

## **SIEMENS MECHATRONICS AND THE INTERNET OF THINGS (IoT)** **(COURSE CODE: 57R2)**

**COURSE DESCRIPTION:** Siemens Mechatronics and the Internet of Things (IoT), the third course in the Siemens Engineering program, requires students to collaborate in teams to research problems and develop solutions. The focus will be on the engineering of mechatronic systems, and includes a combination of robotics, electronics, computer programming, networking, systems, control, and product engineering as well as communications between systems securely over the internet. Students explore PWM and PID control systems utilizing machine intelligence and machine to machine communications.

**OBJECTIVE:** Given the necessary equipment, supplies, and facilities, the student will complete all of the following core standards successfully.

**COURSE CREDIT:** 1 (120 hours) Carnegie unit

**PREREQUISITE:** Siemens Manufacturing and Automation

**RECOMMENDED GRADE LEVELS:** 10, 11, 12

### **A. SAFETY**

**Engineers know the academic subject matter, including safety as required for proficiency within their area. The following accountability criteria are essential for students in the Siemens program of study.**

1. Review school safety policies and procedures.
2. Review classroom safety rules and procedures.
3. Review safety procedures for using equipment in the classroom.
4. Identify major causes of work-related accidents in office environments.
5. Demonstrate safety skills in an office/work environment.

### **B. STUDENT ORGANIZATIONS**

**Engineers know the academic subject matter, including professional development, required for proficiency within their area. The following accountability criteria are essential for students in the Siemens Engineering program of study.**

1. Identify the purpose and goals of a Career and Technology Student Organization (CTSO).
2. Explain how CTSOs are integral parts of specific clusters, majors, and/or courses.
3. Explain the benefits and responsibilities of being a member of a CTSO.
4. List leadership opportunities that are available to students through participation in CTSO conferences, competitions, community service, philanthropy, and other activities.
5. Explain how participation in CTSOs can promote lifelong benefits in other professional and civic organizations.

## **C. TECHNOLOGY KNOWLEDGE**

**Engineers know the academic subject matter, including the ethical use of technology. The following accountability criteria are essential for students in the Siemens Engineering program of study.**

1. Demonstrate proficiency and skills associated with the use of technologies that are common to a specific occupation.
2. Identify proper netiquette when using e-mail, social media, and other technologies for communication purposes.
3. Identify potential abuse and unethical uses of laptops, tablets, computers, and/or networks.
4. Explain the consequences of social, illegal, and unethical uses of technology (e.g., piracy; cyberbullying; illegal downloading; licensing infringement; inappropriate uses of software, hardware, and mobile devices in the work environment).
5. Discuss legal issues and the terms of use related to copyright laws, fair use laws, and ethics pertaining to downloading of images, Creative Commons, photographs, documents, video, sounds, music, trademarks, and other elements for personal use.
6. Describe ethical and legal practices of safeguarding the confidentiality of business-related information.
7. Describe possible threats to a laptop, tablet, computer, and/or network and methods of avoiding attacks.

## **D. PERSONAL QUALITIES AND EMPLOYABILITY SKILLS**

**Engineers know the academic subject matter, including positive work practices and interpersonal skills. The following accountability criteria are essential for students in the Siemens Engineering program of study.**

1. Demonstrate creativity and innovation.
2. Demonstrate critical thinking and problem-solving skills.
3. Demonstrate initiative and self-direction.
4. Demonstrate integrity.
5. Demonstrate work ethic.
6. Demonstrate conflict resolution skills.
7. Demonstrate listening and speaking skills.
8. Demonstrate respect for diversity.
9. Demonstrate customer service orientation.
10. Demonstrate teamwork.

## **E. PROFESSIONAL KNOWLEDGE**

**Engineers know the academic subject matter, including positive work practices and interpersonal skills. The following accountability criteria are essential for students in the Siemens Engineering program of study.**

1. Demonstrate global or “big picture” thinking.
2. Demonstrate career and life management skills and goal-making.
3. Demonstrate continuous learning and adaptability skills to changing job requirements.
4. Demonstrate time and resource management skills.
5. Demonstrates information literacy skills.
6. Demonstrates information security skills.
7. Demonstrates information technology skills.
8. Demonstrates knowledge and use of job-specific tools and technologies.
9. Demonstrate job-specific mathematics skills.
10. Demonstrates professionalism in the workplace.
11. Demonstrate reading and writing skills.
12. Demonstrates workplace safety.

## **F. ENGINEERING DESIGN PROCESS**

**Engineers demonstrate the skills for completing the engineering design process. The following accountability criteria are essential for students in the Siemens Engineering program of study.**

1. Maintain an Engineering Notebook for research, prototype creation, documentation, and daily reflections.
2. Apply engineering design and problem solving as an iterative process incorporating science, mathematics, and engineering to optimally convert resources to meet a design solution.
3. Communicate design solutions utilizing effective technical writing skills including correct spelling, proper grammar, and accurate technical vocabulary.
4. Prepare a quantitative plan for the successful completion of a project.
5. Assume leadership responsibility for collaborative team actions and decisions related to the successful completion of a project.
6. Evaluate the needs and costs of resources necessary for the completion of a project.
7. Prepare and communicate model documentation to include such details as product analysis, size, materials, assembly details, schematics, program design, installation, and service requirements.

## **G. DESIGN FOR MECHATRONICS**

**Engineers demonstrate proficient skills necessary for mechatronics design. The following accountability criteria are essential for students in the Siemens Engineering program of study.**

1. Design, construct, and operate a multi-axis robot for use in an industrial application.
2. Design and create the wiring diagrams for controlling the motion of a robotic arm.
3. Apply the degrees of freedom to describe arm movement used in the programming of the arm.

4. Integrate a robotic arm into an automated work cell for moving and manipulating components.
5. Design and create grippers and other end effectors for custom use in an automated setting.
6. Create a system utilizing sensors to allow a robotic arm to make decisions based upon sensor input.
7. Design a system involving the integration of machines, machine tools, specialized dies, jigs, fixtures, and instruments used in production creating needed parts to make jigs, fixtures, alignment and drill guides, gauges, and other manufacturing and assembly tools with a rapid prototyping/additive manufacturing device.
8. Apply the principles of design for manufacturing, enabling the efficient and effective production of products.
9. Develop a logical argument for selecting the automation to control tools, machines, and labor necessary to produce finished goods from raw materials.
10. Create a plan for protecting the safety, health and welfare of people engaged in the manufacturing environment.
11. Create technical drawings having proper dimensional tolerances and limits necessary for components to fit as designed.
12. Use appropriate instruments accurately to make precision measurements required by plan specification to achieve required dimensions, shapes, location of centers, parallel surfaces, and other component attributes.
13. Understand and apply Statistical Process Control (SPC) to acquire quality control.
14. Research and apply knowledge of material properties to product design and development.

## **H. ELECTRICAL AND CONTROL SYSTEMS**

**Engineers demonstrate proficient skills for designing electrical and control systems. The following accountability criteria are essential for students in the Siemens Engineering program of study.**

1. Design and analyze an electrical system to efficiently convert, transform, and transmit electricity to where it is needed.
2. Create, read and analyze schematics and provide a concise summary for documentation purposes.
3. Research and specify electrical devices necessary to provide needed power.
4. Apply machine control systems, sensory feedback, and information processing to increase efficiency.
5. Use flow charts and state diagrams to apply logic in the design of control programs.

## **I. SENSORS LOGIC AND DATA**

**Engineers demonstrate proficient skills for designing control systems using sensor logic and data. The following accountability criteria are essential for students in the Siemens Engineering program of study.**

1. Design a system using sensors to monitor changes and use that data to inform changes to the system.
2. Apply Boolean logic in the design of a system that monitors inputs.
3. Create programs to initialize, calibrate, and monitor system parameters.
4. Select and apply appropriate sensors to obtain data about system performance.
5. Design a system of elements that manages power to accomplish a task involving defined movement.
6. Design a control system to vary the speed and performance of a motor by utilizing feedback from the system to gain the most efficiency possible.
7. Formulate a system to utilize data collection and analysis to maintain and improve product quality and provide adequate confidence that the product will satisfy design requirements.
8. Design and analyze the application of machine control systems, sensory feedback, and information processing to increase efficiency.

## **J. DESIGN OF ASSEMBLY SYSTEMS**

**Engineers demonstrate proficient skills for designing and maintaining assembly systems. The following accountability criteria are essential for students in the Siemens Engineering program of study.**

1. Apply engineering design of automation to assure alignment for assembly.
2. Create a management plan that includes quality planning, quality control, quality assurance, and quality improvement for an advanced manufacturing environment.
3. Research, construct, and evaluate a plan for an assembly line or work cell.

## **K. INTEGRATION OF COMPUTER NUMERIC CONTROL (CNC)**

**Engineers demonstrate proficient skills for programming and using computer numeric control systems. The following accountability criteria are essential for students in the Siemens Engineering program of study.**

1. Apply Cartesian Coordinates to create toolpaths for machine tools.
2. Research and apply proper cutting tool speeds, feeds, and directions for manufacturing.
3. Create simple Numeric Control (NC) part programs using a text editor or a CAM package.
4. Analyze NC part program files to identify and correct errors.
5. Analyze part geometry to select appropriate cutting tools and fixturing devices needed to create a part using a CNC machine.
6. Edit the tool library of a CNC machine program to establish tool offset values.
7. Design and prepare 3D models with appropriate units for use in toolpath generation.
8. Setup a CAM package by editing the material and tool libraries.
9. Generate tool paths from a CAD program and edit NC part program files to identify and correct errors.

## **L. AUTOMATION WITH PROGRAMMABLE LOGIC CONTROLLERS (PLCS)**

**Engineers demonstrate proficient skills for programming and using logic systems. The following accountability criteria are essential for students in the Siemens Engineering program of study.**

1. Design and analyze an electrical system to efficiently convert, transform, and transmit electricity to where it is needed.
2. Research and specify electrical devices necessary to provide needed power.
3. Apply machine control systems, sensory feedback, and information processing to increase productivity in manufacturing.
4. Use flow charts and diagrams to apply logic in the design of control programs.
5. Design a system of elements that manages power to accomplish a task involving defined movement.
6. Design a control system to vary the speed and performance of a motor by utilizing feedback from the system to gain the most efficiency possible.
7. Formulate a system to utilize data collection and analysis to maintain and improve product quality and provide adequate confidence that the product will satisfy design requirements.
8. Design and analyze the application of machine control systems, sensory feedback, and information processing to increase productivity in manufacturing.

## **M. HUMAN MACHINE INTERFACE (HMI)**

**Engineers demonstrate proficient skills for designing and implementing a human machine interface. The following accountability criteria are essential for students in the Siemens Engineering program of study.**

1. Design the visual displays to obtain and display data from a process controlled by a PLC.
2. Create a system to visualize and remotely control a work cell.
3. Create a communication system to monitor and automatically capture data on demand for storage in a database.
4. Design a system to remotely monitor and display real time machine parameters to allow for changes and updates to the operating parameters.

## **N. PNEUMATICS DESIGN AND CONTROL**

**Engineers demonstrate proficient skills for constructing and operating pneumatics systems. The following accountability criteria are essential for students in the Siemens Engineering program of study.**

1. Construct systems that efficiently utilize a fluid (liquid or gas) under pressure to generate, transmit, and control power.
2. Design an integrated system of machines, machine tools, jigs, fixtures, instruments, and control programs to produce needed parts.
3. Research, construct, and evaluate a plan for an assembly line or work cell.

4. Identify systems, sub-systems, and typical components of an automated manufacturing operation.
5. Apply the necessary safety precautions associated with a fully automated system.

## **O. INTERNET OF THINGS (IOT)**

**Engineers demonstrate proficient skills for designing and implementing a network of IoT devices. The following accountability criteria are essential for students in the Siemens Engineering program of study.**

1. Analyze different types of network setups to select the most appropriate for specific tasks.
2. Compare network operating systems to specify the most appropriate system for data networks.
3. Synthesize applications for use in gathering, analyzing, and display in information environments.
4. Design and implement a program for device security.
5. Evaluate various connectivity options for protocols for communication in the design stage of an automated work cell.
6. Create a method to collect, store, analyze, and display sensor data.
7. Secure the elements of an IOT connected device.

## **P. BUSINESS OF MANUFACTURING**

**Engineers understand and apply the business principles of engineering. The following accountability criteria are essential for students in the Siemens Engineering program of study.**

1. Research and categorize the activities that a business conducts to make discoveries that can either lead to the development of new products or procedures, or to improve existing products or procedures.
2. Research and evaluate the new approaches of rapid development and deployment of products that saves time and is more efficient.
3. Review and evaluate the benefits of a plan for an assembly line or work cell.
4. Create a strategy to increase efficiency and decrease waste by receiving inventory just in time for the production process to reduce costs and reduce use of natural resources.
5. Create a management plan including quality planning, quality control, quality assurance, and quality improvement for an advanced manufacturing environment.
6. Create a plan for protecting the health and safety of the people engaged in a manufacturing environment.

## **Q. CAREER AWARENESS AND DEVELOPMENT**

**Engineers acquire the career development skills necessary for success. The following accountability criteria are essential for students in the Siemens Engineering program of study.**

1. Develop awareness of career opportunities related to each curriculum project.
2. Critique career connections described in each curriculum project engagement scenario.

[Academic Standards and Indicators](#)