GP Allied®

INSPIRED. RELIABLE. GLOBAL

Course Offerings

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GP*Allied* is the most diverse reliability and operations consulting and services company in the world. Combined, our unrivaled technical expertise, solutions portfolio and global reach help you achieve rapid bottom-line improvement and sustained cultural change.

GP*Allied* diversity and expertise result from joining together firms with experts in Maintenance and Reliability, Operational Excellence, and Workforce Development. This winning team allows us to offer you expertise in the fields of Lean, Reliability Engineering, Six Sigma, Condition Monitoring, Change Management, Maintenance Planning and Scheduling, Workforce Development and Maintenance Craft Skills training. However, only GPAllied can offer you solutions that fully integrate these specialties.

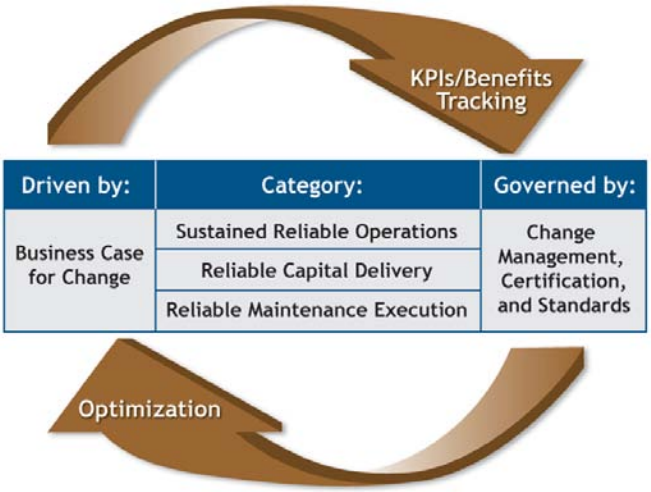
To ensure that GP*Allied* provides you with latest thinking and proven best practices, we have attracted recognized experts to our team, benchmarked best-in-class operations and connected with thought leaders throughout the industry. Furthermore, we ensure that our project team members have technical expertise, as well as expertise as trainers and mentors through a rigorous qualification process and the establishment of work execution standards.

GP*Allied* has modeled their deliverables based on the following core beliefs:

- The reason our clients are in business is to make money
- The first step to ensuring profitability is to have reliable “systems”
- The term “system” speaks to the combination of the people who operate the equipment, the processes they follow to operate the equipment and the equipment itself
- The definition of reliable is: the ability to perform a given task, at a stated rate, for a given period of time, under a given set of circumstances
- The organization must be motivated and prepared for any change to be sustainable
- Having successfully attained reliability, sustaining the improvements is paramount to on-going success
- Optimization is achieved through the use of a culture of continuous improvement
- Clients require a rapid return on investments

To that end, GP*Allied* offers you a complete suite of solutions in the following categories:

- Sustained Reliable Operations
- Reliable Capital Delivery
- Reliable Maintenance Execution



GP*Allied* prides itself on two (2) things: our passion for helping the client and the flexibility of delivery methods.

Our passion is driven by ***the satisfaction of seeing our company help our customers build, utilize and realize the power of the Return on Asset Reliability (ROAR™).***

Our flexibility in delivery methods comes in any one of four (4) different ways. Each way specifically customized to meet the unique needs of the client. Those four (4) ways are:

Training

GP*Allied* offers all of our deliverables as classes for the client who prefers to implement using their own people.

Coaching

For the client who wants more than a training solution, but still prefers to implement using their own personnel, GP*Allied* offers a combination training/coaching package. The training class is augmented by a regimen of coaching and mentoring by our experienced consultants.

Services

Some clients prefer to contract out certain functions. GP*Allied* can deliver our services to the client in one of two forms:

- Project Based – GPAllied personnel are on-site for the duration of the project
- Full Time Equivalent (FTE) – GPAllied personnel are on-site, full time as contracted employees

Consulting

Whether you are starting a major change initiative or looking for the best way to improve performance, GP*Allied*'s consultants guide you as you set your direction, design and deploy your approach, and realize results.

The GP*Allied* vision is to be the premier global provider of sustainable transformation driving improved customer operational and reliability excellence. To that end, we believe the best way to make our vision a reality is to optimize customer business performance through customized solutions utilizing our experienced people, innovative processes, and proven technologies.

Thus achieving operational and reliability excellence sustained through the use of cultural change management with the relentless pursuit to deliver the highest return on investment.

GP*Allied's* expert team provides unparalleled solutions. You can count on us to provide the following:

- A strong foundation to ensure that your organization's systems reliably meet customer needs with lower cost
- A roadmap to build upon that foundation to streamline your processes and help you achieve a culture of sustained continuous improvement
- Effective training to develop your people
- Consultants and trainers with technical expertise, interpersonal skills, and drive to work effectively with your team
- Solutions customized to fit your needs, drawing from a diverse range of methods and services
- A rapid return on your investment

Training Classes

At GP*Allied*, we understand that you are not interested in "training for training's sake". You need hard-hitting, impactful training that addresses the specific need of your employees, delivers value for your training dollars, and produces bottom-line results.

That's what we deliver.

In today's increasingly competitive business environment, your training investment only makes sense if it yields a tangible improvement in KPI's like:

- Production efficiency
- Asset downtime
- Employee retention
- Safety
- Labor costs
- Quality control

With over 200 courses that can be easily customized to your equipment and processes, we are the one-stop shop for all of your technical and change management training needs. We offer these classes on-site at your facilities, for your employees; or periodically around the world on an open-enrollment basis.

When you select us for your training, you receive:

- Training from practitioners and implementers who are also skilled trainers.
- Courses designed with your learning objectives in mind using professional instructional system design combined with our subject-matter expertise.

You can obtain most of the courses in a format that works best for you:

- **Off the Shelf**— you can select our standard training if a generic course suits your needs.
- **Customized** — you can ask us to make minor modifications to better fit your organization's existing terminology and culture (which we can do quickly and cost-effectively), or you can ask us to develop a truly custom curriculum.

- **Public Courses** — you may decide to attend one of our expanding list of publicly offered courses, including those offered through Macomb Community College Workforce Development Institute in Warren, MI.
- **e-Learning** — for certain courses; you can select e-Learning, or a blended solution of e-Learning, instructor-led training, and coaching.

Process Control & Instrumentation

DESCRIPTION

This course provides information on the concepts associated with process control and instrumentation. The lessons cover a wide range of topics such as measurement methods, pressure measurement devices, temperature measurement devices, flow measurement devices, level measurement devices, pilot valves, pneumatic controls, electronic controls, and process controls. There are extensive hands-on exercises for process measurements, controller setup, and process tuning. Upon completion of this course, the participants will be able to explain the function, design, and construction of process control instrumentation; install, remove and maintain process control instrumentation, and identify causes of process control instrumentation failure.

RECOMMENDED AUDIENCE

This course is recommended for electrical maintenance technicians.

YOU WILL LEARN:

- Define the term measurement.
- State the importance of specifying the units of measurement.
- List the fundamental units of measurement in the MKS, CGS, and English Engineering systems.
- Draw and label a block diagram of a Basic Measurement Channel.
- Contrast the terms direct and inferred measurement.
- Discriminate between the terms range and span and between the terms elevated zero and suppressed zero.
- Define the following commonly encountered static characteristics of a process measurement channel; Accuracy, Resolution, Sensitivity, Deadband, Hysteresis, Linearity, Conformity
- Given a diagram, explain each of the following dynamic characteristics of an instrument channel; Dead Time, Time Constant, Rise Time
- Define the terms pressure and hydrostatic pressure and different means of creating pressure.
- Define Pascal's Law and explain its practical applications.
- Explain the different units of pressure and vacuum and convert between them.
- Explain the operation of a manometer, its applications, and how to correctly read one.
- Explain the difference of operation between a bourdon tube and a diaphragm pressure device.
- Explain the operation of a bellows pressure device and its practical application.
- Describe the theory of a dead weight tester and its contribution to pressure measurement.
- Explain the theory and operation of a capacitance type pressure sensor.

- List the major concerns associated with pressure sensor positioning.
- Identify the major components within a pressure switch given a diagram of the switch.
- Convert between the Fahrenheit and Celsius temperature scales.
- State the three methods of heat transfer and give an example of each.
- Explain the principles of operation of liquid-in-glass and filled-system thermometers.
- Explain the principle of operation of a bimetallic strip thermometer.
- State the principles of operation of a thermocouple.
- List three requirements that determine selection of thermocouple type.
- Given a thermocouple table, calculate measurement junction temperature for any millivolt output and reference junction temperature.
- State the law of intermediate metals and intermediate temperatures and explain their significance in thermocouple installations.
- Explain the principle of operation of an RTD and a; 2 wire RTD bridge, 3 wire RTD bridge, 4 wire RTD bridge
- List the advantages and disadvantages of each type of temperature sensor.
- Name three other types of sensors besides thermocouples and RTD's.
- Explain the principle of Radiation Pyrometry and the four types of Pyrometers.
- Discriminate between flow rate and total flow.
- Identify the two classes of flowmeters.
- Explain how Bernoulli's equation relates to head flowmeters.
- Explain the two basic elements of a head flowmeter.
- Explain the three main types of orifice plate construction.
- Explain the operation and construction of venturi tubes, flow nozzles and Dall flow tubes.
- Explain how capacitance sensors and differential pressure transmitters are used as secondary elements in flow measurement channels.
- Explain the operation of a Pitot Tube and Annubar using a simple sketch.
- Explain the operation of a target flowmeter.
- Explain the operation of a magnetic flowmeter including its major advantage and limitation.
- Explain the basic concepts of ultrasonic flow measurement.
- Explain the construction and operation of a rotameter.
- Explain the construction and operation of a nutating disk.
- Explain the difference between direct and inferred methods of level measurement, giving an example of each.
- State the difference between the ball float and chain float noting relative advantages and disadvantages.
- Explain the principle of operation of displacers.
- State the principle of operation for a differential pressure detector used for level measurement and the effect of temperature on its accuracy.
- Explain the operation of bubbler tube level detectors.
- Calculate zero elevation and suppression with respect to level detector placement.
- Define the terms "wet" and "dry" reference leg and when each might be used.

- Explain the principle of operation for capacitance level detectors.
- Explain the principle of operation of ultrasonic level detectors.
- Provide functional definitions for the pneumatic instrument components/subassemblies.
- Explain the purpose of the spring in a bellows-spring, diaphragm-spring or rolling diaphragm-spring subassembly.
- List the two functions of a restriction in pneumatic instrumentation applications.
- Describe how a flapper/nozzle can detect motion and produce a proportional pressure signal.
- Describe how a pilot motion detector can detect motion and produce a proportional pressure signal.
- List the disadvantages of a standard pilot or pilot valve.
- Label the component parts of a pilot motion detector.
- Explain the operation of a non-bleed pilot.
- Explain the operation of a pneumatic relay.
- Discuss the energy conversions which occur in the following pneumatic relays; Direct-acting bleed type, Reverse-acting bleed type, Direct-acting non-bleed type.
- List the five basic functions that instruments perform.
- Define the term feed-forward.
- Define the term feedback.
- State when a moment-balance instrument will be in balance.
- Describe the operation of basic pneumatic devices used to measure temperature, pressure, flow, and level
- Explain the basic steps involved in the calibration of pneumatic measurement devices.
- Identify the feedback mechanism used by the instruments covered.
- State the two types of Motion-Balance Feedback instruments.
- Describe the principles of operation of angle Motion-Balance Feedback type instruments.
- Describe the principles of operation of Linear Motion-Balance Feedback type instruments.
- State when a motion-balance instrument will be in balance.
- List four specific functions performed by an electronic transmitter.
- List six basic sections of an electronic controller.
- Describe the difference in operation between two-wire and four wire power supplies.
- Describe one method of compensating for the effects of drift in a discrete component amplifier.
- Describe how Op-Amps compensate for the effects of drift.
- List the three general categories of electronic transmitters.
- Given a description of any electronic transmitters, state which of the three general categories it fits into.
- Given a basic block diagram describe the operation of the following; LVDT Motion to Current Transmitter, Force Balanced Motion to Current Transmitter, Capacitive Motion to Current Transmitter
- Draw a block diagram of a typical electronic controller.

- Describe how an error signal is generated in an electronic controller.
- Define the term process control.
- Given a simplified block diagram of a process loop, identify the controlled variable, the measured variable, the manipulated variable and the final control element.
- Describe how feedback is used in closed-loop process control.
- Define open-loop control.
- Given a simplified block diagram of a process loop, describe the effect of each components phase shift on control loop operation.
- Calculate the error signal given the setpoint and measured variable signal.
- List the three degrees of stability possible following a disturbance to a closed-loop control system.
- List the three criteria for evaluating the performance of closed loop control.
- List the three key characteristics that determine the response of a system to a supply or demand disturbance.
- Define time constant.
- Define process gain.
- Define dead time.
- Given a simplified process diagram, identify the location of the system capacity and the system resistance.
- Describe the response of a single capacity process to a step change disturbance.
- Describe the response of a multiple capacity process to a step change disturbance.
- Given the response curve of a multi-capacity process, determine the system dead time and time constant.
- Explain the relationship between process gain and time constant.
- Describe the input and output of a two position controller.
- Describe the effect of varying the neutral zone in a two position control system.
- Describe the effect of system delays on two position control.
- List two advantages and two disadvantages of two position control.
- List one common application of two position control.
- List three characteristics of two position control.
- Define proportional control.
- Describe the relationship between proportional band and gain.
- Given the mathematical equation describing proportional control, calculate the controller output for various system conditions.
- List one advantage and one disadvantage of proportional control.
- Describe why offset error occurs in a proportional controller.
- Explain the effect of changing the controller gain on offset error.
- Using a graph, describe the output of a proportional controller in response to a step change in demand. Include the response of the measured variable.
- Define integral control.
- Given the mathematical equation that expresses integral control, describe each term in the equation.
- Describe the relationship between the following terms: integration time constant, minutes per repeat, and repeats per minute.

- List one advantage and one disadvantage of integral control.
- Using a graph, plot the response of an integral controller following a demand disturbance.
- Given the equation and the applicable system parameters, calculate the output of an integral controller at some time after a step change in input.
- Define proportional plus integral control.
- Given the mathematic equation that expresses proportional plus integral control, describe each term in the equation.
- List one advantage and one disadvantage with proportional plus integral control.
- Discuss the effect of changing the gain on the integral section.
- Explain reset windup.
- Using a graph, describe the output of a proportional plus integral controller in response to both a step and ramp charge in demand. Include the response at the measured variable.
- Define derivative control.
- Define derivative time.
- Given the equation and applicable system parameters, calculate the output of a P&D controller at some time during a ramp change input.
- Discuss the effect of changing the proportional band on the derivative action.
- Discuss the effect of changing the derivative time on the proportional action.
- Given a graph of the effects of a demand disturbance, identify the derivative time as too long, too short or optimum.
- Discuss the effect of derivative action on system stability and zero offset.
- List one application where P&D control is used often and one application where it is not used.
- List the advantage gained by the use of each mode in a PID controller.
- Describe the phase relationship between the proportional, integral and derivative action in a PID controller.
- Given the equation for a PID controller, identify the proportional term, the integral term and the derivative term.
- Describe the effect of each mode of a PID controller on stability.
- Graph the response of a PID controller to a ramp change input.
- Describe the three responses of a control system following a disturbance.
- Describe the following closed loop tuning methods; Notch Method, Ultimate Period Method, Dampened Oscillation Method
- Describe the following open loop tuning methods; Time Constant Method, Reaction Rate Method
- Define integral time and derivative time.
- List the six basic control actions.
- List the advantages and disadvantages of the three most commonly used control actions.
- State how the basic proportional controller can be modified to perform the following control actions; Two position control, Proportional plus integral control, Proportional plus derivative control, Proportional plus integral plus derivative control
- Explain the basic steps involved in the calibration of controllers.

- List eight functions of an electronic controller.
- Draw a block diagram of a typical electronic controller.
- Describe how an error signal is generated in an electronic controller.
- Given a simplified schematic of a proportional controller computing unit, identify the circuit components which will vary the following controller responses; Proportional, Derivative, Integral
- Describe the open loop response of a PID controller to a step change in input.
- Given a simplified schematic of a specific commercial controller, identify the circuits that perform the basic controller functions.
- Explain the terms commonly used when referring to micro-processor controls.
- Describe the basic components in a typical microprocessor based controller.
- Define memory and the different types used.
- Recognize the indications on a Moore Mycro 352.
- Describe the operation of a typical microprocessor based controller.
- Describe the typical installation for a microprocessor based controller.
- State the different modes of a Moore 352 and their functions.
- Explain the difference between feedback control and cascade control.
- Describe the function of a cascade control process.
- Evaluate a control loop and determine if it is a feedback or feed-forward control.
- List the major differences of feedback, feedforward, and cascade control.
- Analyze three-element control and describe its use in a control system as compared to one and two element control.
- Describe the function at ratio control.

CLASS DURATION

120 hours (3 weeks).