PetroSkills®

2016 Instrumentation, Controls & Electrical Training Guide

OGCI®

John M. Campbell

RDC

Instrumentation, Controls & Electrical

Course Progression Matrix

The Instrumentation, Controls and Electrical (IC&E) courseware progression covers systems that are essential to any facility engineer, or 'all-rounder,' or a more specialized instrumentation and controls engineer role with your company. The Foundation level is designed for recent graduates or transitional roles. These modules include a strong familiarization in process skills and electrical fundamentals and key applications that engineers face on a daily basis. The Intermediate level opportunities are designed for I&C engineers that have familiarity with instrumentation fundamentals, now seeking more specific sessions focused into key subject areas such as PLC and DCS systems, SCADA technologies, loop tuning methods for PID loops, and the specification and operation of both measurement (including custody transfer) elements and final control elements.

The following instructors have been selected and approved by the PetroSkills Curriculum Network:

Mr. Mick Crabtree
Mr. Dennis Perry
Dr. Rodney Jacobs
Mr. Jason Pingenot

Instrumentation, Controls and Electrical

INTERMEDIATE

- Practical PID Control and Loop Tuning – IC-74 (Page 2)
- Flow and Level Custody Measurement – IC-73 (Page 2)
- Valve and Actuator Technologies – IC-72 (Page 2)
- PLC and SCADA Technologies – IC-71 (Page 2)

FOUNDATION

- Instrumentation and Controls Fundamentals – IC-3 (Page 1)
- Electrical Engineering Fundamentals – E-3 (Page 1)
- ICE Fundamentals for Facilities Engineers – ICE-21 (Page 1)

Instrumentation, Controls and Electrical Systems for Facilities Engineers – ICE-21

FOUNDATION

This foundation-level course provides an overview of electrical systems, instrumentation, process control, and control/safety systems typically encountered in oil and gas facilities, such as: separation, gas dehydration, gas sweetening, NGL recovery, and associated facilities. The focus is to understand terminology, concepts, typical equipment configurations, control strategies, and common pitfalls in order to effectively manage and execute multi-discipline projects.

DESIGNED FOR

Process, chemical, and mechanical engineers, (i.e. non-instrumentation and non-electrical disciplines), as well as other professionals with little or no background in IC&E systems, in order to more effectively execute complete projects. Electrical and Instrumentation Engineers should consider IC-3 and E-3 for more in-depth coverage of alternate disciplines.

YOU WILL LEARN

- Fundamentals of electricity, such as: voltage, current, resistance, and power factor
- Electrical specifications, such as: voltage selection, load lists, and power
- One-line diagrams and components of power distribution, including: transformers, switchgear, MCCs, VFDs, and power distribution
- Infrastructure components, such as: cable, conduit, cable tray, and duct banks
- Classification of hazardous locations and equipment specifications
- Safety risks and mitigation strategies for power systems, including: short circuit and overcurrent protection, ground faults, shock hazards, and arc flash
- Fundamentals of control systems, sensors, controllers, and final elements
- Typical control strategies and configurations for common oil and gas process equipment, such as: separators, pumps, distillation towers, filters, contactors, compressors, heat exchangers, and fired heaters
- Key requirements for instrument specifications: accuracy, signal selection, pressure/temperature limits, material compatibility, installation considerations, capabilities and limits, and relative cost
- Basics of sizing criteria of shutdown and control valves
- Control system functions, limitations, and architectures, including: PLC, DCS, SIS, RTU, and SCADA; common networking systems, including: Ethernet, Modbus and Fieldbus

COURSE CONTENT

Fundamentals of electricity • Power distribution and motor control systems for oil and gas applications • Emergency power systems • Hazardous area classification for oil and gas applications • Electrical safety in industrial facilities • Control system fundamentals • Field measurement and control devices • Programmable electronic systems (PLC, DCS, SIS, SCADA) • Control system networking • Drawings and documentation for IE&C projects

2016 Schedule and Tuition / 5 Days

HOUSTON, US	19-23 SEP	US$4150
KUALA LUMPUR, MY	5-9 SEP	US$5460
LONDON, UK	25-29 APR	US$4780+VAT

Electrical Engineering Fundamentals for Facilities Engineers – E-3

FOUNDATION

This course applies fundamental electrical engineering principles to oil and gas facilities. The course is designed for Facilities Engineers who interface with electrical systems, and provides practical insight and development of new Facilities Electrical Engineers. Through the use of individual and group problem solving, attendees will learn about power transformers, motors, generators, one-line diagram interpretation, protection and coordination of electrical equipment, site and standby generation, electrical safety, and hazardous areas identification. Participants will gain a better understanding of electrical power systems in oil and gas facilities.

DESIGNED FOR

Those facilities personnel who interface with facility electrical power systems, including project engineers, operation leads, instrumentation, controls personnel, and electrical engineers who are new to electrical power systems within oil and gas facilities.

YOU WILL LEARN

- The key components of facilities electric power distribution, which include circuit arrangements, low and medium voltage switchgear, and single-phase and three phase schemes
- Operation, components, electromotive forces, turns and voltage ratios, losses, efficiency, rating, and connections of transformers
- The difference between direct current, induction and synchronous current motors, motor enclosures, and how to select motors
- The principles of protecting electrical equipment, including time current curves, fuses, circuit breakers, and coordination
- What standby power is, including generators and UPS power systems
- The purpose for power generation, which includes standby, prime, base, peak, and co-generation
- What power factor and correction is
- What grounding and bonding systems are, with an overview of ignition sources, separately derived systems, and substation grounding
- Hazardous area identification principles with general information on NEC, IEC, equipment protection, certification, and definitions

COURSE CONTENT

Fundamentals of insulation and conduction • Direct current, alternating current • Transformers power and instrument • Motors Induction and synchronous • Power distribution • System protection and coordination • Standby power systems • Power generation • Variable speed drive principles • Grounding, bonding, and electrical safety • Hazardous area identification

2016 Schedule and Tuition / 5 Days

HOUSTON, US	8-12 FEB	US$4150
ORLANDO, US	3-7 OCT	US$4210

Instrumentation and Controls Fundamentals for Facilities Engineers – IC-3

FOUNDATION

This course applies fundamental instrumentation and control engineering principles to oil and gas facilities design and operation, and is designed to accelerate the development of new facilities Instrumentation and Control Engineers. Through the use of individual and group problem solving, attendees will learn about field measurement devices, final elements and actuators, pressure relief and regulation, documentation, programmable logic controllers, power supplies, SCADA, DCS, SIS, hazardous areas, and installation methods.

DESIGNED FOR

Facilities and project engineers as well as newly graduated electrical, controls and instrument engineers (0-5 yrs.) with a need to improve basic understanding of instrumentation and control systems within oil and gas facilities.

YOU WILL LEARN

- Field measurement devices including level, pressure, temperature, and flow
- Final elements and actuators including control loops, control valves, shutdown valves, actuators, and transducers
- P&ID symbols and instrument tags, loop and logic diagrams, Pitfalls and best practices, ISA symbology, and creation of instrument and I/O Lists
- Signal types and wiring requirements for analog/discrete inputs and outputs as well as other signals such as thermocouple, RTD, pulse, and digital
- Typical control system functions, limitations, and architectures for PLC and DCS systems including programming and ladder logic
- Process control basics with an emphasis on control loops, types, and configurations for common oil and gas process equipment such as separators, pumps, distillation towers, filters, contactors, compressors, heat exchangers, and fired heaters
- Understanding of the PID algorithm, loop tuning, and advanced process control techniques such as feed forward, cascade, selective, and ratio control
- Supervisory Control and Data Acquisition (SCADA) Systems to include telemetry, RTUs, internet, and web based
- Common networking systems including Ethernet, Modbus, and Fieldbus
- Risk mitigation, technologies, and architecture of Safety Instrumented Systems (SIS)
- The best practices for hazardous areas and equipment selection

COURSE CONTENT

Control system fundamentals • Field measurement devices • Control and shutdown valves • Programmable electronic systems (PLC, DCS, SIS, SCADA) • Control system networking

2016 Schedule and Tuition / 5 Days

BAKERSFIELD, US	12-16 SEP	US$4110
DENVER, US	18-22 JUL	US$4160
HOUSTON, US	15-19 FEB	US$4150
	14-18 NOV	US$4150
PERTH, AUSTRALIA	8-12 AUG	US$5600+GST

PLC and SCADA Technologies – IC-71

INTERMEDIATE

This workshop provides engineers and technicians with the basic theoretical and practical understanding of PLC and SCADA systems. It traces the evolution of the PLC as an intelligent black box replacement for the relay panel and how, with the advent of modern communications architectures, it may be combined with Supervisory Control and Data Acquisition (SCADA) systems to allow stand-alone control systems to be configured. Throughout the workshop, participants will learn through active participation using exercises, questionnaires, and practical PC-based simulation (LogixPro), covering: basic ladder logic programming; hardware diagnostics; and implementation of various communication strategies. Participants will also examine the basic requirements of a safety PLC and the various voting system architectures required to meet different Safety Integrity Levels (SILs).

DESIGNED FOR

This workshop is specifically tailored for any personnel who are responsible for designing, selecting, sizing, specifying, installing, testing, operating, and maintaining programmable logic controllers (PLCs) and supervisory (SCADA) systems. This could include facilities, process, chemical, electrical, instrumentation, maintenance, and mechanical engineers and technicians.

YOU WILL LEARN HOW TO

- Describe the fundamental principles of the PLC
- Identify the basic components
- Write a ladder logic program
- Explain the basics of advanced programming according to IEC 61131-3
- Compare different methods of analog processing
- Apply common-sense installation practices
- Examine the different components of a SCADA system
- Describe the basic principles of serial communications
- Evaluate the requirements for PLC-to-SCADA communications
- Distinguish the specific requirements of the PLC in safety-related applications

COURSE CONTENT

Introduction to control systems • SCADA versus DCS • PLC environmental enclosures • Processing and scanning • Digital processing • Analog processing • Installation practices • Interference or noise reduction • Cable spacing and routing • Earthing and grounding • Binary and hexadecimal numbering systems • The IEC 61131-3 standard • Ladder logic diagrams • Functional block diagrams • Derived function blocks • Structured text • Instruction lists • Sequential function chart • SCADA basics • SCADA set-up and simulation • System architecture • Communication strategies • Asynchronous transmission • Coding • The RS 232 standard • The RS 485 standard • Modbus • Safety PLCs • Voting system architectures

See website for dates and locations.

Valve and Actuator Technologies – IC-72

INTERMEDIATE

This workshop provides a total in-depth insight into valve and actuator technology, covering: control valves, check valves, shut-off valves, solenoid valves, and pressure relief valves. A methodology is presented to ensure the optimum selection of size, choice of body and trim materials, components, and ancillaries. Whilst studying both liquid and gas valve sizing, delegates will also learn the correct procedures for calculating the spring wind-up or bench set. Maintenance issues also include: testing for dead-band/hysteresis, stick-slip, and non-linearity; on-line diagnostics; and signature analysis. Throughout the workshop, participants will learn through active participation using exercises, questionnaires, and practical sessions covering: systems choice; basic sizing calculations; computer-based sizing; and maintenance diagnostics.

DESIGNED FOR

Facilities, chemical, electrical, instrumentation, maintenance, and mechanical engineers and technicians involved in designing, selecting, sizing, specifying, installing, testing, operating and maintaining shutoff, pressure relief, and control valves.

YOU WILL LEARN HOW TO

- Compare the major technologies used in the final control element
- Calculate the valve flow coefficient Cv
- Perform flow and system pressure head loss calculations
- Contrast the different types of control, shut-off, and check valves
- Describe the principles of cavitation control and noise reduction
- Select optimum materials of construction to avoid corrosion and erosion
- Identify the correct requirements for trim selection
- Differentiate between inherent and installed characteristics
- Identify ANSI/DN pipe sizes and pressure ratings
- Explain the control valve seat leakage classifications
- Evaluate the optimum valve-actuator combination
- Apply on-line valve testing and diagnostics for deadband and hysteresis, stick-slip, and non-linearity
- Examine the principles of preventive maintenance through the application of signature analysis
- Perform a bench set and calculate actuator spring wind-up
- Pick the correct positioner using our set of guidelines

COURSE CONTENT

Choked flow • Pressure recovery • Flashing and cavitation • Seat leakage • Sizing for liquids and gases • Valve construction • Cavitation control and noise reduction • Valve types • Valve trim and characterization • Valve selection • Actuators and positioners • Valve testing and diagnostics • Maintenance and repair

2016 Schedule and Tuition / 5 Days

HOUSTON, USA	10-14 OCT	US$4150

Flow and Level Custody Measurement – IC-73

INTERMEDIATE

This course is designed to acquaint users with the problems and solutions for high accuracy transfer of liquid and gas petroleum products from supplier to customer. These needs have been brought about by major changes in manufacturing processes and because of several dramatic circumstantial changes such as: the increase in the cost of fuel and raw materials; the need to minimize pollution; and the increasing pressures being brought to bear to adhere to the requirements for health and safety.

DESIGNED FOR

This workshop is specifically tailored for any personnel who are, or will be, responsible for designing, selecting, sizing, specifying, installing, testing, operating, and maintaining instrumentation related to the field of custody level and flow transfer measurement. This could include facilities, process, chemical, electrical, instrumentation, maintenance, and mechanical engineers and technicians.

YOU WILL LEARN HOW TO

- Recall the basics of fluid mechanics
- Identify the fundamental problems related to uncertainty
- Compare the different methods of measuring flow in the oil and gas industries
- Describe the various methods of level measurement
- Compare the different methods used to derive strapping tables
- Evaluate the different custody transfer standards in use today
- Contrast the methods used in flow calibration
- Identify the different types of prover systems
- Explain the methodology used in truck custody transfer
- Examine the challenges regarding pipelines
- Describe the basics of leak detection
- Analyze the methodology for monitoring and controlling production losses
- Evaluate and compare the problems and solutions associated with the measurement of NGL, LPG, and LNG

COURSE CONTENT

Fluid mechanics • Flowmeter classification • Uncertainty analysis • Flow measurement: Turbine; Positive displacement; Ultrasonic flowmeters; Coriolis mass flowmeters • Level measurement: Buoyancy tape systems; Hydrostatic pressure; Ultrasonic measurement; Radar measurement • Flow calibration • Terminal custody transfer • Tank management systems • Lease automatic custody transfer • Truck and rail custody transfer • Pipeline considerations • Fugitive emissions • Leak detection • Real time transient model • Loss control systems • Custody transfer sampling • Monitoring and controlling production losses • Physical leaks • Meter prover performance • API standards • Measuring the suspended S&W content • Calculating net volume • Flowmeter selection and costs • Initial considerations • Meter selection • Properties and measurement of NGL, LPG, and LNG

2016 Schedule and Tuition / 5 Days

HOUSTON, US	7-11 NOV	US$4150

Practical PID Control and Loop Tuning – IC-74

INTERMEDIATE

This workshop provides instrumentation, automation, and process engineers and technicians with the basic theoretical and practical understanding of regulatory control systems and how this can be applied to optimize process control in terms of quality, safety, flexibility, and costs. Centered on the ISA-recommended PC-Control LAB simulator, participants will learn through active participation using exercises, questionnaires, and a series of 16 practical simulation sessions covering: process reaction; tuning methods; diagnostic tools; effect of different algorithms; surge tank level control; analysis of such problems as valve hysteresis, stiction and non-linearities and the impact on controllability; and integral windup.

DESIGNED FOR

Instrumentation, automation, and process engineers and technicians involved in specifying, installing, testing, tuning, operating, and maintaining regulatory PID control systems.

YOU WILL LEARN HOW TO

- Describe such terms as process lag, capacitance, and resistance
- Explain the significance of the process reaction curve
- Identify the effects of filtering on loop performance
- Distinguish the effect of span on the system performance
- Analyze such problems as valve hysteresis, stiction, and non-linearities
- Evaluate the effects of proportional, integral, and derivative control
- Correctly apply both open and closed Loop Tuning according to Ziegler-Nichols
- Apply "as found" tuning
- Estimate the effects on loop tuning using a software-based loop analysis program
- Describe both cascade and feedforward control
- Explain split range control
- Identify and correct problems due to process dead time
- Discuss the top 20 mistakes made in the field of process control

COURSE CONTENT

Basic process considerations • Process lag, capacitance, and resistance • Process reaction curve • 1st and 2nd order reactions • Instrumentation cabling • Filtering • Aliasing • Reaction masking • Sensor placement • Correct PV • Effect of span • Inherent and installed valve characteristics • Actuators • Valve positioners • Testing procedures and analysis • ON/OFF control • Proportional control • Proportional offset • Reset • Integral action and windup • Stability • Derivative action • PID control • Control algorithms • Load disturbances and offset • Speed, stability, and robustness • Open loop reaction curve tuning method (Ziegler-Nichols) • Default and typical settings • Closed loop continuous cycling tuning method (Ziegler-Nichols) • Fine tuning • "As found" tuning • Surge tank level control • Split/parallel range control • Cascade systems • Feed-forward and combined systems • Ratio control • System integration

2016 Schedule and Tuition / 5 Days

HOUSTON, US	14-18 ANOV	US$4150*

**plus computer charge*

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- Geology
- Geophysics
- Petrophysics
- Reservoir Engineering
- Well Construction/Drilling
- Production & Completions Engineering
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- Integrated - Heavy Oil
- Petroleum Data Management

Facilities

- Gas Processing
- Process Facilities
- Water & Corrosion
- Offshore
- Pipeline
- Instrumentation, Controls, & Electrical
- Mechanical
- Reliability Engineering
- Procurement/Supply Chain Management
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