Department of Education | College, Career and Technical Education

May 2024

Robotics & Automated Systems

Primary Career Cluster:	Advanced Manufacturing and STEM
Course Contact:	CTE.Standards@tn.gov
Course Code(s):	C13H15
Prerequisite(s):	*Algebra I* (G02X02, G02H00); *Geometry* (G02H11); *Physical Science* (G03H00); and *Chemistry* (G03H12) or *Physics* (G03H20)
Credit:	1
Grade Level:	11
Focus Elective Graduation Requirement:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other *Advanced Manufacturing* or *STEM* courses.
Program of Study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition, when taken in sequence in the approved program of study.
Programs of Study and Sequence:	This is the third course in the *Mechatronics* and *STEM* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.org/ Technology Student Association (TSA): http://www.tntsa.org
Coordinating Work-Based Learning:	Teachers are encouraged to use embedded WBL activities such as informational interviewing, job shadowing, and career mentoring. For information, visit https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html.
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	013, 014, 015, 016, 017, 018, 047, 070, 078, 081, 125, 126, 127, 128, 129, 157, 210, 211, 212, 213, 214, 230, 232, 233, 413, 414, 415, 416, 417, 418, 449, 470, 477, 519, 531, 535, 537, 582, 595, 596, 700, 740, 760, and 982
Required Teacher Certifications/Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-advanced-manufacturing.html https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-stem.html Best for All Central: https://bestforall.tnedu.gov/

Course at a Glance

CTE courses provide students with an opportunity to develop specific academic, technical, and 21st century skills necessary to be successful in career and in life. In pursuit of ensuring every student in Tennessee achieves this level of success, we begin with rigorous course standards which feed into intentionally designed programs of study.

Students engage in industry relevant content through general education integration and experiences such as career and technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry standard content and technology, solve industry-based problems, meaningfully interact with industry professionals and use/produce industry specific, informational texts.

Using a Career and Technical Student Organization (CTSO) in Your Classroom

CTSOs are a great resource to put classroom learning into real-life experiences for your students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course, note this is not an exhaustive list.

- Participate in CTSO Fall Leadership Conference to engage with peers by demonstrating logical thought processes and developing industry specific skills that involve teamwork and project management.
- Participate in contests that highlight job skill demonstration. These include Career Pathways Showcase, Job Interview, Automated Manufacturing Technology, Engineering Technology, and Robotics.
- Use Standard 3.2 for the student to present to the class using the CTSO format.

Using a Work-Based Learning (WBL) in Your Classroom

Sustained and coordinated activities that relate to the course content are the key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standards 1.1-1.2** | Include a safety briefing in a visit to an industry partner/job site.
- **Standard 2.1-2.2** | Invite a local employer to discuss how robots are used in their facility.
- **Standard 3.1-3.2** | Visit a local company and talk with those employees about career options.
- **Standard 6.1-7.2, 9.1** | Have the students do a project that is useful to a local employer. The employer can critique the student's project.
- **Standard 8.2** | Visit a local industry person visit the class to discuss and demonstrate the importance of quality control.

Course Description

Robotics & Automated Systems is an applied course for students who wish to explore how robots and automated systems are used in industry. Upon completion of this course, proficient students will have an understanding of the historical and current uses of robots and automated systems; programmable circuits, interfacing both inputs and outputs; ethical standards for engineering and technology professions; and testing and maintenance of robots and automated systems.
Note: Standards in this course are presented sequentially for students' learning progression; however, instructors may tailor the order of course standards to their specifications. Students are expected to use engineering notebooks to document procedures, design ideas, and other notes for all projects throughout the course.

Course Standards

1. Safety

1.1 Safety Rules: Accurately read and interpret **safety rules**, including, but not limited to, rules published by the National Science Teachers Association (NSTA), rules pertaining to electrical safety, Occupational Safety and Health Administration (OSHA) guidelines, and state and national code requirements. Be able to distinguish between the rules and explain why certain rules apply.

1.2 Safety Equipment: Identify and explain the intended use of **safety equipment** available in the classroom. For example, demonstrate how to properly inspect, use, and maintain safe operating procedures with tools and equipment.

2. Robotics Overview

2.1 History of Robotics: Research **the historical use of robotics** from textbooks, news media, and other informational texts. Create a presentation concerning the various uses of robotics. For example, explore areas such as the surgical field, space exploration, agriculture, and advanced manufacturing.

2.2 Use of Robots: **Explain why robots should be used in certain circumstances**. Include the use of collaborative robots (cobots) in manufacturing facilities. Cite textual evidence to support claims (for example, assemble evidence from medical journals to support a claim that the use of robots has lowered costs and increased efficiency among medical providers). Other examples may derive from the areas identified in standard 2.1. Defend original arguments and debate peer perspectives using claim(s) and counterclaim(s) developed in the persuasive essay.

3. Career Exploration

3.1 Robotic Careers: **Report on jobs in industries, organizations, and careers in Tennessee and other states that use robotics** (such as Nissan in Automotive Manufacturing). Include work activities involved, postsecondary education needed, and skills necessary for these careers. (These could range from industry certifications to degrees in robotics engineering.)

3.2 Robot Impacts: Research the **ethical considerations involved in developing new and modifying existing robotic technologies**. For example, investigate the National Society of Professional Engineers' (NSPE) Code of Ethics for Engineers or the Computer Ethics Institute's Ten Commandments of Computer Ethics. Select an existing technology and describe the ethical dilemmas faced by both producers and consumers of that technology, such as trade-offs between individual versus societal benefits or unforeseen consequences to the environment. For example, examine why some workers and labor unions may view robots as a threat to their jobs.

4. Programming

4.1 Robotic Programming: Create a flowchart of a **program for a robotic system**. Convert the flowchart into a **working program**. Test, modify, and optimize the program. Write a technical report evaluating the performance of the program. Support all claims with specific examples.

4.2 Data: **Log, store, and export data** received from two or more sensors (for example, vision/light, audio, and touch) in a robotic or automated system. Explain why these procedures would be useful and provide specific examples.

5. Engineering Design and Science & Engineering Practices

5.1 Engineering Design Process: **Compare and contrast the following engineering design process with the eight practices of science and engineering** (Achieve, 2013). Based on observations, explain how the engineering design process and the science and engineering practices overlap, and describe how they might be used in automated systems design.

Engineering Design Process	Science and Engineering Practices
a) Identify the problem	a) Asking questions (for science) and defining problems (for engineering)
b) Identify criteria and specify constraints	b) Developing and using models
c) Brainstorm possible solutions	c) Planning and carrying out investigations
d) Research and generate ideas	d) Analyzing and interpreting data
e) Explore alternative solutions	e) Using mathematics and computational thinking
f) Select an approach	f) Constructing explanations (for science) and designing solutions (for engineering)
g) Write a design proposal	g) Engaging in argument from evidence
h) Develop a model or prototype	h) Obtaining, evaluating, and communicating information
i) Test and evaluate	
j) Refine and improve	
k) Create or make a product	
l) Communicate results	

6. Computers and Electronics

6.1 Robots as Machines: Create an explanatory presentation that describes the parts necessary to make a robot and distinguishes it from a computer and a non-robotic machine. Parts necessary to make a robot include: (1) having a microprocessor for a brain, (2) sensors for input and output, (3) controls, and (4) motors. The presentation should include an informative report that describes various types of sensors (for example, auditory, visual, heat, etc.) and a summary of how sensors provide input. It should also describe various types of output (for example, motors, mechanisms, speakers, light, etc.) and discuss how sensors provide output.

6.2 Programming: Design, develop, and test a **program to control a robotic system** and robotic subsystems. The program should be able to receive data from a robot's input devices, process the data, and create outputs based on the inputs received. Present the robotic system to the class and provide details on the methodology used to design and develop the program, justifying selections as appropriate.

6.3 Feedback Loops: Utilize **feedback loops in a robotic system**. For example, create a demonstration scenario and program a robot that requires the following: start, stop, or change motion within a robotic or automated system based on sensor input, provided by two or more sensors (such as vision/light, audio, and touch).

7. Mechanics

7.1 Mechanics in Robots: Use **mechanical tools, such as motors, gears, and gear trains in the construction of a robotic or automated system**. Identify where forces are acting upon various points on the system and document with simple diagrams. Use the concepts of force, torque, and mechanical advantage to calculate the force acting upon the points in the system.

7.2 Robotic Work: Develop a system to **demonstrate force, torque, work, and power acting upon or being done by a robotic or automated system**. Justify the design by creating mathematical models that show the calculations.

8. Testing, Maintenance, Documentation, and Quality Assurance

8.1 Measure Outputs: Use appropriate instruments to **measure and record electrical, light, and audio outputs of a robotic system.** Compare measured data to acceptable norms for the system. Document whether the system is performing within accepted parameters and cite evidence to support the claims. Perform maintenance or follow recommended procedures to correct malfunctions or underperformance within the system. Write a justification for any maintenance that is performed, citing data obtained from test results.

8.2 Maintenance: Create a service and maintenance report on a robotic or automated system. The report should include text explaining the **maintenance and corrective measures** conducted. It should also include text justifying whether the system is functioning properly or recommending additional measures to correct any issues within the system. Finally, it should include text recommending quality-assurance policies and procedures to assure continuing operation of the system within acceptable parameters and text describing corrective procedures to be used when the system is malfunctioning or operating below optimal performance.

9. Projects

9.1 Robot Project: Working in a team, **design and create a robotic solution to a given problem**. Incorporate the engineering design process, as well as science and engineering practices, to develop a solution that meets the criteria for entries in a regional, state, or national robotics competition. Maintain an engineering notebook to document the details of the project. Write a technical paper (see components of the report below) and develop a presentation describing the solution and development process for the team solution. The technical paper should include, but is not limited to:

a. background,
b. problem definition,
c. design constraints,
d. methodology,
e. data analysis (e.g., charts, graphs, and calculations),
f. results/problem solution (include engineering drawings), and
g. conclusions and recommendations for future research.

Standards Alignment Notes

*References to other standards include:

- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.