

**CUYAMACA COLLEGE**  
COURSE OUTLINE OF RECORD

**CENTER FOR WATER STUDIES 206 – ADVANCED ELECTRICAL & INSTRUMENTATION PROCESSES**

3 hours lecture, 3 units

**Catalog Description**

This course will be an advanced course in instrumentation, controls and SCADA industrial control systems. The focus will be on how these systems are used in the water and wastewater field. This course will cover PLC operations, usage and troubleshooting, how SCADA industrial control systems collect and store data, how the SCADA data historian works and is used by a water and wastewater utility. Finally, the course will look at intelligent equipment, communication standards and the underlying communication network.

**Prerequisite**

“C” grade or higher or “Pass” in CWS 106 or equivalent

**Entrance Skills**

Without the following skills, competencies and/or knowledge, students entering this course will be highly unlikely to succeed:

- 1) Interpret schematic representations commonly used in Programmable Logic Controllers and other programmable devices
- 2) Familiarity with instrumentation and control system terminology
- 3) Understand how programmable devices are utilized in automated control systems
- 4) Describe the various functions of a Supervisory Control and Data Acquisition (SCADA) central computer system
- 5) Discuss sensing and sampling devices commonly used in automated control systems

**Course Content**

- 1) Programmable Logic Controller (PLC)
  - a. Theory of operation
    1. Ladder logic
    2. Run mode
    3. Scan time
    4. Digital inputs
    5. Digital outputs
    6. Analog inputs
    7. Analog outputs
    8. Communication ports
  - b. Maintenance
    1. Proper cleaning
    2. Status LEDs
    3. Using software to view error status
    4. Low battery issues
    5. Hot swappable hardware
    6. Redundancy
  - c. PLC Operations
    1. Latch
    2. Timers
    3. Counters

4. Basic math
  5. Advanced math
  6. Interposing relays
  - d. Hardware and software based HMI panels
    1. Ethernet communications
    2. USB communications
    3. Serial communications
    4. Control circuit
  - e. Popular PLC networks
    1. Modbus TCP
    2. Modbus RTU
    3. Ethernet IP
    4. DF1
    5. Profinet
    6. Profibus
  - f. PLC Communications
    1. Peer to peer
    2. PLC to intelligent device
    3. PLC to SCADA
- 2) How SCADA is used in the water and wastewater field
- a. Wastewater collection
  - b. Wastewater treatment
  - c. Drinking water treatment
  - d. Drinking water distributions systems
  - e. Maintaining SCADA reliability and up time
  - f. IIOT in the water and wastewater field
  - g. MQTT in the water and wastewater field
- 3) SCADA System
- a. Central hardware and software
    1. Computer operating systems
    2. Windows updates
    3. Virus software
    4. Security profile
    5. Life span of hardware
    6. Life span of software
    7. Popular SCADA software
  - b. Data Historian and Alarm processing
    1. Open relational database
    2. SCADA historian with compression and encoding
    3. SQL Queries
    4. Supplying SCADA to other business systems
    5. Alarm processing queries
    6. Sending alarm to hand held devices
  - c. SCADA System Networks
    1. Local area network
    2. Wide area network
    3. Network security between SCADA and the business network
    4. Computer operating systems
  - d. SCADA software and Operating Systems
    1. Windows Operating System
    2. Linux Operating System
    3. Windows updates
    4. Virus software
    5. Security profile

6. Life span of hardware
  7. Life span of software
  8. Popular SCADA software
  9. Address SCADA obsolescence
- 4) SCADA communication technology
    - a. The tag server
    - b. OPC technology
    - c. Using the OPC Quick Client
  - 5) Field trips
    - a. Helix R.M. Levy WTP

### **Course Objectives**

Students will be able to:

- 1) Understand how instrumentation and control systems work
- 2) Describe how a PLC operates and is used in automated control systems
- 3) Be able to perform basic troubleshooting of PLC hardware
- 4) Describe in detail the functions of a SCADA (Supervisory Control and Data Acquisition) central computer system
- 5) Discuss the four building blocks of a SCADA system
- 6) Understand how a SCADA system is used the water and wastewater field.

### **Method of Evaluation**

A grading system will be established by the instructor and implemented uniformly. Grades will be based on demonstrated proficiency in subject matter determined by multiple measurements for evaluation, one of which must be essay exams, skills demonstration or, where appropriate, the symbol system.

- 1) Projects
- 2) Writing assignments
- 3) Exams & quizzes
- 4) Demonstrations utilizing the Field Operations Skills Yard

### **Special Materials Required of Student**

None

### **Minimum Instructional Facilities**

Smart classroom

### **Method of Instruction**

- 1) Lecture and discussion
- 2) Audiovisual
- 3) Field trips
- 4) Demonstrations utilizing the Field Operations Skills Yard

### **Out-of-Class Assignments**

- 1) Reading assignments
- 2) Writing assignments
- 3) Projects and reports

### **Texts and References**

- 1) Required (representative example): Automating Manufacturing Systems with PLCs by Hugh Jack (Version 5.1)
- 2) Supplemental: None

**Student Learning Outcomes**

Upon successful completion of this course, students will be able to:

- 1) Discuss how PLC's are used in automated control systems.
- 2) Perform basic troubleshooting of PLC hardware.
- 3) Describe the functions of a Supervisory Control and Data Acquisition (SCADA) central computer system.
- 4) Describe the four building blocks of a SCADA control system.