# Instrumentation and Control Technician

# Guide to Course Content

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*Recognition:*
*To promote transparency and consistency, this document has been adapted from the 2013 Instrumentation and Control Technician National Occupational Analysis (Employment and Social Development Canada).*

*A complete version of the Occupational Analysis can be found* at www.red-seal.ca

# STRUCTURE OF THE GUIDE TO COURSE CONTENT

To facilitate understanding of the occupation, this guide to course content contains the following sections:

**Description of the Instrumentation and Control Technician trade**: an overview of the trade's duties and training requirements.

**Essential Skills Summary**: an overview of how each of the nine essential skills is applied in this trade.

**Elements of harmonization of apprenticeship training**: includes adoption of Red Seal trade name, number of levels of apprenticeship, total training hours (on-the-job and in-school) and consistent sequencing of technical training content. Implementation for harmonization will take place progressively. Target date of harmonization for the Instrumentation and Control Technician is 2021.

**Task Matrix**: a chart which outlines graphically the major work activities, tasks and sub-tasks of this standard detailing the essential skills and the level of training where the content is covered.

**Major Work Activity (MWA):** the largest division within the standard that is comprised of a distinct set of trade activities.

**Task**: distinct actions that describe the activities within a major work activity.

**Sub-task**: distinct actions that describe the activities within a task.

**Training Profile Chart**: a chart which outlines the model for Saskatchewan Apprenticeship and Trade Certification Commission (SATCC) technical training.

**Technical Training Course Content for the Instrumentation and Control Technician trade**: a chart which outlines the model for SATCC technical training sequencing. For the harmonized level of training, a cross reference to the Harmonized apprenticeship technical training sequencing, at the learning outcome level, is provided.

# DESCRIPTION OF THE INSTRUMENTATION AND CONTROL TECHNICIAN TRADE

*Instrumentation and Control Technicians maintain, diagnose, calibrate and repair measurement and control systems in commercial and industrial settings.*

Instrumentation and control technicians are knowledgeable in overall plant systems and the interactions of processes. They install and service a variety of systems including safety and security, energy delivery (hydraulic, pneumatic and electrical), communication, and process control systems. They also install and service measuring and indicating instruments to monitor process control variables, monitor the operation of equipment and measure the characteristics of the material within a process. Instrumentation and control technicians work with final control devices such as valves, actuators and positioners to manipulate the process medium. They install and terminate electrical, pneumatic and fluid connections. They also work on network and signal transmission systems such as fibre optic and wireless.

Along with the calibration, repair, adjustment and replacement of components, instrumentation and control technicians inspect and test the operation of instruments and systems to diagnose faults and verify repairs. They establish and optimize process control strategies, and configure related systems such as Programmable Logic Controllers (PLCs), Distributed Control Systems (DCSs), Human Machine Interfaces (HMIs) and Supervisory Control and Data Acquisition (SCADA) systems. Instrumentation and control technicians maintain backups, documentation and software revisions as part of maintaining these computer-based control systems. Scheduled maintenance and the commissioning of systems are also important aspects of the work. Instrumentation and control technicians consult technical documentation, drawings, schematics and manuals. They may assist engineering in plant design, modification and hazard analysis, and work with plant operators to optimize plant controls.

Instrumentation and control technicians use hand, power and electronic tools, test equipment, and material handling equipment. They work on a range of instruments including primary control elements, transmitters, analyzers, sensors, detectors, signal conditioners, recorders, controllers and final control elements. These instruments measure and control variables such as pressure, flow, temperature, level, motion, force and chemical composition.

Instrumentation and control technicians work in various industrial sectors such as pulp and paper/fibre processing; nuclear, thermal and hydro power generation; mining; petrochemical; oil and gas; steel; water treatment; manufacturing; and industrial/commercial instrument servicing.

When performing their duties, instrumentation and control technicians must comply with federal, jurisdictional, industrial and site-specific standards, codes and regulations. They must ensure that all processes operate and are maintained within these set standards, codes and regulations. Keeping up-to-date with advances in technology in industry and the trade is important.

Instrumentation and control technicians can work in hazardous environments where they may be exposed to confined spaces, heights, noise, dust, cold and heat. There may also be risks with working with chemicals, gases, radiation, laser equipment and substances under pressure.

Key attributes for people entering this trade are manual dexterity, attention to detail, strong problem solving skills, communication skills, technological aptitude and mathematical and scientific aptitude.

This analysis recognizes similarities or overlaps with other tradespersons and professionals such as process operators, steamfitters/pipefitters, industrial mechanics (millwrights), electricians and engineers.

With experience, instrumentation and control technicians may act as mentors and trainers to apprentices in the trade. They may also move into supervisory, design, advanced control, training, sales and other related positions.

**Training Requirements:** To graduate from each level of the apprenticeship program, an apprentice must successfully complete the required technical training and compile enough on-the-job experience to total at least 1700 hours each year. Total trade time required is 6800 hours and at least 4 years in the trade. There are four levels of technical training delivered by Saskatchewan Polytechnic in Moose Jaw:

Level One: 10 weeks
Level Two: 10 weeks
Level Three: 10 weeks
Level Four: 10 weeks

The information contained in this guide to course content details the technical training delivered for each level of apprenticeship. An apprentice spends approximately 15% of their apprenticeship term in a technical training institute learning the technical and theoretical aspects of the trade. The hours and percentages of technical and practical training may vary according to class needs and progress.

The content of the technical training components is subject to change without notice.

**Entrance Requirements for Apprenticeship Training**

Your grade twelve transcripts (with no modified classes) or GED 12 is your guarantee that you meet the educational entrance requirements for apprenticeship in Saskatchewan. In fact, employers prefer and recommend apprentices who have completed high school. This ensures the individual has all of the necessary skills required to successfully complete the apprenticeship program, and receive journeyperson certification.

Individuals with “modified” or “general” classes in math or science do not meet our entry requirements. These individuals are required to take an entrance assessment prescribed by the SATCC.

English is the language of instruction in all apprenticeship programs and is the common language for business in Saskatchewan. Before admission, all apprentices and/or “upgraders” must be able to understand and communicate in the English language. Applicants whose first language is not English must have a minimum Canadian Language Benchmark Assessment of six (CLB6).

Note: A CLB assessment is valid for a one-year period from date of issue.

| Designated Trade Name | **Math Credit** at the Indicated Grade Level❶ | **Science Credit** at Grade Level |
|---|---|---|
| Instrumentation and Control Technician | Grade 11 | Grade 10 |

❶ - (One of the following) WA – Workplace and Apprenticeship; or F – Foundations; or P – Pre-calculus, or a Math at the indicated grade level (Modified and General Math credits are not acceptable.).

*Applicants who have graduated in advance of 2015-2016, or who do not have access to the revised Science curricula will require a Science at the minimum grade level indicated by trade.

For information about high school curriculum, including Math and Science course names, please see: http://www.curriculum.gov.sk.ca/#

**Individuals not meeting the entrance requirements will be subject to an assessment and any required training**

# ESSENTIAL SKILLS SUMMARY

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

Through extensive research, the Government of Canada and other national and international agencies have identified and validated nine essential skills. These skills are used in nearly every occupation and throughout daily life in different ways.

A series of CCDA-endorsed tools have been developed to support apprentices in their training and to be better prepared for a career in the trades. The tools can be used independently or with the assistance of a tradesperson, trainer, employer, teacher or mentor to:

- understand how essential skills are used in the trades;
- learn about individual essential skills strengths and areas for improvement; and
- improve essential skills and increase success in an apprenticeship program.

The tools are available online or for order at: www.esdc.gc.ca/eng/jobs/les/profiles/index.shtml

The application of these skills may be described throughout this document within the skills and knowledge which support each sub-task of the trade. The most important essential skills for each sub-task have also been identified. The following are summaries of the requirements in each of the essential skills, taken from the essential skills profile. A link to the complete essential skills profile can be found at www.red-seal.ca.

## READING

Instrumentation and control technicians require reading skills to locate and interpret technical information for their trade. These texts include technical articles about new products and industry practices, bulletins from manufacturers and on health and safety, calibration and service guides, incident reports, procedures, manuals and notes.

## DOCUMENT USE

Instrumentation and control technicians locate and interpret information in both print and electronic formats. Types of documents referenced include computer printouts with numeric information, supplier catalogue listings and engineering documentation such as forms, graphs, tables, charts, schematics, assembly diagrams and drawings. They may also create documents such as on-site sketches and detailed schematics, assembly drawings, graphs and charts.

## WRITING

Writing skills are used by instrumentation and control technicians to create parts lists, maintenance schedules, and inspection reports. Instrumentation and control technicians write procedures for the control and operation of equipment and to troubleshoot faults. They use writing skills when communicating through e-mail and providing status updates in logbooks.

## ORAL COMMUNICATION

In order to coordinate work, instrumentation and control technicians interact with other tradespeople such as steamfitter/pipefitters, welders, machinists, electricians and industrial mechanics (millwrights). They may also discuss systems design and problems with supervisors and engineers, and provide expert advice and opinion. Instrumentation and control technicians also exchange technical repair and troubleshooting information and speak to process operators about equipment and machinery breakdown. At times, they may make formal presentations to explain monitoring procedures or new equipment.

## NUMERACY

Instrumentation and control technicians must apply measurement and calculation, data analysis and numerical estimation skills to their tasks. Some of these tasks include measuring analyzer malfunctions, calculating flow, calculating volume displacement, monitoring pressure, interpreting deviations on graphs, and comparing values and measurements. Instrumentation and control technicians evaluate sets of data collected from tests and simulations to troubleshoot faults, assess equipment performance and assess the progress of wear.

## THINKING

Instrumentation and control technicians troubleshoot malfunctions, take corrective measures to avoid potential hazards and decide whether to repair or replace components based on time and cost factors. They plan and organize maintenance schedules, the installation of new machinery and the tradespeople assigned to install the machinery. Instrumentation and control technicians must be able to think quickly and synthesize the information at hand to deal with emergencies such as serious equipment malfunctions that could cause injury, or property and environmental damage.

## WORKING WITH OTHERS

Even though instrumentation and control technicians often work alone, they may also work with other tradespeople, professionals and process operators. Instrumentation and control technicians work with process operators to ensure instrumentation is properly maintained and emergencies are handled quickly. They work with other tradespeople to perform functions such as testing transmitters or controllers, and installing control valves. Instrumentation and control technicians sometimes work as part of a crew, for example when running wires. In doing so they may fill the role of either team member or team leader on project teams

## DIGITAL TECHNOLOGY

Instrumentation and control technicians install and service programmable process control systems such as PLCs, DCSs, SCADA systems and HMIs. They may use hand-held digital devices to configure settings and to access data such as measurement and operational values. Instrumentation and control technicians may use word processing software, databases, spreadsheets, communication software and devices, the Internet, and computer-assisted design (CAD), manufacturing or machining software depending on the task at hand.

## CONTINUOUS LEARNING

Instrumentation and control technicians may attend training in areas that are new or continually evolving in the trade such as safety, digital technology and more sophisticated computer applications relating to process control. They may attend technical courses offered by suppliers' representatives covering new equipment, as well as team leadership/communication seminars. Continuous learning also occurs through the reading of technical literature and by troubleshooting.

# ELEMENTS OF HARMONIZATION FOR APPRENTICESHIP TRAINING

At the request of industry, the Harmonization Initiative was launched in 2013 to *substantively align* apprenticeship systems across Canada by making training requirements more consistent in the Red Seal trades. Harmonization aims to improve the mobility of apprentices, support an increase in their completion rates and enable employers to access a larger pool of apprentices.

As part of this work, the Canadian Council of the Directors of Apprenticeship (CCDA) identified four main harmonization priorities in consultation with industry and training stakeholders:

## 1. Trade name

The official Red Seal name for this trade is Instrumentation and Control Technician.

## 2. Number of levels of apprenticeship

The number of levels of technical training recommended for the Instrumentation and Control Technician trade is four.

## 3. Total training hours during apprenticeship training

The total hours of training, including both on-the-job and in-school training for the Instrumentation and Control Technician trade is 6800.

## 4. Consistent sequencing of training content (at each level) using the most recent occupational standard

Implementation for harmonization will take place progressively. Level one to be implemented in 2021.

# INSTRUMENTATION AND CONTROL TECHNICIAN TASK MATRIX CHART

This chart outlines the major work activities, tasks and sub-tasks from the 2013 Instrumentation and Control Technician National Occupational Analysis.

The Task Matrix Chart will be updated every year until Harmonization implementation is complete. Implementation for harmonization will take place progressively. Level two to be implemented in 2023.

## A – COMMON OCCUPATIONAL SKILLS

| | | | | |
|---|---|---|---|---|
| **Task A-1 Performs safety-related functions** | **1.01 Maintains safe work environment** 1 | **1.02 Uses personal protective equipment (PPE) and safety equipment** 1 | **1.03 Performs de-energizing, lock-out and tag-out procedures** 1 | |
| **Task A-2 Organizes work** | **2.01 Uses diagrams, drawings and schematics** 1,3 | **2.02 Plans tasks** 1,3 | | |
| **Task A-3 Performs routine trade activities** | **3.01 Maintains calibration, configuration and test equipment** 1 | **3.02 Maintains tools** 1 | **3.03 Maintains documentation.** 1,3 | **3.04 Operates material handling equipment** 1 |

## B – PROCESS MEASURING AND INDICATING DEVICES

| | | | | |
|---|---|---|---|---|
| **Task B-4 Installs and services pressure, temperature, level and flow devices** | **4.01 Installs pressure, temperature, level and flow devices** 1,2 | **4.02 Maintains pressure, temperature, level and flow devices** 1,2 | **4.03 Diagnoses pressure, temperature, level and flow devices** 1,2 | **4.04 Repairs pressure, temperature, level and flow devices** 1,2 |

| | | | | |
|---|---|---|---|---|
| Task B-5 Installs and services motion, speed, position and vibration devices | 5.01 Installs motion, speed, position and vibration devices 3 | 5.02 Maintains motion, speed, position and vibration devices 3 | 5.03 Diagnoses motion, speed, position and vibration devices 3 | 5.04 Repairs motion, speed, position and vibration devices 3 |
| Task B-6 Installs and services mass, density and consistency devices | 6.01 Installs mass, density and consistency devices 3 | 6.02 Maintains mass, density and consistency devices 3 | 6.03 Diagnoses mass, density and consistency devices 3 | 6.04 Repairs mass, density and consistency devices 3 |
| Task B-7 Installs and services process analyzers | 7.01 Installs process analyzers 3 | 7.02 Maintains process analyzers 3 | 7.03 Diagnoses process analyzers 3 | 7.04 Repairs process analyzers 3 |
| Task B-8 Installs and services multiple variable computing devices | 8.01 Installs multiple variable computing devices 4 | 8.02 Maintains multiple variable computing devices 4 | 8.03 Diagnoses multiple variable computing devices 4 | 8.04 Repairs multiple variable computing devices 4 |

## C – SAFETY AND SECURITY SYSTEMS AND DEVICES

| | | | | | |
|---|---|---|---|---|---|
| Task C-9 Installs and services safety systems and devices | 9.01 Installs safety systems and devices 4 | 9.02 Maintains safety systems and devices 4 | 9.03 Diagnoses safety systems and devices 4 | 9.04 Repairs safety systems and devices 4 | |
| Task C-10 Installs and services facility security systems. (NOT COMMON CORE) | 10.01 Installs facility security systems. (NOT COMMON CORE) | 10.02 Maintains facility security systems. (NOT COMMON CORE) | 10.03 Diagnoses facility security systems. (NOT COMMON CORE) | 10.04 Repairs facility security systems. (NOT COMMON CORE) | |
| Task C-11 Installs and services safety instrumented systems (SISs) | 11.01 Installs SISs 4 | 11.02 Configures SISs 4 | 11.03 Maintains SISs 4 | 11.04 Diagnoses SISs 4 | 11.05 Repairs SISs 4 |

# D – HYDRAULIC, PNEUMATIC AND ELECTRICAL SYSTEMS

| | | | | |
|---|---|---|---|---|
| Task D-12 Installs and services control devices for hydraulic systems | 12.01 Installs control devices for hydraulic systems<br>1,2 | 12.02 Maintains control devices for hydraulic systems<br>1,2 | 12.03 Diagnoses control devices for hydraulic systems<br>1,2 | 12.04 Repairs control devices for hydraulic systems<br>1,2 |
| Task D-13 Installs and services pneumatic equipment | 13.01 Installs pneumatic equipment<br>1,2 | 13.02 Maintains pneumatic equipment<br>1,2 | 13.03 Diagnoses pneumatic equipment<br>1,2 | 13.04 Repairs pneumatic equipment<br>1,2 |
| Task D-14 Installs and services electrical and electronic equipment | 14.01 Installs electrical and electronic equipment<br>1,2,3 | 14.02 Maintains electrical and electronic equipment<br>1,2,3 | 14.03 Diagnoses electrical and electronic equipment<br>1,2,3 | 14.04 Repairs electrical and electronic equipment<br>1,2,3 |

# E – FINAL CONTROL DEVICES

| | | | | |
|---|---|---|---|---|
| Task E-15 Installs and services valves | 15.01 Installs valves<br>2 | 15.02 Maintains valves<br>2 | 15.03 Diagnoses valves<br>2 | 15.04 Repairs valves<br>2 |
| Task E-16 Installs and services actuators | 16.01 Installs actuators<br>2 | 16.02 Maintains actuators<br>2 | 16.03 Diagnoses actuators<br>2 | 16.04 Repairs actuators<br>2 |
| Task E-17 Installs and services positioners | 17.01 Installs positioners<br>2 | 17.02 Maintains positioners<br>2 | 17.03 Diagnoses positioners<br>2 | 17.04 Repairs positioners<br>2 |
| Task E-18 Configures and services variable speed drives (VSDs) | 18.01 Configures VSDs<br>3 | 18.02 Maintains VSDs<br>3 | 18.03 Diagnoses VSDs<br>3 | 18.04 Repairs VSDs<br>3 |

## F – COMMUNICATION SYSTEMS AND DEVICES

| | | | |
|---|---|---|---|
| Task F-19 Installs and services control network systems | 19.01 Performs installation and configuration on control network systems<br>3 | 19.02 Diagnoses control network systems<br>3 | 19.03 Performs maintenance and repairs on control network systems<br>3 |
| Task F-20 Installs and services signal converters | 20.01 Performs installation and configuration of signal converters<br>3 | 20.02 Diagnoses signal converters<br>3 | 20.03 Performs maintenance and repairs on signal converters<br>3 |
| Task F-21 Installs and services gateways, bridges and media converters | 21.01 Performs installation and configuration of gateways, bridges and media converters<br>3 | 21.02 Diagnoses gateways, bridges and media converters<br>3 | 21.03 Performs maintenance and repairs on gateways, bridges and media converters<br>3 |

## G – CONTROL SYSTEMS AND PROCESS CONTROL

| | | | |
|---|---|---|---|
| Task G-22 Establishes and optimizes process control strategies | 22.01 Determines process control strategy<br>3,4 | 22.02 Optimizes process control<br>3,4 | |
| Task G-23 - Installs and services stand-alone controllers (SACs) | 23.01 Installs SACs<br>3,4 | 23.02 Configures SACs<br>3,4 | 23.03 Performs maintenance, diagnostics and repairs on SACs<br>3,4 |

| | | | |
|---|---|---|---|
| **Task G-24 Installs and services programmable logic controllers (PLCs)** | **24.01 Installs PLCs**<br>**4** | **24.02 Configures PLCs**<br>**4** | **24.03 Performs maintenance, diagnosis and repairs on PLCs**<br>**4** |
| **Task G-25 Installs and services distributed control systems (DSCs)** | **25.01 Installs DCSs**<br>**4** | **25.02 Configures DCSs**<br>**4** | **25.03 Performs maintenance, diagnosis and repairs on DCSs**<br>**4** |
| **Task G-26 Installs and services human machine interface (HMIs)** | **26.01 Installs HMIs**<br>**4** | **26.02 Configures HMIs**<br>**4** | **26.03 Performs maintenance, diagnosis and repairs on HMIs**<br>**4** |
| **Task G-27 Installs and services supervisory control and data acquisition (SCADA) systems** | **27.01 Installs SCADA systems**<br>**4** | **27.02 Configures SCADA systems**<br>**4** | **27.03 Performs maintenance, diagnosis and repairs on SCADA systems**<br>**4** |

# TRAINING PROFILE CHART

This Training Profile Chart represents Saskatchewan Apprenticeship and Trade Certification Commission (SATCC) technical training at the topic level.

| Level One | Transcript Code | Hours |
|---|---|---|
| Basic Electronics | ELTR 115 - Theory | 50 |
| | ELTR 116 - Shop | 50 |
| Instrument Measurement | INST 100 - Theory | 60 |
| | INST 101 - Shop | 50 |
| Safety and Shop Practice | MACH 107 | 30 |
| Mathematics | MATH 157 | 30 |
| Physics | PHYS 122 | 30 |
| | | 300 |

| Level Two | Transcript Code | Hours |
|---|---|---|
| Instrument Measurement | MEAS 204 | 50 |
| Electronics | CIRC 204 | 70 |
| Instrument Control | CNTR 211 - Theory | 30 |
| | CNTR 212 – Shop | 30 |
| Final Control Elements | INST 212 – Theory | 30 |
| | INST 213 - Shop | 30 |
| Analytical Instruments | MEAS 204 | 30 |
| Chemistry | Chem 202 | 30 |
| | | 300 |

| Level Three | Transcript Code | Hours |
|---|---|---|
| Chemistry | CHEM 301 | 40 |
| Project Management | PROJ 302 | 50 |
| Instrument Control | CNTR 300 | 40 |
| Instrument Logic | CIRC 300 | 50 |
| Analytical Instruments | MEAS 300 | 40 |
| Instrument Measurement | MEAS 301 | 50 |
| Data Communications | CIRC 301 | 50 |
| | | 300 |

| Level Four | Transcript Code | Hours |
|---|---|---|
| Process Applications | CNTR 420 | 20 |
| Data Communications | DGTL 400 | 70 |
| Analytical Instruments | INST 400 – Theory | 50 |
| | INST 401 – Shop | 40 |
| Programmable Logic Controllers | INST 402 | 40 |
| Distributed Systems | INST 421 | 50 |
| Instrument Control | INST 422 | 30 |
| | | 300 |

# TECHNICAL TRAINING COURSE CONTENT

This chart outlines the model for Saskatchewan Apprenticeship and Trade Certification Commission (SATCC) technical training sequencing.

Implementation for harmonization will take place progressively. Level one to be implemented in 2021.

## Level One — 10 weeks — 300 hours

### Physics — 30 hours

- calculate the pressures of static and moving liquids
- examine the expansion and contraction properties of materials with temperature
- compare how matter stores heat with temperature changes
- classify three forms of heat transfer
- demonstrate four methods of vector addition
- differentiate between work, power and energy
- compare the mechanical advantage of simple machines

### Basic Electronics – Theory — 50 hours

- analyse/measure current, voltage and resistance in an electrical circuit
- analyse Ohm's law, power and energy
- analyse series, parallel and combination circuits
- analyse inductance and capacitance in simple RC and RL circuits
- determine r, x and z in AC circuits and resonant circuits
- measure characteristics of diodes
- evaluate dc rectifier circuits
- evaluate Zener diode circuits

### Basic Electronics – Shop — 50 hours

- measure current, voltage and resistance in an electrical circuit
- analyze Ohm's and Kirchhoff's laws
- measure the equivalent resistance of series-parallel circuits
- evaluate various theorems
- evaluate AC measurements
- measure time constant of RC and RL circuits
- evaluate voltages and phase angles in AC circuits
- measure characteristics of diodes
- evaluate the rectified dc power supply using half-wave, full-wave and bridge rectified configurations
- measure load regulations for Zener regulator circuits

### Instrument Measurement – Theory — 60 hours

- evaluate instrument tube installation
- describe pressure measurement
- describe level measurement
- describe temperature measurement
- describe flow measurement

**Instrument Measurement – Shop** — **50 hours**

- install instrument tube lines
- measure pressure
- measure level
- measure temperature
- measure flow

**Safety and Shop Practice** — **30 hours**

- work safely in an industrial environment
- discuss dangerous gasses
- utilize tools in practical applications
- examine tools and equipment, their applications, maintenance and procedures for use
- assemble piping and cable fittings and their associated components
- examine material handling equipment and accessories, their applications and limitations
- explain the basics of oxy-acetylene cutting and welding

**Mathematics** — **30 hours**

- perform basic numerical computations
- perform basic algebraic operations
- perform basic trigonometry functions
- perform basic graphing with linear equations
- perform basic operations with exponentials and logarithms

## Level Two — 10 weeks — 300 hours

### Instrument Measurement — 50 hours

- assess wiring principles for measurement instrumentation
- construct electrical process loop wiring diagrams from piping and instrument drawings (P&ID's) as per ISA (International Society of Automation) Standards
- analyze methods of protection for hazardous locations.
- configure process alarms
- interpret the principle of operation of microprocessor-based instruments
- demonstrate knowledge to calibrate conventional and microprocessor-based instruments

### Electronics — 70 hours

- demonstrate knowledge of solid-state devices and their applications
- analyze the fundamentals of solid-state devices
- discuss the differences between analog and digital signals
- demonstrate knowledge of logic gates, truth tables and flip flops
- describe the applications of logic gates, truth tables and flip flops
- demonstrate knowledge of the general network topologies used in local area networks (LANs)

### Instrument Control – Theory — 30 hours

- demonstrate knowledge of the fundamental elements associated with pneumatic controllers
- describe commonly used control theory terms and basic types of control modes
- demonstrate knowledge of procedures used to install and calibrate pneumatic controllers
- demonstrate knowledge of procedures used to troubleshoot and repair pneumatic controllers
- demonstrate knowledge of tuning pneumatic controllers

### Instrument Control – Shop — 30 hours

- employ commonly used control modes and terms as they apply to pneumatic analogue controllers
- calibrate single, two, and three mode controllers
- tune single, two, and three mode controllers
- examine advanced control techniques including cascade, feedforward, ratio, and override

### Final Control Elements – Theory — 30 hours

- examine control valve terminology
- compare various final control elements
- demonstrate knowledge of actuators, their components, calculations, and operation
- demonstrate knowledge of control valves, their components, calculations, and operation
- describe the characteristics and applications of control valve accessories
- discuss the operation of hydraulic systems and their components

### Final Control Elements – Shop — 30 hours

- demonstrate knowledge of procedures used to inspect and overhaul control valves
- demonstrate knowledge of procedures used to inspect and overhaul actuators
- demonstrate knowledge of procedures used to inspect, overhaul, and calibrate positioners
- perform general maintenance on control valve assemblies
- perform inspection and calibration of current-to-pressure (I/P) transducers

demonstrate operation of various final control elements

## Analytical Instruments — 30 hours

- demonstrate knowledge of process sample systems and conditioning of samples
- demonstrate knowledge of process analyzers, their components, purpose, applications, characteristics, and operation
- demonstrate knowledge of procedures used to install, maintain, calibrate and troubleshoot process analyzers
- demonstrate knowledge of vibration analysis and its importance in rotating equipment
- demonstrate knowledge of humidity analysis
- demonstrate knowledge of solution density analysis

## Chemistry — 30 hours

- demonstrate safe laboratory protocol
- classify periodic table elements and examine the chemical nomenclature of ionic and molecular compounds
- solve problems involving stoichiometric values in chemical reactions
- solve problems involving solubilities of gases, liquids, and solids
- solve problems involving the density of gases, liquids, and solids
- solve problems involving humidity in the calculation of condensation dew points

## Level Three — 10 weeks — 300 hours

### Chemistry — 40 hours

- Demonstrate knowledge of acid/base chemistry using pH calculations and Measurements.
- Measure and calculate the correlation between ionic solution concentrations and conductivity measurements.
- Measure and calculate the relationship of chemical oxidation-reduction reactions to electrode potentials in voltaic and concentration electrolytic cells.
- Demonstrate and measure the process of UV light absorption in quantitatively measuring solution turbidity, suspension, and dissolved solids concentration.
- Measure and calculate dissolved oxygen concentrations due to changes in soluble salts, turbulence, aeration, pollution, temperature, and pressure.

### Project Management — 50 hours

- Examine project management concepts.
- Perform the steps required to initiate an industrial instrumentation project.
- Demonstrate how to develop a comprehensive project plan.
- Identify the resources required to execute a project plan.
- Identify the monitoring and controlling requirements of a project plan.
- Identify closing requirements of a project plan.

### Instrument Control — 40 hours

- Demonstrate knowledge of feedforward process control applications.
- Demonstrate knowledge of selective process control applications.
- Demonstrate knowledge of ratio control process control applications.
- Demonstrate knowledge of cascade control process control applications.
- Demonstrate knowledge of multivariable control process control applications.

### Instrument Logic — 50 hours

- Demonstrate knowledge of electromechanical relays, terminology and related devices used in building relay logic circuits.
- Apply knowledge of relays and switches in the design of functional relay logic circuits.
- Demonstrate knowledge of PLCs and related devices used in building logic circuits.
- Apply knowledge of PLC programming in the design of various logic circuits.
- Explain the operation and features of Variable Frequency Drives (VFDs).
- Apply Knowledge of VFD operation in the control of motors.

### Analytical Instruments — 40 hours

- Apply knowledge of pH measurement principles.
- Apply knowledge of ORP measurement principles.
- Apply knowledge of conductivity measurement principles.
- Apply knowledge of turbidity measurement principles,

- Apply knowledge of dissolved oxygen measurement principles.

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**Instrument Measurement** **50 hours**

- Perform configurations, calibrations, and asset management using industrial database software.
- Demonstrate the capabilities of a Digital Valve Controller.
- Demonstrate how to safely install, maintain, calibrate, and troubleshoot microprocessor-based pressure transmitters.
- Demonstrate how to safely install, maintain, calibrate, and troubleshoot microprocessor-based level transmitters.
- Demonstrate how to safely install, maintain, calibrate, and troubleshoot microprocessor-based flow transmitters.
- Demonstrate how to safely install, maintain, calibrate, and troubleshoot microprocessor-based temperature transmitters.

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**Data Communications** **50 hours**

- Classify various types of communication media.
- Apply knowledge of existing traditional and current communication protocols.
- Examine various types of Industrial Local Area Network (ILAN) topologies.
- Differentiate network media access techniques.
- Categorize various encoding and error checking methods.
- Classify various types of network architecture.

## Level Four — 10 weeks — 300 hours

### Process Applications — 20 hours

- describe basic industrial boiler control
- apply boiler control principles using simulation software
- describe fundamental process of pulp and paper production
- describe fundamental process of mining
- describe fundamental aspects of petroleum refining

### Data Communications — 70 hours

- explain the function of the local area networks (LAN) devices
- explain some of the common network access methods
- evaluate the supervisory control and data acquisition (SCADA) environment and what functions this equipment performs

### Analytical Instruments – Theory — 50 hours

- describe chromatography measurement principles
- describe oxygen measurement principles
- describe pH measurement principles
- describe ORP measurement principles
- describe conductivity measurement principles
- describe toxic and combustible gas measurement principles

### Analytical Instruments – Shop — 40 hours

- apply chromatography measurement principles
- apply oxygen measurement principles
- apply pH measurement principles
- apply ORP measurement principles
- apply conductivity measurement principles
- apply toxic and combustible gas measurement principles

### Programmable Logic Controllers — 40 hours

- evaluate modular PLC system components
- prepare modules for use in an application
- configure a programmable logic controller
- apply commonly used programming techniques
- apply system design principles
- service and troubleshoot the PLC system
- implement SIS (Safety Instrumented Systems)

### Distribution Systems — 50 hours

- identify DCS system architectures
- identify structure and terminology of DCS systems
- configure I/O of a distributed control system (DCS)
- configure HART field devices using AMS or hand held communicator
- configure monitoring modules
- configure PID (proportional, integral, derivative) modules
- configure a cascade control strategy
- create an operator graphics display

- configure discrete control modules
- operate and tune control loops

**Instrument Control** **30 hours**

- configure digital controllers
- incorporate digital controllers in a process application
- tune a process using Lambda tuning
- configure a controller using configuration software