



Instrumentation and Control Technician Course Outline

2023-24

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. For the harmonized level of training, a cross reference to the Red Seal National Occupational Analysis (NOA) apprenticeship technical training sequencing, at the learning outcome level, is provided.

Level One	10 weeks	300 hours
Physics		30 hours
<ul style="list-style-type: none">• 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
<ul style="list-style-type: none">• 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
<ul style="list-style-type: none">• 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
<ul style="list-style-type: none">• evaluate instrument tube installation• describe pressure measurement• describe level measurement• describe temperature measurement• describe flow measurement		

Instrument Measurement – Shop

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

50 hours

Safety and Shop Practice

- 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

30 hours

Mathematics

- 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

30 hours

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
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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)
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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
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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
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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
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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.
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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.
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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.
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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.
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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.

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.

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
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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
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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
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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
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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)
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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
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- configure discrete control modules
 - operate and tune control loops
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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



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	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
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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) 4	10.02 Maintains facility security systems. (NOT COMMON CORE) 4	10.03 Diagnoses facility security systems. (NOT COMMON CORE) 4	10.04 Repairs facility security systems. (NOT COMMON CORE) 4	
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 1,2	12.02 Maintains control devices for hydraulic systems 1,2	12.03 Diagnoses control devices for hydraulic systems 1,2	12.04 Repairs control devices for hydraulic systems 1,2
Task D-13 Installs and services pneumatic equipment	13.01 Installs pneumatic equipment 1,2	13.02 Maintains pneumatic equipment 1,2	13.03 Diagnoses pneumatic equipment 1,2	13.04 Repairs pneumatic equipment 1,2
Task D-14 Installs and services electrical and electronic equipment	14.01 Installs electrical and electronic equipment 1,2,3	14.02 Maintains electrical and electronic equipment 1,2,3	14.03 Diagnoses electrical and electronic equipment 1,2,3	14.04 Repairs electrical and electronic equipment 1,2,3

E – FINAL CONTROL DEVICES

Task E-15 Installs and services valves	15.01 Installs valves 2	15.02 Maintains valves 2	15.03 Diagnoses valves 2	15.04 Repairs valves 2
Task E-16 Installs and services actuators	16.01 Installs actuators 2	16.02 Maintains actuators 2	16.03 Diagnoses actuators 2	16.04 Repairs actuators 2
Task E-17 Installs and services positioners	17.01 Installs positioners 2	17.02 Maintains positioners 2	17.03 Diagnoses positioners 2	17.04 Repairs positioners 2
Task E-18 Configures and services variable speed drives (VSDs)	18.01 Configures VSDs 3	18.02 Maintains VSDs 3	18.03 Diagnoses VSDs 3	18.04 Repairs VSDs 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 3	19.02 Diagnoses control network systems 3	19.03 Performs maintenance and repairs on control network systems 3
Task F-20 Installs and services signal converters	20.01 Performs installation and configuration of signal converters 3	20.02 Diagnoses signal converters 3	20.03 Performs maintenance and repairs on signal converters 3
Task F-21 Installs and services gateways, bridges and media converters	21.01 Performs installation and configuration of gateways, bridges and media converters 3	21.02 Diagnoses gateways, bridges and media converters 3	21.03 Performs maintenance and repairs on gateways, bridges and media converters 3

G – CONTROL SYSTEMS AND PROCESS CONTROL

Task G-22 Establishes and optimizes process control strategies	22.01 Determines process control strategy 3,4	22.02 Optimizes process control 3,4	
Task G-23 - Installs and services stand-alone controllers (SACs)	23.01 Installs SACs 3,4	23.02 Configures SACs 3,4	23.03 Performs maintenance, diagnostics and repairs on SACs 3,4
Task G-24 Installs and services programmable logic controllers (PLCs)	24.01 Installs PLCs 4	24.02 Configures PLCs 4	24.03 Performs maintenance, diagnosis and repairs on PLCs 4

Task G-25 Installs and services distributed control systems (DCSs)	25.01 Installs DCSs 4	25.02 Configures DCSs 4	25.03 Performs maintenance, diagnosis and repairs on DCSs 4
Task G-26 Installs and services human machine interface (HMIs)	26.01 Installs HMIs 4	26.02 Configures HMIs 4	26.03 Performs maintenance, diagnosis and repairs on HMIs 4
Task G-27 Installs and services supervisory control and data acquisition (SCADA) systems	27.01 Installs SCADA systems 4	27.02 Configures SCADA systems 4	27.03 Performs maintenance, diagnosis and repairs on SCADA systems 4

**The Instrumentation and Control Technician Red Seal National Occupational Analysis (NOA), describing the “full scope” of the trade, can be found at www.red-seal.ca*

For more detailed information on course content, please refer to the Instrumentation and Control Technician Guide to Course Content at www.saskapprenticeship.ca