Mechatronics (MTRN)

MTRN 2200. Industrial Wiring for Automated Systems. 1 Hour.
Covers industry standards for industrial and automation electronics. Emphasis on becoming familiar with and using the National Electrical Code and the International Electrical Code. ***COURSE LEARNING OUTCOMES (CLOS)*** At the successful conclusion of this course, students will be able to: 1. Explain the importance of national and international electrical codes. 2. Summarize information contained in national and international electrical codes. Prerequisites: MECH 1000 (Grade C- or higher). Corequisites: MTRN 2205. FA.

MTRN 2205. Industrial Wiring for Automated Systems Lab. 2 Hours.
Lab component of MTRN 2200. Applies National Electrical Code and International Electrical Code to create and use electrical diagrams to define installation methods and system requirements for automation systems. Explains how to use electrical diagrams for troubleshooting. **COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Create electrical diagrams that meet codes. 2. Use electrical diagrams to design and interpret installation methods and system requirements for mechatronic systems. Corequisites: MTRN 2200. FA.

MTRN 2300. Introduction to Programmable Logic Controllers. 2 Hours.
Introduces programmable logic controllers (PLCs) including hardware, ladder logic programming, troubleshooting, and maintenance. Also discusses PLC machine and human interfacing. **COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Explain the function, components, and operation of PLCs. 2. Describe how PLCs interface with other system components and human operators. 3. Use digital and analog I/O. 4. Install and execute a PLC program. Prerequisites: MECH 1200 (Grade C- or higher). Corequisite: MTRN 2305. FA.

MTRN 2305. Introduction to Programmable Logic Controllers Lab. 2 Hours.
Lab component of MTRN 2300. Applies information from MTRN 2300 to able to control mechatronic systems with PLCs. Emphasis is on programming, troubleshooting, and maintaining PLCs and its connection to mechatronic components. **COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Program a PLC using ladder logic. 2. Install and troubleshoot a PLC program. 3. Control a mechatronic system with a PLC. Corequisite: MTRN 2300. FA.

MTRN 2350. Advanced PLC Programming and Applications. 2 Hours.
Follow-up course to MTRN 2300. Students learn about PLC program structure and how to increase program complexity to perform additional tasks. Also covers how to debug and simplify programs and provides additional information on PLC networking and human interfacing. **COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Discuss advanced applications where a PLC is used. 2. Create a PLC program that could control an advanced industrial control application. 3. Apply advanced programming techniques for specialized applications. Prerequisites: MTRN 2300 (Grade C- or higher). Corequisite: MTRN 2355. FA.

MTRN 2355. Advanced PLC Programming and Applications Lab. 2 Hours.
Lab component of MTRN 2350. Students apply principles of advanced PLC programming and debugging to perform more complex control tasks. Covers how to apply networking principles to communicate with a PLC. **COURSE LEARNING OUTCOMES (CLOs) ** At the successful conclusion of this course, students will be able to: 1. Create and implement a PLC program to control an advanced industrial control application. 2. Debug a complex PLC program. 3. Use a PLC to measure and scale analog signals. Corequisite: MTRN 2350. FA.

MTRN 2400. Mechanical Components. 4 Hours.
An introduction to mechanical components common in automated industrial systems. Topics include how to analyze and select gears, belts, chains, shafts, and bearings for a mechatronic application. Reviews and reinforces the concepts of the structure of metals, metals selection, and mechanical properties. **COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Describe basic mechanical components such as gears, belt and chain drives, shafts, and bearings and explain their role in a mechatronic system. 2. Discuss how the structure of metals is related to mechanical properties. 3. Identify and select mechanical components based on mechatronic system requirements. 4. Design a mechanism that integrates mechanical components to accomplish a task. Prerequisites: MECH 1000 (Grade C- or higher). FA.

MTRN 3360. Industrial Robots. 2 Hours.
Applications and programming of industrial robotics. Includes an introduction to industrial robotics and an overview of basic operations such as powering up, jogging, fault recovery. Covers the creation of basic motion programs and the use of vision systems. **COURSE LEARNING OUTCOMES (CLOs) ** At the successful conclusion of this course, students will be able to: 1. Identify industrial applications where robots are commonly used. 2. Summarize the key steps to successfully implement robots into an industrial process. 2. Describe how to integrate a vision system and an industrial robot. Prerequisites: MTRN 2350. Corequisites: MTRN 3365. SP.

MTRN 3365. Industrial Robots Lab. 1 Hour.
Lab component of MTRN 3360. Practical experiences creating, modifying, and running robot programs. Covers how to power up and jog a robot, resolve common faults, and how to program a robot to accomplish one or more tasks. ** COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course students will be able to: 1. Describe components and operation of an industrial robot. 2. Demonstrate basic programming of a robotic system. 3. Troubleshoot and resolve common problems related to the robotic system. Corequisites: MTRN 3360. SP.

MTRN 3400. Fluid Power Systems. 2 Hours.
This course covers the design, installation, control, and maintenance of industrial hydraulics and pneumatics used in mechatronic systems. It also provides a background on basic hydraulic and pneumatic principles and theory. **COURSE LEARNING OUTCOMES (CLOs) ** At the successful conclusion of this course, students will be able to: 1. Explain fundamental fluid power theoretical concepts. 2. Choose common hydraulic and pneumatic components, their uses and performance. 3. Design a fluid control system and explain the steps necessary to build and control it. Prerequisites: MTRN 2400 (Grade C- or higher). Corequisite: MTRN 3405. SP.

MTRN 3405. Fluid Power Systems Lab. 1 Hour.
Lab component of MTRN 3400. Practical application of fluid power principles used in automated systems. Students have the opportunity of designing, assembling, and programming an automated fluid power system. *COURSE LEARNING OUTCOMES (CLOs) ** At the successful conclusion of this course, students will be able to: 1. Design and build a simple fluid power system using commercial components. 2. Program the controls to monitor and actuate a fluid power system. 3. Troubleshoot an automated fluid power system. Corequisite: MTRN 3400. SP.

MTRN 3500. Motion Control in Mechatronic Systems. 3 Hours.
Focuses on the control of automated systems using electric motors. Covers variable speed drives and servo motor selection as well as speed/position control of these motors for a mechatronic system. ** COURSE LEARNING OUTCOMES (CLOs) ** At the successful conclusion of this course, students will be able to: 1. Explain methods of motion control in mechatronic systems. 2. Describe and evaluate the components used for motion control in mechatronic systems. 3. Apply the principles of AC and DC servo motors to design a motion control system. Prerequisite: MTRN 2350 (Grade C- or higher). Corequisite: MTRN 3505. SP.

MTRN 3505. Motion Control in Mechatronic Systems Lab. 1 Hour.
Lab component of MTRN 3500. Utilizes concepts of servo motor selection, programming, and troubleshooting to produce the speed and position control required for an automated system. ** COURSE LEARNING OUTCOMES (CLOs) ** At the successful conclusion of this course, students will be able to: 1. Select an appropriate AC or DC servo motor for a mechatronic application. 2. Create a program that controls speed and position in a mechatronic system. 3. Troubleshoot a motion control system. Corequisite: MTRN 3500. SP.

MTRN 3550. Automation Sensors. 2 Hours.
Fundamentals of basic sensors used in automated environments. Students learn to implement sensors and actuators into an automated application through lecture and laboratory experiments. Topics include proximity sensors, speed/position encoders, pressure transducers, thermocouples/thermistors, and flow and strain sensors. The course culminates in a major design project that will be presented to the public at Engineering Design Day. **COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Describe principles of acquiring measurements of physical phenomena, such as temperature, pressure, velocity, flow, and strain. 2. Manipulate sensor signals for microcontrollers and PLCs. 3. Create microcontroller and PLC programs that acquire and interpret sensor signals. Prerequisite: MTRN 2300 (Grade C- or higher). Corequisite: MTRN 3555. SP.

MTRN 3555. Automation Sensors Lab. 1 Hour.
Lab component of MTRN 3550. Students are assigned to a Engineering Design Day team with students in MECH 2255. **COURSE LEARNING OUTCOMES (CLOs) ** At the successful conclusion of this course, students will be able to: 1. Collect and analyze measurements of physical phenomena such as temperature, pressure, velocity, flow, and strain using data acquisition equipment. 2. Design and prototype, as a member of a team, an automated system that meets defined specifications. Corequisite: MTRN 3550. SP.

MTRN 3560. Industrial Motor Controls. 2 Hours.
This course covers electric motors and motor control devices that are common in an industrial environment. Course content includes information on DC/AC motor theory as well as their installation, maintenance and troubleshooting. Also covers motor controls such as starting, speed control, and stopping systems. **COURSE LEARNING OUTCOMES (CLOs) ** At the successful conclusion of this course, students will be able to: 1. Describe the types of electric motors. 2. Explain the operation and function of various motor control devices. 3. Demonstrate how to protect motors and prevent motor failure. Prerequisites: MTRN 2200. Corequisite: MTRN 3565. SP.

MTRN 3565. Industrial Motor Controls Lab. 2 Hours.
Lab component of MTRN 3560. Provides students with opportunities to apply principles related to industrial motors and motor controls. **COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Identify the main types of industrial motors. 2. Install wiring for transformers and electric motors. 3. Identify, install, and troubleshoot motor control devices. Corequisite: MTRN 3560. SP.

MTRN 3600. Industrial Networks. 2 Hours.
Introduces concepts related to the design of an industrial network wherein computers, PLCs, sensors, etc. exchange data. Covers strengths and weaknesses of various communications solutions. ** COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Explain how data is processed and transferred in an industrial network. 2. Discuss the pros and cons of various types of industrial networks and protocols. 3. Select an appropriate network design based on given requirements. Prerequisite: MTRN 3500 (Grade C- or higher). Corequisite: MTRN 3605. FA.

MTRN 3605. Industrial Networks Lab. 1 Hour.
Lab component of MTRN 3600. Students implement network concepts in a simulated industrial environment. **COURSE LEARNING OUTCOMES (CLOs) ** At the successful conclusion of this course, students will be able to: 1. Use industrial network software to facilitate communication of computers, human-machine interfaces, PLCs, sensors, etc. 2. Demonstrate a working PLC network. 3. Debug data communication issues in a simulated industrial network. Corequisite: MTRN 3600 (Grade C- or higher). FA.

MTRN 4000. Product Design I. 3 Hours.
First course in the product design series required for Mechatronics majors. Students work in multi-disciplinary teams to develop a product through customer needs identification, concept generation and selection, concept testing, benchmarking, design parameter specification, engineering analysis, and critical function prototyping. The course culminates in an alpha prototype and formal design review of the product with faculty and industry leaders. **COURSE LEARNING OUTCOMES (CLOs) ** At the successful conclusion of this course, students will be able to: 1. Define and propose, in teams, solutions to a team-perceived problem using engineering design principles and ethics. 2. Formulate background for a team-defined project using prior work such as journal articles, patent databases, and/or benchmark data. 3. Propose project milestones and a plan to achieve project milestones. 4. Design and perform a feasibility study. 5. Prototype, in teams, an alpha solution to a team-defined problem. Prerequisites: MECH 1100 and 1150 and MTRN 3500 (Grade C- or higher). FA.

MTRN 4010. Product Design II. 3 Hours.
Second course in the product design series required for Mechatronic majors. Student teams further develop their product through engineering analysis, beta testing, economic analysis, design for manufacturing, design reviews, and documentation. The course culminates in a final product that will be presented to the public at Engineering Design Day. **COURSE LEARNING OUTCOMES (CLOs) ** At the successful conclusion of this course, students will be able to: 1. Evaluate economic considerations of a team-defined problem. 2. Propose a design and/or improvement to a component and/or system using engineering analysis. 3. Prepare and present a technical oral and poster presentation. 4. Prototype, in teams, a beta solution to a team-defined problem. Prerequisite: MTRN 4000 (Grade C- or higher). SP.

MTRN 4500. Advanced Automation Controls. 3 Hours.
Theory and applications of advanced controls for automated mechatronic systems. Students learn to model and control multi-domain systems through lecture and laboratory experiments. Topics include: automated control of mechanical, electrical, electromechanical, fluidic, and thermal systems. **COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Analyze response of dynamic systems in multiple domains, such as mechanical, electrical, fluid, and thermal. 2. Use analog and digital methods to control dynamic systems. 3. Use software to model, analyze, and control dynamic systems. Corequisite: MTRN 4505. SP.

MTRN 4505. Advanced Automation Controls Lab. 1 Hour.
Lab component of MTRN 4500. Students have the opportunity apply principles of automation controls to model, analyze, and control systems in multiple domains. **COURSE LEARNING OUTCOMES (CLOs) ** At the successful conclusion of this course, students will be able to: 1. Measure relevant system parameters when prototyping physical system models. 2. Evaluate control algorithms for mechatronic systems. 3. Select and then integrate appropriate control algorithms. 4. Implement control algorithms to manage a mechatronic system through the use of software. Corequisite: MTRN 4500. SP.

MTRN 4600. Advanced Mechatronic System Design. 2 Hours.
Using a systems-level viewpoint, students learn how to integrate multiple functional elements to achieved a desired outcome. Course material is a combination of conceptual information, case studies, and practical hands-on experiences. **COURSE LEARNING OUTCOMES (CLOs) ** At the successful conclusion of this course, students will be able to: 1. Describe the underlying principles of mechatronics system design. 2. Identify examples of good mechatronic systems. 3. Explain how to integrate multiple mechatronic subsystems to accomplish a predefined task. Prerequisites: MTRN 2350 AND MTRN 3400 (Grade C- or higher). FA.

MTRN 4605. Advanced Mechatronic System Design Lab. 1 Hour.
Lab component of MTRN 4600. Students apply principles of mechatronic system design in a simulated industrial setting. **COURSE LEARNING OUTCOMES (CLOs) ** At the successful conclusion of this course, students will be able to: 1. Create a working mechatronic system by implementing correct design principles. 2. Troubleshoot a custom mechatronic system. 3. Demonstrate solutions to common issues encountered while creating mechatronic systems. Corequisite: MTRN 4600. FA.

MTRN 4700. Semiconductors and Mechatronics. 3 Hours.
Introduction to semiconductor materials, physics, and devices with a focus on how they relate to mechatronic systems. Introduction to semiconductor theory and electronic device concepts to analyze diodes, amplifiers, and transistors in a mechatronic systems context. **COURSE LEARNING OUTCOMES (CLOs)** At the successful conclusion of this course, students will be able to: 1. Model and analyze semiconductor p-n junctions. 2. Differentiate among different types of transistors and other electrical components. 3. Design semiconductor process flows using knowledge of basic microfabrication processes. Prerequisites: MECH 2210 AND ENGR 2050 (Grade C- or higher). SP.