INDUSTRIAL SOLUTIONS LABORATORY

Department Project Information

Department Name	*Electromechanical Engineering Technology*	**Date Submitted**	*04/3/2026*
Project Title	*Real-time SCADA system for automation and integration within the ETEM Curriculum (UNCC_EMET_SCADA)*	**Planned Starting Semester**	*Fall 2026*

Senior Design Project Description

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills:

Discipline	Number	Discipline	Number
Mechanical		Electrical	
Computer		Systems	
Other (Electromechanical)	4		

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Project Overview:

In the realm of industrial automation, SCADA (Supervisory Control and Data Acquisition) systems serve as the central nervous system for large-scale processes. It is a sophisticated architecture that combines hardware and software to enable real-time monitoring, data collection, and automated control of equipment across large distances and complex facilities.

In the power sector, SCADA is used to monitor grid health with real-time tracking of voltage, current, power factor, and frequency along critical components and sectors of the power transmission and distribution network. SCADA allows for control of load balancing where power flow can be dynamically adjusted to prevent blackouts and transformer overloads. Fault detection and isolation are also main uses of SCADA where system devices can be remotely opened and closed under certain fault conditions allowing for the rerouting of power.

A SCADA system is comprised of several layers of technology that work together: the Human-Machine Interface (HMI) which serves as the graphical dashboard where operators interact with the system, the Master Terminal Unit (MTU) which serves as the "brain" or central server that processes data, sends commands to the field, and manages the database, and Remote Terminal Units (RTUs) and Programmable Logic Controllers (PLCs) which serve as the physical hardware interfaces providing field data to the system.

This project aims to create a SCADA system using industry automation and communication devices which can be integrated into two or more courses within the Electromechanical Engineering Technology curriculum and used as a static, but mobile, interactive display for teaching and promotional purposes. Simulated loads and faults will be created to replicate a real-world power grid, and a large real-time human-machine interface will be designed and programmed to visualize system faults and statuses. The system will be integrated into two courses currently offered in the Electromechanical Engineering Technology curriculum: ETEM4161 – Elements of Automation and ETEM4131 – Intelligent Industrial Systems. ETEM4161 utilizes both the SEL-2411 and SEL-3350 automation controllers which have Modbus and DNP3 communication capabilities. Students program these devices to automate system controls and feed this data to a replicated SCADA system. This project aims to design, develop, and integrate this SCADA system for use in this course. In ETEM4131, students learn about SCADA systems and their uses through industry case studies. By developing a SCADA system, students in ETEM4131 will be able to develop and test their work with a physical system and gather exposure to industry HMI and SCADA software (Ignition).

Major system devices, which include the RTUs, are provided by the department. All other hardware necessary to fulfill the project requirements below must be purchased within the project's budget. Mechanical design of the system should be simple and include a mobile rack and large display screen(s). A significant portion of the project will include RTU programming (for simulated system loads, faults, and communication of data) and user interface programming using Ignition, a widely used industrial SCADA and HMI platform.

Project Requirements:

- The system must communicate with 15 virtual substation RTUs for monitoring, control, and fault isolation purposes.
- The system must include a user interface which is programmed using Ignition.
- The RTU program for each virtual substation must mimic on-campus infrastructure and loads that send data to the SCADA system.
- The system must accept simulated relays with both analog and digital inputs from Axion Chassis for fault detection and automation of fault isolation.
- The system must have two modes:
    - Campus-replication mode where each RTU represents a building and its associated loads and monitoring devices on UNC Charlotte's campus.
    - Regional mode where each RTU represents a substation or power generation facility and their associated loads and monitoring devices.
- The system must be able to monitor power loads, currents, breaker statuses, fault conditions, etc.
- The system must allow for future expansion for the collection of real power data from campus utility devices.
- The user interface must be visually appealing, representative system infrastructure, and include all necessary system information to include voltages, currents, frequencies, faults, breaker statuses, etc.
- The system must be a semi-portable rack/container system that can be pushed through a standard doorway and fit in an elevator.
- The equipment wiring must follow industry wiring standards (training will be provided).
- Additional equipment budget, which does not include the market value of department-provided devices, must not exceed $2,000.

Expected Deliverables/Results:

- Fully programmed and electrically, mechanically, and digitally complete SCADA system that is both functional and visually appealing.
- Design documents: mechanical drawings (3D CAD), electrical drawings (schematic and wiring diagrams), and flow diagrams for complete system operation.
- Procurement documents: Bill of materials, budget, component/device manuals for reference
- Testing plan for user operation and system demonstration of simulated faults.
- Final report as required by the course.

Disposition of Deliverables at the End of the Project:

Hardware developed is the property of the department. After the final expo, the equipment will be delivered to the Electromechanical Engineering Technology program.

List here any specific skills, requirements, specific courses, and knowledge needed or suggested:

- Experience with SEL automation devices such as the SEL-3350 RTAC
- Experience with AcSELerator software package
- Experience with Ignition SCADA and HMI software
- Knowledge of industrial communication protocols (DNP3, Modbus, Ethernet/IP)
- Knowledge in networking and troubleshooting (preferably with Wireshark)
- Skills in wiring, mechanical assembly, electrical and mechanical CAD, and GUI design