

RBTC 1345 1A1

- **Credit Hours:** 3 (2 Lecture Hours, 3 Lab Hours)
- **Term/Semester:** Fall 2026
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- **Class Meeting Time:** T 5-7
- **Class Location:** ATC 107

Instructor Information

- **Instructor Name:** Weldon Jacobs
- **LIT Office Location:** ATC Building across street from main campus
LIT Phone Number: 409-247-4945
LIT Email Address: wcjacobs@lit.edu
- **Office Hours:** T 4:30 – 5 or by appointment

Course Description

A study of the basic principles of robot controllers, controller input/output, memory, and interfacing with computer-integrated manufacturing. This course highlights specialized data communications and electrical integrations using Universal Robots CB-Series/e-Series control architectures and collaborative ecosystems.

Required Materials & Textbook

- **Hardware platform:** Access to Universal Robots UR3e, UR5e, or UR10e training stations.
- **Software:** Universal Robots URSim Offline Simulator environment (Current Version) and URPolyScope GUI.
- **Supplies:** ANSI Z87.1 safety glasses, 16GB flash drive, wire strippers, digital multimeter.

Student Learning Outcomes (SLOs)

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

1. Explain structural operational principles of collaborative robot controllers and hardware registers.
2. Safe-wire, configure, and troubleshoot industrial digital/analog I/O logic systems.
3. Establish operational TCP/IP, Modbus TCP, and Ethernet/IP links between a UR controller and external automation rigs.
4. Program logic-based safety boundaries and collaborative speed limitations matching industrial safety standards.

Course Requirements & Grading Scale

Grading Breakdown

- **Laboratory Exercises & Integration Projects:** 40%
- **Unit Exams (Midterm):** 20%
- **Quizzes & Homework Assignments:** 15%
- **Final Comprehensive Examination:** 25%

LIT Alpha-Numerical Scale

- **A:** 90 – 100%
 - **B:** 80 – 89%
 - **C:** 70 – 79%
 - **D:** 60 – 69%
 - **F:** Below 60%
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Course Outline & 16-Week Schedule

Week 1: Introduction to Collaborative Robotics & Safety

- Orientation to LIT guidelines and House Bill 2504 requirements.
- Differences between traditional industrial automation and collaborative robot (cobot) principles.
- ISO 10218-2 and ISO/TS 15066 safety standards for risk mitigation.

Week 2: Universal Robots Controller Hardware Architecture

- Anatomy of the UR Control Box (e-Series power supplies, safety control boards, and energy storage).
- Understanding structural grounding, emergency stop circuits, and safeguarding loops.

Week 3: PolyScope UI, Teach Pendant, & URSim Installation

- Operating the PolyScope user interface framework.
- Local software configuration of simulated environments via the offline URSim package.
- Backing up system files, initialization logs, and operational `.script` packages.

Week 4: Motion Controls & Tool Center Point (TCP) Configurations

- Jogging operations via Cartesian coordinate planes (Base, Tool, User) vs. Joint space.
- Direct hardware configuration of the Tool Center Point (TCP) orientation variables and structural orientation payloads.

Week 5: Universal Robots Control Box Electrical I/O

- Mapping the physical terminal strips inside the UR Control Box.
- Sourcing and sinking principles applied specifically to 24V configurable digital inputs and outputs.

Week 6: Tool-Flange Interfacing & End-Effectors

- Wiring sensors and tools directly to the Tool I/O M8 8-pin connector block.
- Interfacing tools with UR+ certified vacuum grippers and electric smart-actuators.

Week 7: Unit Examination I & Advanced I/O Debugging

- **Exam 1** (Physical Controller Layouts and Electrical Configuration Principles).
- Laboratory Check: Troubleshooting physical sensor failures using a digital multimeter.

Week 8: Universal Robots Safety System Interfacing

- Mapping Configurable Safety Inputs (Emergency Stop outputs, Safeguard resets).
- Programming software safety profiles: Reduced Mode boundaries, safety planes, and custom tool speed restrictions.

Week 9: Variables, Registers, & Thread Operations

- Managing software registers (Boolean, Integer, Float registers) for external read/write commands.
- Implementing background concurrent processing using PolyScope Program Threads.

Week 10: Conditional Program Handshakes

- Building flexible loop frameworks utilizing logical `IF/THEN`, `WAIT`, and `SWITCH` blocks.
- Synchronizing peripheral device status checking checkpoints to establish basic hardware handshake cycles.

Week 11: Analog Interfacing & Continuous Feedback

- Wiring 0-10V or 4-20mA devices directly to UR analog input terminal lines.
- Setting up real-time scaling parameters to drive adaptive tool trajectories from analogue sensor inputs.

Week 12: Unit Examination II & Modbus TCP Communication

- **Exam 2** (Logic Programming and Electrical Handshaking Frameworks).
- Introduction to the industrial Modbus TCP protocol.
- Mapping remote PLC registers directly into the UR PolyScope I/O monitoring screen.

Week 13: Advanced Network Integration (PROFINET / EtherNet/IP)

- Setting up explicit industrial IP addresses and data packets on local area networks.
- Configuring internal UR data registers to act as dynamic server nodes for master automated systems.

Week 14: URScript Scripting Language Fundamentals

- Introduction to programming directly via raw `.script` command files.
- Writing direct socket terminal connections (TCP/IP socket communication commands) to feed external strings to the cobot.

Week 15: Laboratory Capstone Integration Project

- Execution of complete automated cells requiring seamless external device handshake sequences.
- Final lab checkout, electrical harness clean-up, and equipment storage procedure checklist.

Week 16: Comprehensive Final Exam Block

- **Final Examination:** Theoretical and logical engineering concepts (LIT Institutional Block Schedule).
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Course & Institutional Policies

Attendance Policy

Class attendance is mandatory for skill mastery. Students must sign the attendance roster at every session. Missing more than 20% of scheduled class sessions may result in an administrative institutional drop or an automatic failing grade (F) for the course.

Academic Integrity

Students are expected to perform their own work on all assignments, tests, and labs. Cheating, plagiarism, or fabrication will result in disciplinary action up to an automatic failing grade (F) in the course and referral to the disciplinary dean.

Students with Disabilities (ADA Statement)

Lamar Institute of Technology complies with Section 504 of the Rehabilitation Act and the Americans with Disabilities Act. Students needing accommodations must contact the Special Populations Coordinator in the Student Success department early in the semester to arrange verified accommodations.

Campus Carry Policy

Texas Government Code Section 411.2031 permits licensed individuals to carry concealed handguns on campus property. Review the official LIT Campus Carry guidelines online for precise boundary details regarding designated exclusion zones.
