating devices.			
4.01	Installs pressure, temperature, level and flow measuring and indicating devices.	ICT-155	Introduction to Pressure Measurement and Calibration
		ICT-255	Process Measurement

NOA Sub-task		IPG Unit	
4.02	Calibrates pressure, temperature, level and flow measuring and indicating devices.	ICT-155	Introduction to Pressure Measurement and Calibration
		ICT-255	Process Measurement
4.03	Maintains pressure, temperature, level and flow measuring and indicating devices.	ICT-155	Introduction to Pressure Measurement and Calibration
		ICT-255	Process Measurement
Task 5 - Services motion, speed, position and vibration measuring and indicating devices.			
5.01	Installs motion, speed, position and vibration measuring and indicating devices.	ICT-400	Equipment Monitoring Devices
5.02	Calibrates motion, speed, position and vibration measuring and indicating devices.	ICT-400	Equipment Monitoring Devices
5.03	Maintains motion, speed, position and vibration measuring and indicating devices.	ICT-400	Equipment Monitoring Devices
Task 6 - Services mass, density and consistency measuring and indicating devices.			
6.01	Installs mass, density and consistency measuring and indicating devices.	ICT-325	Process Analyzers I (Solids and Liquids)
		ICT-430	Process Analyzers II (Gases)
6.02	Calibrates mass, density and consistency measuring and indicating devices.	ICT-325	Process Analyzers I (Solids and Liquids)
		ICT-430	Process Analyzers II (Gases)
6.03	Maintains mass, density and consistency measuring and indicating devices.	ICT-325	Process Analyzers I (Solids and Liquids)
		ICT-430	Process Analyzers II (Gases)
Task 7 - Services analyzers.			
7.01	Installs analyzers.	ICT-325	Process Analyzers I (Solids and Liquids)
		ICT-430	Process Analyzers II (Gases)
7.02	Calibrates analyzers.	ICT-325	Process Analyzers I (Solids and Liquids)
		ICT-430	Process Analyzers II (Gases)
7.03	Maintains analyzers.	ICT-325	Process Analyzers I (Solids and Liquids)
		ICT-430	Process Analyzers II (Gases)
Task 8 - Services safety systems and security systems.			
8.01	Install safety systems and security systems.	ICT-425	Safety and Security Systems

NOA Sub-task		IPG Unit	
8.02	Calibrates safety systems and security systems.	ICT-425	Safety and Security Systems
8.03	Maintains safety systems and security systems.	ICT-425	Safety and Security Systems
Task 9 - Services hydraulic equipment.			
9.01	Install hydraulic equipment. (NOT COMMON CORE)		
9.02	Maintains hydraulic equipment.	ICT-205	Introduction to Fluids
		ICT-210	Hydraulic Supply Systems I
		ICT-215	Hydraulic Supply Systems II
Task 10 - Services pneumatic equipment.			
10.01	Installs pneumatic equipment.	ICT-205	Introduction to Fluids
		ICT-225	Pneumatic Supply Systems I
		ICT-230	Pneumatic Supply System II
		ICT-220	Compressors
10.02	Maintains pneumatic equipment.	ICT-205	Introduction to Fluids
		ICT-225	Pneumatic Supply Systems I
		ICT-230	Pneumatic Supply Systems II
		ICT-220	Compressors
Task 11 - Services electrical and electronic equipment.			
11.01	Installs electrical and electronic equipment.	ICT-125	DC Theory
		ICT-130	Series and Parallel Circuits
		ICT-135	Voltage Drop and Power Loss
		ICT-245	Single-Phase Theory
		ICT-140	Conductors and Cables
		ICT-150	Wireways, Conduit, EMT and Fittings
		ICT-240	Electronics (Circuits and Components)
		ICT-250	Power Supplies
		ICT-320	Drives and Motors
11.02	Maintains electrical and electronic equipment.	ICT-125	DC Theory
		ICT-130	Series and Parallel Circuits
		ICT-135	Voltage Drop and Power Loss
		ICT-245	Single-Phase Theory
		ICT-140	Conductors and Cables
		ICT-150	Wireways, Conduit, EMT and Fittings
		ICT-240	Electronics (Circuits and Components)
		ICT-250	Power Supplies

NOA Sub-task		IPG Unit	
		ICT-320	Drives and Motors
Task 12 - Services valves.			
12.01	Installs valves.	ICT-235	Final Control Elements
12.02	Maintains valves.	ICT-235	Final Control Elements
Task 13 - Services actuators.			
13.01	Installs actuators.	ICT-235	Final Control Elements
13.02	Maintains actuators.	ICT-235	Final Control Elements
Task 14 - Services positioners.			
14.01	Installs positioners.	ICT-235	Final Control Elements
14.02	Calibrates positioners.	ICT-235	Final Control Elements
14.03	Maintains positioners.	ICT-235	Final Control Elements
Task 15 - Services signal transmission systems.			
15.01	Installs signal transmission systems.	ICT-405	Signal Transmission Systems
15.02	Configures signal transmission systems.	ICT-405	Signal Transmission Systems
15.03	Maintains signal transmission systems.	ICT-405	Signal Transmission Systems
Task 16 - Services signal converters.			
16.01	Installs signal converters.	ICT-405	Signal Transmission Systems
16.02	Calibrates signal converters.	ICT-405	Signal Transmission Systems
16.03	Maintains signal converters.	ICT-405	Signal Transmission Systems
Task 17 - Services Supervisory Control and Data Acquisition (SCADA) systems.			
17.01	Installs SCADA systems.	ICT-415	Supervisory Control and Data Acquisition Systems
17.02	Configures SCADA systems.	ICT-415	Supervisory Control and Data Acquisition Systems
17.03	Maintains SCADA systems.	ICT-415	Supervisory Control and Data Acquisition Systems
Task 18 - Implements process control strategies.			
18.01	Selects process control strategy.	ICT-300	Basic Process Control
		ICT-410	Advanced Process Control
18.02	Configures process control strategy.	ICT-300	Basic Process Control
		ICT-410	Advanced Process Control
Task 19 - Services stand-alone controllers.			
19.01	Installs stand-alone controllers.	ICT-300	Basic Process Control
		ICT-410	Advanced Process Control
19.02	Configures stand-alone controllers.	ICT-300	Basic Process Control
		ICT-410	Advanced Process Control
19.03	Calibrates stand-alone controllers.	ICT-300	Basic Process Control
		ICT-410	Advanced Process Control

NOA Sub-task		IPG Unit	
19.04	Maintains stand-alone controllers.	ICT-300	Basic Process Control
		ICT-410	Advanced Process Control
Task 20 - Services programmable logic controllers (PLCs).			
20.01	Installs PLCs.	ICT-310	Programmable Logic Controller Systems
20.02	Configures PLCs.	ICT-310	Programmable Logic Controller Systems
20.03	Diagnoses PLC problems.	ICT-310	Programmable Logic Controller Systems
20.04	Maintains PLCs.	ICT-310	Programmable Logic Controller Systems
Task 21 - Services distributed control systems (DCSs).			
21.01	Installs DCSs.	ICT-315	Distributed Control Systems
21.02	Configures DCSs.	ICT-315	Distributed Control Systems
21.03	Diagnoses DCS problems.	ICT-315	Distributed Control Systems
21.04	Maintains DCSs.	ICT-315	Distributed Control Systems
Task 22 - Services human machine interface (HMI).			
22.01	Installs HMIs.	ICT-420	Human Machine Interface Systems
22.02	Configures HMIs.	ICT-420	Human Machine Interface Systems
22.03	Diagnoses HMI problems.	ICT-420	Human Machine Interface Systems
22.04	Maintains HMIs.	ICT-420	Human Machine Interface Systems

LEVEL 1

ICT-100

Safety

Learning Outcomes:

- Demonstrate knowledge of safety equipment, their applications, maintenance and procedures for use.
- Demonstrate knowledge of safe work practices.
- Demonstrate knowledge of regulatory requirements pertaining to safety.

Objectives and Content:

1. Identify types of personal protective equipment (PPE) and clothing and describe their applications and limitations.
2. Describe the procedures used to care for and maintain PPE.
3. Identify hazards and describe safe work practices.
 - i) personal
 - ii) workplace
 - energy state awareness
 - isolation and de-energizing procedures
 - tag out/lockout
 - confined space
 - fire
 - heights
 - nuclear
 - chemical/gas
 - arc flash
 - temperature extremes
 - iii) environmental
 - discharge/spills
4. Identify and describe workplace safety and health regulations.
 - i) federal
 - Material Safety Data Sheets (MSDS)
 - Workplace Hazardous Material Information System (WHMIS)
 - Transportation of Dangerous Goods (TDG)
 - Atomic Energy Control Act and Regulations
 - ii) provincial/territorial
 - iii) municipal

ICT-105 Tools and Equipment

Learning Outcomes:

- Demonstrate knowledge of tools and equipment, their applications, maintenance and procedures for use.
- Demonstrate knowledge of installation and mounting hardware and their applications.

Objectives and Content:

1. Identify types of hand tools and describe their applications and procedures for use.
2. Describe the procedures used to inspect and maintain hand tools.
3. Identify types of portable power tools and describe their applications and procedures for use.
 - i) electric
 - ii) hydraulic
 - iii) pneumatic
4. Describe the procedures used to inspect and maintain portable power tools.
5. Identify types of stationary power tools and describe their applications and procedures for use.
 - i) electric
 - ii) hydraulic
 - iii) pneumatic
6. Describe the procedures used to inspect and maintain stationary power tools.
7. Identify types of calibration, configuration and test equipment and describe their applications.
8. Identify types of powder actuated tools and describe their applications.
9. Identify types of installation and mounting hardware and describe their applications.

ICT-110

Material Handling Equipment

Learning Outcomes:

- Demonstrate knowledge of material handling equipment and accessories, their applications and limitations.

Objectives and Content:

1. Define terminology associated with material handling equipment and accessories.
2. Identify hazards and describe safe work practices pertaining to material handling.
 - i) load considerations
 - ii) supervision of material handling
 - iii) securing work area
 - iv) communication
3. Identify codes and regulations pertaining to material handling.
4. Identify types of material handling equipment and accessories and describe their applications and limitations.
5. Describe the procedures used to inspect, maintain and store material handling equipment.

Learning Outcomes:

- Demonstrate knowledge of effective communication practices.
- Demonstrate knowledge of trade related documentation and its use.

Objectives and Content:

1. Describe the importance of effective verbal and non-verbal communication.
 - i) other tradespersons
 - ii) colleagues
 - iii) supervisors
 - iv) suppliers/manufacturers
2. Identify types of trade related documentation and describe their purpose, applications and procedures for use.
 - i) manufacturers' specifications
 - ii) codes and standards
 - iii) work orders
 - iv) maintenance schedules
 - v) calibration/maintenance records

Learning Outcomes:

- Demonstrate knowledge of drawings, schematics and specifications and their applications.
- Demonstrate knowledge of interpreting and extracting information from drawings, schematics and specifications.

Objectives and Content:

1. Define terminology associated with drawings, schematics and specifications.
2. Identify types of drawings and describe their applications.
 - i) mechanical
 - plant layout
 - process equipment details
 - ii) process
 - Process and Instrument Drawings/Process and Control (P&ID/P&C)
 - Scientific Apparatus Manufacturers Association (SAMA)
 - loop drawings
 - iii) electrical
 - schematics
 - wiring diagrams
 - iv) as-builts
3. Interpret and extract information from drawings.
 - i) lines
 - ii) legends
 - iii) symbols and abbreviations
 - iv) notes and specifications
4. Interpret and extract information from schematics and specifications.

Learning Outcomes:

- Demonstrate knowledge of direct current (DC) electricity, its characteristics and associated principles.
- Demonstrate knowledge of ohm's law.
- Demonstrate knowledge of units of measure and symbols relating to DC electricity.
- Demonstrate knowledge of the instruments and procedures used to measure electricity.

Objectives and Content:

1. Define terminology associated with DC electricity.
2. Identify hazards and describe safe work practices pertaining to DC electricity.
3. Explain the atomic structure of matter.
4. Identify the forms of energy that produce electricity and describe their associated principles.
 - i) chemical action
 - ii) piezoelectric effect
 - iii) magnetism
 - iv) heat
 - v) light and solar
 - vi) friction
5. Identify the components of an electric circuit and describe the procedures used to analyze them.
 - i) electron path (conductors)
 - closed circuit
 - open circuit
 - short circuit
 - ii) load
 - iii) source
 - iv) control

6. Identify units of measure and symbols pertaining to DC electricity.
7. Explain Ohm's Law.
8. Identify the basic electrical properties and describe their relationship.
 - i) voltage
 - ii) current
 - iii) resistance
 - iv) power
9. Identify instruments used for measuring electricity and describe their applications and procedures for use.
10. Perform calculations to determine electricity related values.
11. Use instruments to troubleshoot DC components.

Learning Outcomes:

- Demonstrate knowledge of series, parallel and complex circuits, their characteristics and operation.

Objectives and Content:

1. Define terminology associated with series and parallel circuits.
2. Explain the characteristics and operation of series circuits.
3. Explain the characteristics and operation of parallel circuits.
4. Identify types of complex circuits and describe their characteristics and operation.
 - i) series-parallel
 - ii) parallel-series
5. Explain Kirchhoff's Laws.
 - i) current
 - ii) voltage
6. Perform calculations to determine series, parallel and complex circuit related values.
7. Describe the procedures used to troubleshoot series, parallel and complex circuits.
8. Use instruments to troubleshoot series, parallel and complex circuits.

Learning Outcomes:

- Demonstrate knowledge of voltage drop and power loss and its impact on a circuit.

Objectives and Content:

1. Define terminology associated with voltage drop and power loss.
2. Identify types of conductors and describe their characteristics and applications.
3. Identify the units of measure used to describe conductor size.
4. Identify types of insulators and describe their characteristics and applications.
5. Explain conductor resistance and its effect on a circuit.
6. Describe the procedures used to determine conductor resistance.
7. Explain line voltage drop and its effect on a circuit.
8. Perform calculations to determine line voltage drop.
9. Explain power loss and its effect on a circuit.
10. Perform calculations to determine power loss.

Learning Outcomes:

- Demonstrate knowledge of conductors and cables and their associated components.
- Demonstrate knowledge of the procedures used to install conductors and cables.
- Demonstrate knowledge of the procedures used to terminate conductors.

Objectives and Content:

1. Define terminology associated with conductors and cables.
2. Identify hazards and describe safe work practices pertaining to conductors and cables.
3. Identify tools and equipment relating to conductors and cables and describe their applications and procedures for use.
4. Interpret codes and regulations pertaining to conductors and cables.
 - i) Canadian Electrical Code (CEC)
5. Interpret information pertaining to conductors and cables found on drawings and specifications.
6. Identify types of conductors and cables and describe their characteristics and applications.
7. Identify conductor and cable components and accessories and describe their characteristics and applications.
8. Identify methods of circuit protection and describe their characteristics and applications.
9. Identify the considerations used when selecting conductors and cables and their associated components and accessories.

10. Describe the procedures used to install conductors and cables and their associated components and accessories.
11. Describe the procedures used to terminate conductors.

ICT-145 On-off Control Devices

Learning Outcomes:

- Demonstrate knowledge of on-off control devices, their components and operation.
- Demonstrate knowledge of the procedure used to install, maintain, troubleshoot and replace on-off control devices.

Objectives and Content:

1. Define terminology associated with on-off control devices.
2. Identify hazards and describe safe work practices pertaining to on-off control devices.
 - i) energy state awareness
3. Interpret codes and regulations pertaining to on-off control devices.
4. Interpret information pertaining to on-off control devices found on drawings specifications and nameplates.
5. Identify types of on-off control devices and describe their characteristics and applications.
 - i) pushbuttons
 - ii) switches
 - limit
 - proximity
 - centrifugal
 - thermal
 - iii) photo sensors
 - iv) relays
6. Describe the procedures used to select and install on-off control devices.
7. Describe the procedures used to maintain, troubleshoot and replace on-off control devices.

ICT-150 Wireways, Conduit, Electrical Metallic Tubing (EMT) and Fittings

Learning Outcomes:

- Demonstrate knowledge of wireways, conduit, EMT and fittings, their characteristics and applications.
- Demonstrate knowledge of the procedures used to install wireways, conduit, EMT and fittings.

Objectives and Content:

1. Define terminology associated with wireways, conduit, EMT and fittings.
2. Identify hazards and describe safe work practices pertaining to wireways, conduit, EMT and fittings.
3. Identify tools and equipment relating to wireways, conduit, EMT and fittings and describe their applications and procedures for use.
4. Interpret codes and regulations pertaining to wireways, conduit, EMT and fittings.
5. Interpret information pertaining to wireways, conduit, EMT and fittings found on drawings and specifications.
6. Identify types of wireways, conduit and EMT and describe their characteristics and applications.
7. Identify wireway, conduit and EMT fittings and accessories and describe their characteristics and applications.
8. Describe the procedures used to bend conduit and EMT.
9. Describe the procedures used to install wireways, conduit and EMT and their fittings and accessories.

Learning Outcomes:

- Demonstrate knowledge of pressure measurement and calibration.
- Demonstrate knowledge of the procedures used to install, calibrate, maintain and troubleshoot basic pressure measurement devices.

Objectives and Content:

1. Define terminology associated with pressure measurement and calibration.
2. Identify hazards and describe safe work practices pertaining to pressure measurement and calibration.
 - i) intrinsic safety
3. Identify tools and equipment relating to pressure measurement and calibration and describe their applications and procedures for use.
4. Interpret information pertaining to pressure measuring devices found on drawings, specifications and nameplates.
5. Interpret and maintain calibration records.
6. Identify units of measure used to express pressure measurement values.
7. Perform conversions and calculations relating to pressure measurement.
8. Explain the principles of pressure measurement and its relationship to temperature, level and flow.
9. Identify types of basic pressure measurement devices and describe their applications.
 - i) pneumatic
 - ii) hydraulic
10. Identify pressure related calibration standards and describe their applications.
 - i) dead weight tester

- ii) manometer
 - iii) test gauges and calibrators
11. Describe the procedures used to install and calibrate basic pressure measurement devices.
- i) gauges
 - ii) recorders
 - iii) switches
 - iv) transmitters
12. Calibrate basic pressure measurement devices.
13. Describe the procedures used to maintain and troubleshoot basic pressure measurement devices.

Learning Outcomes:

- Demonstrate knowledge of tubing and piping systems, their components and operation.
- Demonstrate knowledge of the procedures used to install, maintain and troubleshoot tubing and piping systems and their components.

Objectives and Content:

1. Define terminology associated with tubing and piping systems.
2. Identify hazards and describe safe work practices pertaining to tubing and piping systems.
3. Identify tools and equipment relating to tubing and piping systems and describe their applications and procedures for use.
4. Interpret codes and regulations pertaining to tubing and piping systems.
5. Interpret information pertaining to tubing and piping systems found on drawings and specifications.
6. Identify types of tubing and piping systems and describe their applications.
 - i) rigid
 - ii) flexible
 - tubing
 - hoses
 - iii) ferrous
 - iv) non-ferrous
7. Identify types of tubing and piping and describe their compatibility, characteristics and applications.
8. Identify types of tube and pipe fittings and describe their characteristics and applications.

9. Identify tubing and piping system accessories and describe their characteristics and applications.
10. Identify types of valves used in tubing and piping systems and describe their applications and operation.
11. Describe the procedures used to select and install tubing and piping system components and accessories.
12. Perform tube bending and installation.
13. Describe the procedures used to maintain and troubleshoot tubing and piping systems and components.

LEVEL 2

ICT-200 Job Planning

Learning Outcomes:

- Demonstrate knowledge of the procedures used to plan and organize jobs.

Objectives and Content:

1. Identify sources of information relevant to job planning.
 - i) documentation
 - ii) drawings
 - iii) related professionals
 - iv) clients
2. Describe the considerations for determining job requirements.
 - i) personnel
 - ii) tools and equipment
 - iii) materials
 - iv) permits
 - v) safety planning
3. Describe the procedures used to plan job tasks.
4. Explain the importance of maintaining a parts inventory.

ICT-205 Introduction to Fluids

Learning Outcomes:

- Demonstrate knowledge of the principles and applications of fluids.

Objectives and Content:

1. Define terminology associated with fluids.
2. Identify hazards and describe safe work practices pertaining to fluids.
3. Explain the principles and theories of fluids.
 - i) Pascal's law
 - ii) Boyle's law
 - iii) Charles' law
 - iv) Combined Gas law
 - v) Bernoulli's principle
4. Describe units of measure as they relate to fluids.
5. Identify fluid related formulae and describe their applications.
6. Identify fluid related symbols and abbreviations found on drawings and schematics.

Learning Outcomes:

- Demonstrate knowledge of hydraulic supply systems, their components and operation.
- Demonstrate knowledge of schematics, their use and interpretation.
- Demonstrate knowledge of hydraulic related calculations.

Objectives and Content:

1. Define terminology associated with hydraulic supply systems.
2. Identify hazards and describe safe work practices pertaining to hydraulic supply systems.
 - i) energy state awareness
 - accumulators
 - suspended loads
3. Interpret information pertaining to hydraulic supply systems found on drawings and specifications.
4. Identify types of hydraulic supply systems and describe their applications and operation.
5. Identify hydraulic supply system components and describe their purpose and operation.
 - i) pumps
 - ii) motors
 - iii) actuators
 - iv) valves
 - v) accumulators
6. Interpret schematics to determine the operation of hydraulic supply systems.
7. Perform hydraulic calculations.

Learning Outcomes:

- Demonstrate knowledge of the procedures used to maintain and troubleshoot hydraulic supply systems and components.
- Demonstrate knowledge of the procedures used to commission hydraulic supply systems.

Objectives and Content:

1. Identify tools and equipment relating to hydraulic supply systems and describe their applications and procedures for use.
2. Identify types of fluids used in hydraulic supply systems and describe their characteristics and applications.
3. Describe the procedures used to maintain and troubleshoot hydraulic supply systems and components.
 - i) check hoses, piping and tubing
 - ii) check fluids (condition and level)
 - iii) check/change filters
 - iv) determine operating parameters
 - v) adjust system pressure, temperature and flow
4. Describe the procedures used to commission hydraulic supply systems and components.
 - i) initial
 - ii) return to service

Learning Outcomes:

- Demonstrate knowledge of compressors, their components and operation.
- Demonstrate knowledge of the procedures used to maintain and troubleshoot compressors and components.
- Demonstrate knowledge of the procedures used to commission compressors.

Objectives and Content:

1. Define terminology associated with compressors.
2. Identify hazards and describe safe work practices associated with compressors.
 - i) energy state awareness
3. Identify tools and equipment relating to compressors and describe their applications and procedures for use.
4. Identify classifications and types of compressors, their specifications and applications.
 - i) dynamic/centrifugal
 - ii) positive displacement
5. Identify compressor components and accessories and describe their purpose and operation.
6. Describe the procedures used to select and size compressors and their components.
7. Describe the procedures used to maintain and troubleshoot compressors and their components.
8. Describe the procedures used to commission compressors and their components.

Learning Outcomes:

- Demonstrate knowledge of pneumatic supply systems, their components and operation.
- Demonstrate knowledge of schematics, their use and interpretation.
- Demonstrate knowledge of pneumatic related calculations.

Objectives and Content:

1. Define terminology associated with pneumatic supply systems.
2. Identify hazards and describe safe work practices pertaining to pneumatic supply systems.
 - i) energy state awareness
3. Interpret information pertaining to pneumatic supply systems found on drawings and specifications.
4. Identify types of pneumatic supply systems and describe their applications and operation.
 - i) instrument air
 - ii) service air
5. Identify types of pneumatic supply system components and describe their purpose and operation.
 - i) compressors
 - ii) relays
 - iii) valves
 - iv) regulators
 - v) gauges
 - vi) actuators
6. Describe the methods of air treatment in pneumatic supply systems.
 - i) filters
 - ii) dryers
 - iii) after-coolers

- iv) de-icers
 - v) receivers
7. Interpret schematics to determine the operation of pneumatic supply systems.
 8. Perform pneumatic related calculations.

Learning Outcomes:

- Demonstrate knowledge of the procedures used to install, maintain and troubleshoot pneumatic supply system equipment and components.
- Demonstrate knowledge of the procedures used to commission pneumatic supply systems.

Objectives and Content:

1. Identify tools and equipment relating to pneumatic supply systems and describe their applications and procedures for use.
2. Describe the procedures used to select and install pneumatic supply systems and components.
3. Describe the procedures used to maintain and troubleshoot pneumatic supply systems and components.
 - i) compressors
 - ii) lubricating fluids (condition and level)
 - iii) dryers
 - iv) de-icers
 - v) hoses, piping and tubing
 - vi) filters
4. Describe the procedures used to commission pneumatic supply systems and components.

Learning Outcomes:

- Demonstrate knowledge of final control elements, their accessories, components and operation.
- Demonstrate knowledge of the procedures used to install, maintain, troubleshoot and replace final control elements, their accessories and components.

Objectives and Content:

1. Define terminology associated with final control elements.
2. Identify hazards and describe safe work practices pertaining to final control elements.
3. Identify tools and equipment relating to final control elements and describe their applications and procedures for use.
4. Interpret codes and regulations pertaining to final control elements.
5. Interpret information pertaining to final control elements found on drawings, specifications and nameplates.
6. Identify types of final control elements and describe their components applications and operation.
 - i) valves
 - ii) dampers
 - iii) louvres
 - iv) positive displacement metering pumps
 - v) motors
 - vi) process regulators
7. Identify types of energy systems used to operate final control elements and describe their characteristics and applications.
 - i) hydraulic
 - ii) pneumatic
 - iii) electric
 - iv) manual operation

8. Identify final control element accessories and describe their components, purpose and operation.
 - i) actuators
 - hydraulic
 - pneumatic
 - electric
 - ii) boosters
 - volume
 - pressure
 - iii) positioners
 - electric
 - pneumatic
 - smart
 - iv) regulators
 - v) switches
 - vi) hand wheels
 - vii) variable speed drives
9. Describe the procedures used to select, size and install final control elements, their accessories and components.
10. Describe the procedures used to maintain, troubleshoot and replace final control elements, their accessories and components.

Learning Outcomes:

- Demonstrate knowledge of AC/DC circuits and their characteristics.
- Demonstrate knowledge of electronics, their components, applications and operation.
- Demonstrate knowledge of the procedures used to install, maintain, troubleshoot and replace electronic circuits and their components.

Objectives and Content:

1. Define terminology associated with electronics.
2. Identify hazards and describe safe work practices pertaining to electronics.
 - i) energy state awareness
 - ii) static electricity discharge
3. Identify tools and equipment relating to electronic circuitry and describe their applications and procedures for use.
4. Interpret codes and regulations pertaining to electronics.
5. Interpret information pertaining to electronics found on devices, drawings and specifications.
6. Explain conventional current flow vs. electron flow theory in electronics.
7. Identify number systems used in electronics and describe their applications.
 - i) binary
 - ii) decimal
 - iii) hexadecimal
 - iv) octal
 - v) binary coded decimal (BCD)
8. Perform conversions between number systems.
9. Identify types of logic gates and describe their applications.

10. Identify semiconductor materials used in electronics and describe their characteristics and applications.
11. Identify electronic components and describe their purpose and operation in a circuit.
 - i) rectifiers
 - ii) diodes
 - iii) transistors
 - iv) op amps
 - v) thyristors
12. Describe the procedures used to select and install electronic circuits.
13. Describe the procedures used to maintain, troubleshoot and replace electronic circuitry.
14. Perform calculations pertaining to electronics.
 - i) power
 - ii) current
 - iii) voltage
 - iv) frequency (timing)
 - v) logic

Learning Outcomes:

- Demonstrate knowledge of single-phase electricity, its characteristics and associated principles.
- Demonstrate knowledge of AC devices and their characteristics.

Objectives and Content:

1. Define terminology associated with single-phase electricity.
2. Identify hazards and describe safe work practices pertaining to single-phase electricity.
3. Identify units of measure and symbols pertaining to single-phase electricity.
4. Explain the principles of magnetism.
5. Explain the principles of electromagnetism.
6. Explain the principles of electromagnetic induction.
7. Identify the types of electromagnetic induction and describe their characteristics and applications.
 - i) self induction
 - ii) mutual induction
8. Explain alternating current (AC) generation.
9. Identify types of devices used in AC generation and describe their characteristics and applications.
10. Identify types of transformers used in control circuitry and describe their characteristics and applications.
11. Identify types of AC/DC circuits and describe their characteristics.
 - i) resistance/capacitance (RC)

- ii) resistance/inductance (RL)
 - iii) resistance/inductance/capacitance (RLC)
12. Perform calculations pertaining to single-phase electricity.

Learning Outcomes:

- Demonstrate knowledge of power supplies, their components and operation.
- Demonstrate knowledge of the procedures used to install, maintain, troubleshoot, and replace power supplies.

Objectives and Content:

1. Define terminology associated with power supplies.
2. Identify hazards and describe safe work practices pertaining to power supplies.
3. Interpret codes and regulations pertaining to power supplies.
4. Interpret information pertaining to power supplies found on drawings, specifications and nameplates.
5. Identify types of power supplies and describe their characteristics and operating principles.
 - i) AC/DC power supplies
 - ii) uninterruptable power supplies (UPS)
6. Describe the procedures used to select and install power supplies.
7. Describe the procedures used to maintain, troubleshoot and replace power supplies.

Learning Outcomes:

- Demonstrate knowledge of process measurement and its associated principles.
- Demonstrate knowledge of process measuring and indicating devices, their components and operation.
- Demonstrate knowledge of the procedures used to install, calibrate, configure, maintain, troubleshoot and replace process measuring and indicating devices.

Objectives and Content:

1. Define terminology associated with process measurement.
2. Identify hazards and describe safe work practices pertaining to process measurement.
3. Identify tools and equipment relating to process measuring and indicating devices and describe their applications and procedures for use.
4. Interpret codes and regulations pertaining to process measuring and indicating devices.
5. Interpret information pertaining to process measuring and indicating devices found on drawings, specifications and nameplates.
6. Identify units of measure used to express process measurement values.
7. Perform conversions and calculations relating to process measurement.
8. Identify forms of process measurement and explain their associated principles.
 - i) pressure
 - ii) temperature
 - iii) level
 - iv) flow
9. Identify types of process measuring and indicating devices and describe their characteristics and applications.
 - i) process switches

- ii) indicators
 - iii) conventional transmitters
 - pneumatic
 - electronic
 - iv) smart transmitters
 - v) recorders and data loggers
-
10. Describe the procedures used to select and install process measuring and indicating devices.
 11. Describe the procedures used to calibrate and configure process measuring and indicating devices.
 12. Calibrate and configure process measuring and indicating devices.
 13. Describe the procedures used to maintain, troubleshoot and replace process measuring and indicating devices.

LEVEL 3

Learning Outcomes:

- Demonstrate knowledge of basic process control and its purpose.
- Demonstrate knowledge of basic process controllers, their components and operation.
- Demonstrate knowledge of the procedures used to install, configure, calibrate, maintain, and troubleshoot basic process controllers.
- Demonstrate knowledge of the procedures used to maintain, troubleshoot and tune basic process control systems.
- Demonstrate knowledge of the procedures used to commission basic process controllers and their systems.

Objectives and Content:

1. Define terminology associated with process control.
2. Identify hazards and describe safe work practices pertaining to process control.
3. Identify tools and equipment used to configure and calibrate process controllers and describe their applications and procedures for use.
4. Interpret codes and regulations pertaining to process control.
5. Interpret information pertaining to basic process control found on drawings and specifications.
6. Explain basic process control and its purpose.
7. Identify methods of basic process control and describe their applications.
 - i) on-off
 - ii) feedback
 - iii) cascade
 - iv) auto selection (override)
8. Identify modes of process control and describe their characteristics, operation and combinations.
 - i) on-off

- ii) proportional (P)
 - iii) integral (I)
 - iv) derivative (D)
 - v) P, I, PI, PD, PID
9. Explain process dynamics and their impact on process control.
 10. Describe the procedures used to select and install process controllers.
 11. Describe the procedures used to configure and calibrate process controllers.
 12. Describe the procedures used to tune control loops.
 - i) closed loop methods
 - ii) open loop methods
 13. Describe the procedures used to maintain and troubleshoot process controllers.
 14. Describe the procedures used to maintain and troubleshoot process control loops.
 15. Describe the procedures used to commission process controllers and their loops.

Learning Outcomes:

- Demonstrate knowledge of trade related computer equipment and accessories and their use.

Objectives and Content:

1. Define terminology associated with trade related computer use.
2. Identify hazards and describe safe work practices pertaining to trade related computer use.
 - i) online vs. offline applications
 - ii) hazardous locations
3. Identify trade related computer equipment and accessories and describe their characteristics and applications.
 - i) hardware
 - ii) software/firmware
 - iii) interfacing equipment
4. Identify the requirements and describe the procedures used to backup data and equipment configuration.

Learning Outcomes:

- Demonstrate knowledge of programming languages.
- Demonstrate knowledge of programmable logic controller (PLC) systems, their components and operation.
- Demonstrate knowledge of the procedures used to install, configure, maintain, troubleshoot and replace PLC systems.

Objectives and Content:

1. Define terminology associated with PLC systems.
2. Identify hazards and describe safe work practices pertaining to PLCs.
 - i) online vs. offline applications
 - ii) hazardous locations
3. Interpret codes and regulations pertaining to PLCs.
4. Interpret information pertaining to PLC systems found on drawings and specifications.
5. Identify sources of information pertaining to PLC system maintenance, configuration and programming.
6. Identify programming languages used to program PLC systems.
 - i) ladder diagram (LD)
 - ii) function block diagram (FBD)
 - iii) structured text (ST)
 - iv) instruction list (IL)
 - v) sequential function chart (SFC)
 - vi) boolean logic diagrams
7. Interpret programming languages and describe their applications and the procedures used to program PLC systems.
 - i) ladder diagram (LD)

- ii) function block diagram (FBD)
 - iii) sequential function chart (SFC)
8. Identify PLC system components and describe their purpose and operation.
- i) hardware
 - ii) software
 - iii) network communication protocols
9. Describe the procedures used to select and install PLC systems and their components.
10. Describe the procedures used to configure and program PLC systems and their components.
- i) I/O configuration
 - ii) data table
 - iii) user program
 - iv) communication interface
11. Describe the procedures used to maintain, troubleshoot and replace PLC systems and their components.

Learning Outcomes:

- Demonstrate knowledge of distributed control systems (DCSs), their components and operation.
- Demonstrate knowledge of the procedures used to install, configure, upgrade, maintain, troubleshoot and replace DCSs and components.

Objectives and Content:

1. Define terminology associated with DCSs.
2. Identify hazards and describe safe work practices pertaining to DCSs.
3. Identify tools and equipment relating to DCSs and describe their applications and procedures for use.
4. Interpret codes and regulations pertaining to DCSs.
5. Interpret information pertaining to DCSs found on drawings and specifications.
6. Identify sources of information pertaining to DCSs maintenance, configuration and programming.
7. Describe the procedures used to program a DCS.
8. Identify DCS components and describe their purpose and operation.
 - i) hardware
 - ii) software
 - iii) network communication protocols
9. Describe the procedures used to select and install DCSs and their components.
10. Describe the procedures used to configure and upgrade DCSs and their components.
11. Describe the procedures used to maintain, troubleshoot and replace DCSs and their components.

Learning Outcomes:

- Demonstrate knowledge of drives and motors, their components and operation.
- Demonstrate knowledge of the procedures used to calibrate, configure, maintain and troubleshoot drives.
- Demonstrate knowledge of the procedures used maintain and troubleshoot motors.

Objectives and Content:

1. Define terminology associated with drives and motors.
2. Identify hazards and describe safe work practices pertaining to drives and motors.
3. Interpret codes and regulations pertaining to drives and motors.
4. Interpret information pertaining to drives and motors found on drawings, specifications and nameplates.
5. Explain single and three-phase power and their applications in drives and motors.
6. Identify types of drives and describe their characteristics and operating principles.
 - i) AC drives
 - ii) DC drives
7. Identify types of motors and describe their characteristics and operating principles.
 - i) control motors
 - servo
 - stepping
 - ii) single-phase
 - iii) three-phase

8. Describe the procedures used to calibrate and configure drives.
9. Describe the procedures used to maintain and troubleshoot drives and motors.

Learning Outcomes:

- Demonstrate knowledge of process analyzers, their components and operation.
- Demonstrate knowledge of the procedures used to install, configure, calibrate, maintain, troubleshoot and replace process analyzers.
- Demonstrate knowledge of process sample conditioning.

Objectives and Content:

1. Define terminology associated with process analyzers.
2. Identify hazards and describe safe work practices pertaining to process analyzers.
3. Identify tools and equipment relating to process analyzers and describe their applications and procedures for use.
4. Interpret codes and regulations pertaining to process analyzers.
5. Interpret information pertaining to process analyzers found on drawings and specifications.
6. Explain the principles of operation for process analyzers.
7. Identify types of process analyzers and describe their characteristics and applications.
 - i) pH
 - ii) oxidation reduction potential (ORP)
 - iii) conductivity
 - iv) dissolved oxygen (D.O.)
 - v) mass and density
 - vi) viscosity
 - vii) consistency
 - viii) turbidity
 - ix) chromatography
 - x) environmental
 - waste water

- xi) nuclear
 - solids composition
 - liquids composition
- 8. Identify process analyzer components and describe their purpose and operation.
- 9. Describe the procedures used to select and install process analyzers and their components.
- 10. Describe the procedures used to configure and calibrate process analyzers.
- 11. Describe the procedures used to maintain, troubleshoot and replace process analyzers and their components.
- 12. Describe process sample conditioning and its importance to process analysis.
- 13. Describe the procedures and equipment used to obtain and condition samples for process analysis.

LEVEL 4

Learning Outcomes:

- Demonstrate knowledge of equipment monitoring and its associated principles.
- Demonstrate knowledge of equipment monitoring devices, their components and operation.
- Demonstrate knowledge of the procedures used to install, calibrate, configure, maintain, troubleshoot and replace equipment monitoring devices.

Objectives and Content:

1. Define terminology associated with equipment monitoring devices.
2. Identify hazards and describe safe work practices pertaining to equipment monitoring devices.
3. Identify tools and equipment relating to equipment monitoring devices and describe their applications and procedures for use.
4. Interpret codes and regulations pertaining to equipment monitoring devices.
5. Interpret information pertaining to equipment monitoring devices found on drawings and specifications.
6. Identify units of measure used to express equipment monitoring values.
7. Perform calculations relating to equipment monitoring.
8. Identify types of equipment monitoring devices and describe their characteristics and applications.
 - i) vibration
 - ii) motion
 - iii) speed
 - iv) position
 - v) current
9. Describe the procedures used to select and install equipment monitoring devices.

10. Describe the procedures used to calibrate and configure equipment monitoring devices.
11. Describe the procedures used to maintain, troubleshoot and replace equipment monitoring devices.

Learning Outcomes:

- Demonstrate knowledge of signal transmission systems, their components and operation.
- Demonstrate knowledge of the procedures used to install, configure, upgrade, maintain, troubleshoot and replace signal transmission systems.

Objectives and Content:

1. Define terminology associated with signal transmission.
2. Identify hazards and describe safe work practices pertaining to signal transmission.
3. Identify tools and equipment relating to signal transmission systems and describe their applications and procedures for use.
4. Interpret codes and regulations pertaining to signal transmission.
5. Interpret information pertaining to signal transmission found on drawings and specifications.
6. Identify types of communication protocols and describe their characteristics and applications.
7. Identify types of signal transmission systems and describe their characteristics and applications.
 - i) pneumatic
 - ii) wired
 - iii) fibre optic
 - iv) wireless
8. Identify signal transmission system components and accessories and describe their purpose and operation.
 - i) tubing
 - ii) cables
 - iii) antennas

- iv) converters
 - v) transducers
 - vi) multi-plexers
 - vii) network switches/hubs
-
- 9. Describe the procedures used to select and install signal transmission systems and their components.
 - 10. Describe the procedures used to configure, calibrate and upgrade signal transmission systems and their components.
 - 11. Describe the procedures used to maintain, troubleshoot and replace signal transmission systems and their components.

Learning Outcomes:

- Demonstrate knowledge of advanced process control and its purpose.
- Demonstrate knowledge of the procedures used to, configure, tune, maintain, and troubleshoot process control systems.
- Demonstrate knowledge of the procedures used to commission and optimize process control systems.

Objectives and Content:

1. Define terminology associated with advanced process control.
2. Identify hazards and describe safe work practices pertaining to advanced process control.
3. Interpret codes and regulations pertaining to advanced process control.
4. Interpret information pertaining to advanced process control found on drawings and specifications.
5. Explain advanced process control and its purpose.
6. Identify methods of advanced process control and describe their applications.
 - i) ratio
 - ii) feed forward
 - iii) adaptive
7. Explain process loop interactions and their impact on process control.
8. Describe the procedures used to configure and tune process control systems.
9. Describe the procedures used to maintain and troubleshoot process control systems.
10. Describe the procedures used to commission and optimize process control systems.

Learning Outcomes:

- Demonstrate knowledge of supervisory control and data acquisition (SCADA) systems, their components and operation.
- Demonstrate knowledge of the procedures used to install, configure, upgrade maintain, troubleshoot and replace SCADA systems and components.

Objectives and Content:

1. Define terminology associated with SCADA systems.
2. Identify hazards and describe safe work practices pertaining to SCADA systems.
3. Identify tools and equipment relating to SCADA systems and describe their applications and procedures for use.
4. Interpret codes and regulations pertaining to SCADA systems.
5. Interpret information pertaining to SCADA systems found on drawings and specifications.
6. Identify sources of information pertaining to SCADA maintenance, configuration and programming.
7. Describe the procedures to program a SCADA system.
8. Identify SCADA system components and describe their purpose and operation.
 - i) hardware
 - ii) software
 - iii) network communication protocols
9. Describe the procedures used to select and install SCADA systems and their components.
10. Describe the procedures used to configure and upgrade SCADA systems and their components.

11. Describe the procedures used to maintain, troubleshoot and replace SCADA systems and their components.

Learning Outcomes:

- Demonstrate knowledge of human machine interface (HMI) systems, their components and operation.
- Demonstrate knowledge of the procedures used to install, configure, upgrade, maintain and troubleshoot HMI systems.

Objectives and Content:

1. Define terminology associated with HMI systems.
2. Identify hazards and describe safe work practices pertaining to HMI systems.
3. Identify tools and equipment relating to HMI systems and describe their applications and procedures for use.
4. Interpret information pertaining to HMI systems found on drawings and specifications.
5. Identify types of HMI systems and describe their characteristics and applications.
6. Identify HMI system components and describe their purpose and operation.
 - i) hardware
 - ii) software
7. Describe the procedures used to select and install HMI systems and their components.
8. Describe the procedures used to configure and upgrade HMI systems and their components.
9. Describe the procedures used to maintain and troubleshoot HMI systems and their components.

Learning Outcomes:

- Demonstrate knowledge of safety and security systems, their components and operation.
- Demonstrate knowledge of the procedures used to install, maintain, troubleshoot, configure, calibrate and replace safety and security systems and their components.

Objectives and Content:

1. Define terminology associated with safety and security systems.
2. Identify hazards and describe safe work practices pertaining to safety and security systems.
3. Identify tools and equipment relating to safety and security systems and describe their applications and procedures for use.
4. Interpret codes and regulations pertaining to safety and security systems.
5. Interpret information pertaining to safety and security systems found on drawings and specifications.
6. Identify types of safety and security systems and describe their components, characteristics and applications.
 - i) gas detection
 - ii) heat detection
 - iii) fire detection
 - iv) smoke detection
 - v) intruder detection
 - vi) security and safety cameras
 - vii) Safety Instrument Systems (SIS)
 - viii) machinery safety system
 - emergency stop monitoring
 - safety sensors and devices
 - ix) safety relief valves

7. Describe the procedures used to select and install safety and security systems and their components.
8. Describe the procedures used to configure and calibrate safety and security systems and their components.
9. Describe the procedures used to maintain, troubleshoot and replace safety and security systems and their components.

Learning Outcomes:

- Demonstrate knowledge of process analyzers, their components and operation.
- Demonstrate knowledge of the procedures used to install, configure, calibrate, maintain, troubleshoot and replace process analyzers.
- Demonstrate knowledge of process sample conditioning.

Objectives and Content:

1. Define terminology associated with process analyzers.
2. Identify hazards and describe safe work practices pertaining to process analyzers.
3. Identify tools and equipment relating to process analyzers and describe their applications and procedures for use.
4. Interpret codes and regulations pertaining to process analyzers.
5. Interpret information pertaining to process analyzers found on drawings and specifications.
6. Explain the principles of operation for process analyzers.
7. Identify types of process analyzers and describe their characteristics and applications.
 - i) chromatography
 - ii) spectrographic
 - iii) flue gas analyzers
 - iv) environmental
 - gas
 - noise
8. Identify process analyzer components and describe their purpose and operation.
9. Describe the procedures used to select and install process analyzers and their components.

10. Describe the procedures used to configure and calibrate process analyzers.
11. Describe the procedures used to maintain, troubleshoot and replace process analyzers and their components.
12. Describe process sample conditioning and its importance to process analysis.
13. Describe the procedures and equipment used to obtain and condition samples for process analysis.