



**El Camino College**  
**COURSE OUTLINE OF RECORD – Official**

<b>Course Acronym:</b>	ACR
<b>Course Number:</b>	62
<b>Descriptive Title:</b>	Energy Control and Optimization Systems
<b>Division:</b>	Industry and Technology
<b>Department:</b>	Air Conditioning and Refrigeration
<b>Course Disciplines:</b>	Air Conditioning and Refrigeration, Heating
<b>Catalog Description:</b>	In this course students will apply knowledge gained to develop, plan, direct, implement, optimize, and sustain system energy efficiency and control in single and multi-site locations. Course topics include direct digital controls, programmable controls, configurable controllers, multi-zone systems, communication protocols, control system commissioning, logic circuits, object and property program structure, and interoperability
<b>Prerequisite:</b>	Air Conditioning and Refrigeration 61 with a minimum grade of C
<b>Co-requisite:</b>	
<b>Recommended Preparation:</b>	
<b>Enrollment Limitation:</b>	
<b>Hours Lecture (per week):</b>	3
<b>Hours Laboratory (per week):</b>	3
<b>Outside Study Hours:</b>	6
<b>Total Course Hours:</b>	108
<b>Course Units:</b>	4
<b>Grading Method:</b>	Letter Grade only
<b>Credit Status:</b>	Credit, degree applicable
<b>Transfer CSU:</b>	Yes
<b>Effective Date:</b>	2/17/2015
<b>Transfer UC:</b>	No
<b>Effective Date:</b>	
<b>General Education:</b> ECC	
<b>Term:</b>	
<b>Other:</b>	
<b>CSU GE:</b>	
<b>Term:</b>	

Other:	
IGETC:	
Term:	
Other:	
<p><b>Student Learning Outcomes:</b></p>	<p><b>SLO #1 Develop an energy and control optimization strategy for a single building control system</b></p> <p>After reading the textbook, participating in class discussions and laboratory exercises students will apply their knowledge toward developing an energy and control optimization strategy for a single building control system.</p> <p><b>SLO #2 Proportional Integral Derivative (PID) Strategy</b></p> <p>Students in this course will apply a Proportional integral derivative (PID) strategy to the control of a variable speed fan and a 3 stage compressor air-conditioning system.</p> <p><b>SLO #3 DDC Controllers</b></p> <p>Students completing course requirements will demonstrate the ability to setup and configure a programmable and configurable controller inputs, outputs, virtual points, and perform simple logic programming on DDC controllers.</p> <p><b>SLO #4 Using different network architecture in system automation and intelligent control systems</b></p> <p>Students completing this course will have the skills necessary to assess the performance and energy efficiency impact of using different network architecture in system automation and intelligent control systems.</p>
<p><b>Course Objectives:</b></p>	<ol style="list-style-type: none"> <li>1. Select and evaluate control strategies.</li> <li>2. Identify, quantify, and apply the concepts of data communication to automation systems.</li> <li>3. Model an energy response in the implementation of automation system design.</li> <li>4. Evaluate control system performance and sustainability.</li> <li>5. Identify control system architecture and hierarchy.</li> <li>6. Specify control system designs and their impact on indoor environmental quality, energy efficiency, and reliability of systems and equipment.</li> <li>7. Interface automation system components and develop control strategies to enhance system energy efficiency and environmental performance.</li> </ol>
<p><b>Major Topics:</b></p>	<p><b>I. Control System Approach (6 hours, Lecture)</b></p> <ol style="list-style-type: none"> <li>A. Control hierarchy</li> <li>B. Priority levels</li> <li>C. Interconnect microcontrollers</li> <li>D. Local and supervisory control</li> <li>E. Communication protocols</li> <li>F. Networking</li> <li>G. System integration</li> <li>H. Interoperability</li> <li>I. Single and multi-zone systems</li> </ol>

## **II. Inputs and Outputs Setup and Configuration (15 hours, Lab)**

- A. Analog inputs
- B. Analog outputs
- C. Binary inputs
- D. Binary outputs
- E. Virtual points
- F. Bindings

## **III. Configurable Controllers (12 hours, Lecture)**

- A. Hierarchy
- B. Installation
- C. Setup
- D. Configuration
- E. Testing

## **IV. Control Loops (12 hours, Lab)**

- A. Closed loop
- B. Open loop
- C. Feedback
- D. Point setup and configuration
- E. Range and offset
- F. Point testing

## **V. Set Point Logic (18 hours, Lecture)**

- A. Modulating
- B. Two position
- C. Control differential
- D. Dead band
- E. Error or offset
- F. Proportional control
- G. Integral control
- H. Derivative control

## **VI. Logic Implementation (8 hours, Lab)**

- A. Point configuration
- B. Output control
- C. Feedback control
- D. Low level programming
- E. Proportional Integral Derivative (PID) loop setup and testing

## **VII. Commissioning (10 hours, Lecture)**

- A. Test
- B. Data collection
- C. Data analysis
- D. System verification
- E. Local Area Network (LAN) and Wide Area Network (WAN) network architecture

	<p>F. Commissioning report</p> <p><b>VIII. Test and Validation (11 hours, Lab)</b></p> <p>A. Functional testing  B. System calibration  C. System analysis  D. Power analysis  E. Communication network certification</p> <p><b>IX. Programming (8 hours, Lecture)</b></p> <p>A. Logic controller circuits  B. Object and property programming structure  C. Input and output control  D. Program compile  E. Program performance  F. Trending  G. Test and validation</p> <p><b>X. Program implementation (8 hours, Lab)</b></p> <p>A. Setup  B. Configure  C. Logic circuit compile and download  D. Test and validation</p>
<b>Total Lecture Hours:</b>	54
<b>Total Laboratory Hours:</b>	54
<b>Total Hours:</b>	108
<b>Primary Method of Evaluation:</b>	2) Problem solving demonstrations (computational or non-computational)
<b>Typical Assignment Using Primary Method of Evaluation:</b>	Develop a five-page controls document that successfully illustrates the integration of system and unit level controllers into an automation system architecture and documents system specifications, sequence of operation, inputs and outputs, and specific supervisory level control. Submit controls document to the instructor.
<b>Critical Thinking Assignment 1:</b>	Develop a five-page system level graphical programming document that illustrates programming logic, input output control, feedback, and priority level control. Submit programming document to the instructor.
<b>Critical Thinking Assignment 2:</b>	Develop a Parameter Identification (PID) control loop program within a Programmable Logic Unit (PLC) with closed loop feedback, limit control, error checking, set point reset, and priority control commands. Consult instructor for evaluation.
<b>Other Evaluation Methods:</b>	Completion, Essay Exams, Laboratory Reports, Performance Exams, Quizzes, Reading Reports, Written Homework
<b>Instructional Methods:</b>	Demonstration, Group Activities, Guest Speakers, Lab, Lecture, Multimedia presentations, Role play/simulation
<b>If other:</b>	Internet Presentation/Resources

<b>Work Outside of Class:</b>	Answer questions, Observation of or participation in an activity related to course content (such as theatre event, museum, concert, debate, meeting), Problem solving activity, Skill practice
<b>If Other:</b>	
<b>Up-To-Date Representative Textbooks:</b>	Andrew Althouse, Carl Turnquist, A.F. Bracciano, D. C. Bracciano and G. M. Bracciano. <u>Modern Refrigeration and Air Conditioning</u> . 22nd edition. Goodheart Willcox. 2025  Text available in printed text and digital format.
<b>Alternative Textbooks:</b>	
<b>Required Supplementary Readings:</b>	
<b>Other Required Materials:</b>	
<b>Requisite:</b>	Prerequisite
<b>Category:</b>	sequential
<b>Requisite course(s): List both prerequisites and corequisites in this box.</b>	Air Conditioning and Refrigeration-61
<b>Requisite and Matching skill(s): Bold the requisite skill. List the corresponding course objective under each skill(s).</b>	<p><b>Knowledge of automation system networking.</b></p> <p>ACR 61 - Identify key components of automation systems.</p> <p>ACR 61 - Demonstrate understanding of automation hierarchy, integration, and interoperability.</p> <p>ACR 61 - Develop and implement commissioning plans for new and existing equipment.</p> <p>ACR 61 - Develop test procedures for data collection and analysis.</p> <p>ACR 61 - Demonstrate understanding, differentiate, evaluate, and identification of communication protocols.</p> <p>ACR 61 - Demonstrate the application of smart system components and design.</p> <p>ACR 61 - Demonstrate understanding of interconnection of automation system controller types.</p> <p>ACR 61 - Analyze controller network architecture, setup, and configuration.</p>
<b>Requisite Skill:</b>	
<b>Requisite Skill and Matching Skill(s): Bold the requisite skill(s). If applicable</b>	
<b>Requisite course:</b>	

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<b>Enrollment Limitations and Category:</b>	
<b>Enrollment Limitations Impact:</b>	
<b>Course Created by:</b>	Timothy Muckey
<b>Date:</b>	12/16/2013
<b>Original Board Approval Date:</b>	02/17/2015
<b>Last Reviewed and/or Revised by:</b>	Vincent Bethel
<b>Date:</b>	04/01/2024
<b>Last Board Approval Date:</b>	06/17/2024 effective FALL 2025