Arkansas Computer Science and Computing Standards

High School Robotics

Draft 11242020

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Arkansas Computer Science and Computing Standards for High School Robotics

Introduction

The Arkansas Computer Science and Computing Standards for High School are designed to provide understandings of concepts in computer science that are necessary for students to function in an ever-changing technological world. Through these standards, students will explore, apply, and move toward mastery in skills and concepts related to Computational Thinking and Problem Solving; Data, Information, and Security; Algorithms and Programs; Computers and Communications; and Professionalism and Impacts of Computing. These standards help students learn to accomplish tasks and solve problems independently and collaboratively. These standards give students the tools and skills needed to be successful in college and careers, whether in computer science and computing or in other fields.

State developed pathways within the Arkansas High School Computer Science and Computing Initiative all begin with a common course and associated set of standards in year one. This common course allows for consistency across the state and all schools regarding the basic knowledge and skills needed for any student entering a technology-based field.

The course standards have been combined into one-credit (typically yearly) standards to afford the classroom educator additional flexibility in their curriculum choices; however, the course codes remain based on one-half credit (typically semester). Each state-developed pathway will have three credits (six pathway specific course codes) worth of Computer Science Flex Credit (465XXX) course codes.

The Arkansas State Board of Education (SBE) does not place any prerequisites on the Arkansas computer science high school courses, but allows for schools to place students in any of the courses based on ability and desire. The Arkansas Department of Education (ADE) recommends that districts develop and formally adopt a written policy outlining placement protocols. Evaluation tools and placement criteria will be the responsibility of the local districts.

The SBE and ADE authorize schools to enroll students across levels in the same sections of the master schedule (a.k.a. stacking) as long as the number of students does not exceed Standards of Accreditation maximums and/or ratios and the school can reasonably assure a high-quality educational experience for all students within that section.

Implementation of the Arkansas Computer Science and Computing Standards for High School Robotics begins during the 2021-2022 school year.

Course Title: Robotics
Course/Unit Credit: 0.5 credit per listed course code

	Robotics Year 1 - Level 1 / Level 2	**Robotics Year 2 - Level 3 / Level 4**	**Advanced Robotics Year 3 - Advanced**
Robotics	465510 / 465520	465530 / 465540	465550 / 465560

Teacher Licensure: Please refer to the Course Code Management System (https://adedata.arkansas.gov/ccms/) for the most current licensure codes.
Grades: 9-12
Prerequisites: There are no ADE established course prerequisites for any of the Arkansas Computer Science and Computing Initiative high school courses; it is up to the local district to determine placement based on student ability.

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Computer Science and Computing Practices

Students exhibit proficiency in computer science and computing through:

Communication - Students effectively communicate, using accurate and appropriate terminology, when explaining the task completion or problem solving strategies used. They recognize that creating good documentation is an ongoing and important part of the communication process.

Collaboration - Students productively work with others while ensuring multiple voices are heard and considered. They understand that diverse thoughts may lead to creative solutions and that some problems may be best solved collaboratively.

Storytelling - Students creatively combine multimedia tools, such as graphics, animations, and videos with research, writing, and oral presentations to create ethical, data-driven stories.

Professionalism - Students embrace professionalism by demonstrating skills and behaviors necessary for success in technical careers.

Ethics and Impact - Students comprehend the ramifications of actions prior to taking them. They are aware of their own digital and cyber presence and its impact on other individuals and society.

Inclusion - Students encourage diversity in the field of computer science and computing regardless of race, ethnicity, gender, or other differences.

Learning by Failure - Students reflect upon and critique their work while embracing a willingness to seek feedback and constructive instruction from teachers and peers. They utilize the feedback to continually improve current projects, educational experiences, knowledge, and confidence.

Perseverance - Students expect difficulties and persist in overcoming challenges that occur when completing tasks. They recognize making and correcting mistakes is necessary for the learning process while problem solving.

Understanding - Students recognize patterns, utilize tools, and apply problem solving strategies to build understanding, find solutions, and successfully deliver high-quality work.

Patterns - Students understand and utilize the logical structure of information through identifying patterns and creating conceptual models. They decompose complex problems into simpler modules and patterns.

Problem Solving - Students exhibit proficiency through the process of identifying and systematically solving problems. They recognize problem solving is an ongoing process.

Research - Students purposefully gather information and seek to expand their knowledge through various methods and mediums. They embrace the practice of gaining knowledge to develop novel approaches for solving problems and addressing issues they have not previously encountered, in addition to merely searching for answers.

Tools - Students evaluate and select tools to be used when completing tasks and solving problems. They understand that appropriate tools may include, but are not limited to, their mind, pencil and paper, manipulatives, software applications, programming languages, or appropriate computing devices.

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Arkansas Computer Science and Computing Standards for High School

Strand	Content Cluster
Computational Thinking and Problem Solving	
	1. Students will analyze and utilize problem-solving strategies.
	2. Students will analyze and utilize connections between concepts of mathematics and computer science.
Data, Information, and Security	
	3. Students will analyze and utilize data through the use of computing devices.
	4. Students will analyze and utilize concepts of cybersecurity.
Algorithms and Programs	
	5. Students will create, evaluate, and modify algorithms.
	6. Students will create programs to solve problems.
Computers and Communications	
	7. Students will analyze the utilization of computers within industry.
	8. Students will analyze communication methods and systems used to transmit information among computing devices.
	9. Students will utilize appropriate hardware and software.
Professionalism and Impacts of Computing	
	10. Students will analyze the impacts of technology and professionalism within the computing community.
	11. Students will demonstrate understanding of storytelling with data and appropriately communicate about technical information.

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Understanding the Arkansas Computer Science and Computing Standards Documents:

- This Arkansas Department of Education curriculum standards document is intended to assist in district curriculum development, unit design, and to provide a uniform, comprehensive guide for instruction.
- The goal for each student is proficiency in all academic standards for the course/year in which the student is enrolled.
- The Practice Standards are intended to be habits of mind for all students and were written broadly in order to apply to all grades/levels. The Practice Standards are not content standards and are not intended to be formally assessed.
- Notes (NOTE:) and examples given (e.g.,) found within the document are not mandated by the Arkansas State Board of Education, but are provided for clarification of the standards by the Arkansas Department of Education and/or the standards drafting committee. The notes and examples given are subject to change as understandings of the standards evolve.
- Within the high school documents, the numbering for standards is read as: Course Abbreviation - Year - Content Cluster - Standard. Example: "CSPG.Y1.2.3" would be Computer Science Programming - Year 1 - Content Cluster 2 - Standard 3.
- Within the Coding Block document, the numbering for standards is read as: Course Abbreviation - Content Cluster - Standard. Example: "CSCB.1.2" would be Coding Block, Content Cluster 1, Standard 2.
- Within the K-8 Computer Science Standards documents, the numbering for standards is read as: Course Abbreviation - Grade - Content Cluster - Standard. Example: "CSK8.G1.2.3" would be K-8, Grade 1, Content Cluster 2, Standard 3
- Ancillary documents and supporting information may be released to assist in further understanding of the standards with possible classroom implementation strategies included.

"Research" and Learning

The Arkansas Department of Education Office of Computer Science recognizes that the use of the term "research" as an action verb within academic standards is not mainstream, though not unheard of, and exists as a measurable objective within other Arkansas K-12 academic standards. The members of the internal team, composed of the State Director of Computer Science and nine state-wide Computer Science Specialists, discussed this at length amongst ourselves and with many committee members. While there existed varying opinions for various reasons, the internal team opted to keep "research" as an action verb within the standards for the following reasons:

1. The internal team believes that this use of "research" and the skill-building activities students will undertake while performing said research will produce students that have a skillset which industry representatives have identified as missing from workers entering technical job fields.
2. As the field of Computer Science and Computing is ever changing and growing, professionals and students within this field must conduct informal research on an almost daily basis to maintain relevant knowledge and skills.
3. The use of "research" within this document does not determine classroom implementation; however, it is used to indicate that the student should take individual and active efforts to seek out knowledge to develop novel approaches for solving problems and addressing issues they have not previously encountered, in addition to merely searching for answers.
4. The use of "research" should not infer that a student should be required to do an extensive qualitative or quantitative research project from the use of "research" anywhere in this document; however, a more formal research project is not prohibited if the teacher feels it is appropriate.

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Strand: Computational Thinking and Problem Solving

Content Cluster 1: Students will analyze and utilize problem-solving strategies.

Year 1 - Level 1 / Level 2	Year 2 - Level 3 / Level 4	Year 3 - Advanced
CSRB.Y1.1.1 Leverage problem-solving strategies to solve problems of level-appropriate complexity	CSRB.Y2.1.1 Leverage problem-solving strategies to solve problems of level-appropriate complexity CSRB Y2: Utilize the engineering design process	CSRB.Y3.1.1 Utilize the engineering design process to solve problems of level-appropriate complexity
NOTE: Problem-solving strategies that encompass computational thinking include, but are not limited to, abstraction, algorithm development, decomposition, and pattern recognition. NOTE CSRB Y2-Y3: Problem solving details may include, but are not limited to, accounting for cost, aesthetics, efficiency, maintainability, reliability, and safety.		
CSRB.Y1.1.2 Analyze and utilize multiple representations of problem-solving logic used to solve problems of appropriate complexity	CSRB.Y2.1.2 Analyze and utilize multiple representations of problem-solving logic used to solve problems of appropriate complexity CSRB Y2: Develop schematics relevant to robotics system architecture	CSRB.Y3.1.2 Analyze and utilize multiple representations of problem-solving logic used to solve problems of level-appropriate complexity, such as schematics and 3D modeling
NOTE: Representations may include, but are not limited to, backlog, decision matrix, design brief, documentation, fault tree analysis, flowchart, pseudocode, and sprints.		
CSRB.Y1.1.3 Analyze and utilize collaborative methods in problem solving of level-appropriate complexity	CSRB.Y2.1.3 Analyze and utilize collaborative methods in problem solving of level-appropriate complexity	CSRB.Y3.1.3 Analyze and utilize collaborative methods in problem solving of level-appropriate complexity
NOTE: Collaborative methods may include, but are not limited to, distributive (divide and conquer), paired programming, and redundant parallel.		
CSRB.Y1.1.4 Analyze and utilize level-appropriate troubleshooting strategies for hardware and software issues	CSRB.Y2.1.4 Analyze and utilize level-appropriate troubleshooting strategies for hardware and software	CSRB.Y3.1.4 Analyze and utilize level-appropriate troubleshooting strategies for hardware and software

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Strand: Computational Thinking and Problem Solving

Content Cluster 2: Students will analyze and utilize connections between concepts of mathematics and computer science.

Year 1 - Level 1 / Level 2	Year 2 - Level 3 / Level 4	Year 3 - Advanced
CSRB.Y1.2.1 Interpret relational and logical expressions of level-appropriate complexity using comparison and Boolean operators	*Continuation of this standard is not specifically included or excluded*	*Continuation of this standard is not specifically included or excluded*
NOTE: Boolean operators include AND, OR, NOT, and XOR. Comparison operators may include, but are not limited to, <, >, and !=.		
CSRB.Y1.2.2 Classify the types of information that can be stored as variables and analyze the appropriateness of each (e.g., Booleans, characters, integers, floating points, strings)	CSRB.Y2.2.2 Classify and utilize types of information that are stored in robotics systems including, but not limited to, 2D and 3D coordinate system and sensor data	CSRB.Y3.2.2 Utilize types of information that are stored in robotics systems including, but not limited to, 2D and 3D coordinate system and sensor data
CSRB.Y1.2.3 Analyze how computer science concepts relate to the field of mathematics	*Continuation of this standard is not specifically included or excluded*	*Continuation of this standard is not specifically included or excluded*
NOTE: Concepts may include, but are not limited to, different division methods (e.g., integer, long, modular), random number generation, domain, maximum, mean, minimum, mode, and range.		
CSRB.Y1.2.4 Discuss and apply concepts of abstraction	CSRB.Y2.2.4 Analyze and utilize concepts of abstraction as modeling and abstraction as encapsulation	*Continuation of this standard is not specifically included or excluded*
NOTE: Abstraction is the process of reducing information and detail to facilitate focus on relevant concepts and functionality (displaying only essential information while hiding the details).		
CSRB.Y1.2.5 Perform operations of level-appropriate complexity with binary, decimal, and hexadecimal numbers	CSRB.Y2.2.5 Perform operations of level-appropriate complexity with binary, octal, decimal, and hexadecimal numbers	*Continuation of this standard is not specifically included or excluded*
NOTE: Operations may include, but are not limited to, addition, subtraction, multiplication, division, and conversion.		

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CSRB.Y1.2.6 Demonstrate operator precedence in expressions and statements	*Continuation of this standard is not specifically included or excluded*	*Continuation of this standard is not specifically included or excluded*
NOTE: Operators include, but are not limited to, addition, subtraction, division, modulus division, concatenation, square root, and exponentiation. Operator precedence may include, but is not limited to, inside-out, order of operations, and the understanding that the assignment statement of "x = 1" is not the same as "1 = x."		
This standard is not specifically required until Year 2	CSRB.Y2.2.7 Explain how concepts of mechanical engineering including, but not limited to, gear ratios, speed, stability, and torque relate to the implementation of robotics systems and subsystems	CSRB.Y3.2.7 Apply concepts of mechanical engineering including, but not limited to, gear ratios, speed, stability, and torque
This standard is not specifically required until Year 2	CSRB.Y2.2.8 Explain how concepts of electrical engineering including, but not limited to, applying Ohm's law, using a multimeter, and understanding electric motors as they relate to the implementation of robotics systems and subsystems	CSRB.Y3.2.8 Apply concepts of electrical engineering including, but not limited to, applying fundamental laws of electricity (e.g., Kirchhoff's Law, Ohm's Law), using a multimeter, and understanding electric motors as they relate to the implementation of robotics systems and subsystems
This standard is not specifically required until Year 2	CSRB.Y2.2.9 Describe and represent basic electrical quantities including, but not limited to charge, current, energy, power, and voltage and describe the relationships among them	*Continuation of this standard is not specifically included or excluded*

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Strand: Data, Information, and Security

Content Cluster 3: Students will analyze and utilize data through the use of computing devices.

Year 1 - Level 1 / Level 2	Year 2 - Level 3 / Level 4	Year 3 - Advanced
CSRB.Y1.3.1 Define, store, access, and manipulate level-appropriate data (e.g., primitive, linear)	CSRB.Y2.3.1 Create programs to store, access, and manipulate level-appropriate data (e.g., structured data, objects) CSRB Y2: Create programs to store, access, and manipulate level-appropriate robotics system data (e.g., position, sensor input)	CSRB.Y3.3.1 Create programs to store, access, and manipulate, with a high level of efficiency, level-appropriate robotics system data
NOTE: Primitive data may include, but is not limited to, Boolean, character, double, float, and integer. Linear data may include, but is not limited to, arrays, lists, strings, and vectors. Structured data may include, but is not limited to, arrays, classes, linked lists, maps, multidimensional arrays, and structs. Objects may include, but are not limited to, constructors, data members, and methods. Defining, storing, and accessing may include, but are not limited to, type declaration, variables, and modifiers (e.g., final, pass-by-value, pass-by-reference parameters, private, protected, public). Manipulating data may include, but is not limited to, arranging (e.g., queuing, stacking), bit manipulation, casting, rearranging, and sorting.		
CSRB.Y1.3.2 Define and discuss different examples of level-appropriate quantitative and qualitative data	CSRB.Y2.3.2 Define and discuss different examples of level-appropriate quantitative and qualitative data	CSRB.Y3.3.2 Analyze how quantitative and qualitative data are utilized in robotic systems
This standard is not specifically required until Year 2	CSRB.Y2.3.3 Research, discuss, and create level-appropriate programs to model and simulate probabilistic and real-world scenarios	CSRB.Y3.3.3 Create and evaluate models and simulations to answer student-identified scenarios
NOTE: Probabilistic scenarios may include, but are not limited to, flipping a coin, random walkers, and rolling dice. Real-world scenarios may include, but are not limited to, city population and predator-prey. NOTE CSRB Y2-Y3: Student-identified scenarios may include, but are not limited to, environmental and industry-relevant examples, such as packing, picking, and sorting.		

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CSRB.Y1.3.4 Analyze, utilize, and visually represent level-appropriate data	CSRB.Y2.3.4 Analyze, utilize, and visually represent level-appropriate static and dynamic data	CSRB.Y3.3.4 Analyze, utilize, and visually represent level-appropriate static and dynamic data, including, but not limited to, data collected through robotic sensors
NOTE: Visual representation tools may include, but are not limited to, analytics reports, graphical representations, programming language libraries, and spreadsheets. Dynamic data may include, but are not limited to, network traffic, real-time weather data, sensor statuses, stock market valuations, and system status.		
CSRB.Y1.3.5 Perform level-appropriate data analysis using computing tools	CSRB.Y2.3.5 Perform level-appropriate data analysis using computing tools	CSRB.Y3.3.5 Perform level-appropriate data analysis using computing tools
NOTE: Analysis may include, but is not limited to, maximum values, mean values, minimum values, ranges, and string comparisons.		

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Strand: Data, Information, and Security

Content Cluster 4: Students will analyze and utilize concepts of cybersecurity.

Year 1 - Level 1 / Level 2	Year 2 - Level 3 / Level 4	Year 3 - Advanced
CSRB.Y1.4.1 Identify the five pillars of cybersecurity and evaluate the relevance of each pillar to computer science concepts	CSRB.Y2.4.1 Apply the five pillars of cybersecurity as applicable to level-appropriate computer science concepts	*Continuation of this standard is not specifically included or excluded*
NOTE: Additional concepts and key terms of the five pillars of cybersecurity (confidentiality, integrity, availability, non-repudiation, and authentication) may include, but are not limited to, access control paradigms, accountability, authorization, least-privilege, and need-to-know.		
CSRB.Y1.4.2 Research and describe different roles within the hacking community (e.g., white hat, black hat, gray hat hacking), including positive and negative motivations, significant impacts, and social stereotypes	*Continuation of this standard is not specifically included or excluded*	*Continuation of this standard is not specifically included or excluded*
NOTE: White hat hacking may include, but is not limited to, bug bounty programs and contracted penetration testing. A significant impact example may include, but is not limited to, Charlie Miller's compromisation of Fiat Chrysler vehicles. Black hat hacking may include, but is not limited to, the unauthorized processes of accessing systems to destroy, compromise, or steal data and deny access to services or systems. A significant impact example may include, but is not limited to, Behzad Mesri's alleged theft of data from Home Box Office (HBO) and subsequent ransom demands. Gray hat hacking may include, but is not limited to, unauthorized processes of accessing systems to report, correct, and draw attention to security vulnerabilities. A significant example of gray hat hacking is intentionally not included; students and teachers are encouraged to explore and discuss the nuances of "right versus wrong" and motivations within this community, including nation-state actions.		
CSRB.Y1.4.3 Research and describe the impacts of ransomware, trojans, viruses, and other malware	CSRB.Y2.4.3 Research and describe common attacks on software, hardware, and networks	*Continuation of this standard is not specifically included or excluded*
NOTE: Common hardware attacks may include, but are not limited to, clones, hardware trojans, and side-channel attacks. Common software attacks may include, but are not limited to, buffer overflows, deployment errors, software bugs, and Structured Query Language (SQL) and command injection. Common network attacks may include, but are not limited to, man-in-the-middle attacks, packet sniffing, protocol abuse, and spoofing of media access control (MAC) or internet protocol (IP) addresses.		
CSRB.Y1.4.4	*Continuation of this standard is not specifically included or excluded*	*Continuation of this standard is not specifically included or excluded*

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Explain implications related to identification and responsible reporting of a vulnerability versus exploitation		

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Strand: Algorithms and Programs

Content Cluster 5: Students will create, evaluate, and modify algorithms.

Year 1 - Level 1 / Level 2	Year 2 - Level 3 / Level 4	Year 3 - Advanced
CSRB.Y1.5.1 Design and implement level-appropriate algorithms that use sequence, selection, and iteration	CSRB.Y2.5.1 Design and implement level-appropriate algorithms that use iteration, recursion, selection, and sequence	CSRB.Y3.5.1 Design and implement algorithms that solve student-identified problems
CSRB.Y1.5.2 Illustrate the flow of execution of algorithms in level-appropriate programs including branching and looping	*Continuation of this standard is not specifically included or excluded*	*Continuation of this standard is not specifically included or excluded*
NOTE: Illustrations may include, but are not limited to, flowcharts and pseudocode.		
CSRB.Y1.5.3 Evaluate the qualities of level-appropriate student-created and non-student-created algorithms	CSRB.Y2.5.3 Evaluate the qualities of level-appropriate student-created and non-student-created algorithms including classic search and sort algorithms	*Continuation of this standard is not specifically included or excluded*
NOTE: Evaluation tools may include, but are not limited to, code review and test cases. Qualities may include, but are not limited to, correctness, efficiency, exception handling, input/data/model validation, portability, readability, scalability, and usability.		
CSRB.Y1.5.4 Use a systematic approach to detect and resolve errors in a given algorithm	CSRB.Y2.5.4 Use a systematic approach to detect and resolve errors in a given algorithm	CSRB.Y3.5.4 Use a systematic approach to detect and resolve errors in a given algorithm

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Strand: Algorithms and Programs

Content Cluster 6: Students will create programs to solve problems.

Year 1 - Level 1 / Level 2	Year 2 - Level 3 / Level 4	Year 3 - Advanced
CSRB.Y1.6.1 Create programs using procedures to solve problems of level-appropriate complexity	CSRB.Y2.6.1 Create programs to solve problems of level-appropriate complexity	CSRB.Y3.6.1 Create programs that utilize robotic systems to solve problems of level-appropriate complexity
NOTE: “Procedures” is considered interchangeable with “functions” for meeting this standard. Problems may include, but are not limited to, encoding, encryption, finding minimum/maximum values, identifying prime numbers, searching and sorting, and solving classic computer science tasks such as The Towers of Hanoi problem.		
CSRB.Y1.6.2 Discuss and apply best practices of program design and format (e.g., descriptive names, documentation, indentation, user experience design, whitespace)	CSRB.Y2.6.2 Discuss and apply best practices of program design and format (e.g., descriptive names, documentation, indentation, user experience design, whitespace)	CSRB.Y3.6.2 Discuss and apply best practices of program design, user experience design, and format (e.g., descriptive names, documentation, indentation, whitespace)
CSRB.Y1.6.3 Determine the scope and state of variables declared in procedures and control structures over time	CSRB.Y2.6.3 Determine the scope and state of variables defined in procedures and classes	*Continuation of this standard is not specifically included or excluded*
NOTE: “Procedures” is considered interchangeable with “functions” for meeting this standard.		
CSRB.Y1.6.4 Create programs of level-appropriate complexity that read from standard input, write to standard output, read from a file, write to a file, and append to a file	CSRB.Y2.6.4 Create programs that read from, write to, and append to a file of level-appropriate complexity that includes structured data	CSRB.Y3.6.4 Create programs of level-appropriate complexity that leverage real-time sensory input to make decisions for completing physical tasks
NOTE: Standard input and output is platform-specific. Standard input and output on personal computers may include, but are not limited to, a keyboard and terminal. Standard input and output on mobile application devices may include, but are not limited to, touchscreen and speakers. Standard input and output on robots may include, but are not limited to, sensors and servos. Structured data refers to any representation of data which can be interpreted by an external or separate computing system including, but not limited to, comma-separated values (CSV), JavaScript Object Notation (JSON), Extensible Markup Language (XML), and other line-based text documents.		
CSRB.Y1.6.5 Use a systematic approach to detect logic, runtime, and syntax errors within a program	CSRB.Y2.6.5 Use a systematic approach to detect logic, runtime, and syntax errors within a program	CSRB.Y3.6.5 Use a systematic approach to detect logic, runtime, and syntax errors within a program

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This standard is not specifically required until Year 2	CSRB.Y2.6.6 Create programs that utilize various robotics system operations to solve problems	CSRB.Y3.6.6 Create programs that utilize various robotics system operations to solve real-world problems
NOTE CSRB Y2-Y3: Robotics system operations may include, but are not limited to, breaking the plane, calibration, cycle paths, homing, material gripping/engagement, material placement, operation, recovery, runtime, safety parameters, and travel.		

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Strand: Computers and Communications

Content Cluster 7: Students will analyze the utilization of computers within industry.

Year 1 - Level 1 / Level 2	Year 2 - Level 3 / Level 4	Year 3 - Advanced
CSRB.Y1.7.1 Identify hardware and software specific to carrying out the mission of regional industries	CSRB.Y2.7.1 Utilize hardware and/or software to solve level-appropriate industry-based problems	CSRB.Y3.7.1 Utilize multiple hardware and software tools simultaneously to solve level-appropriate industry-based problems
NOTE CSRB Y2-Y3: Industry-based problems may include, but are not limited to, cobots, dexterity movement, packing, palletizing, picking, and sorting.		
CSRB.Y1.7.2 Research advancing and emerging technologies (e.g., artificially intelligent agents, blockchain, extended reality, Internet of Things (IoT), machine learning, robotics)	CSRB.Y2.7.2 Research cutting-edge robotics technology (e.g., analytics, artificial intelligence, autonomous vehicles, big data, end-of-arm tools, IoT, machine learning, vision) and its effects on the way business may be conducted in the future	CSRB.Y3.7.2 Research integration of multiple technologies (e.g., analytics, artificial intelligence, big data, end-of-arm tools, IoT machine learning, vision) to solve level-appropriate industry-based problems

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Strand: Computers and Communications

Content Cluster 8: Students will analyze communication methods and systems used to transmit information among computing devices.

Year 1 - Level 1 / Level 2	Year 2 - Level 3 / Level 4	Year 3 - Advanced
CSRB.Y1.8.1 Utilize the command line to accomplish common network troubleshooting tasks at an introductory level	*Continuation of this standard is not specifically included or excluded*	*Continuation of this standard is not specifically included or excluded*
NOTE: Common network troubleshooting tasks may include, but are not limited to, viewing internal IP address information (e.g., ipconfig /all); viewing external IP address information using an external service (e.g., ifconfig.me, myip.com, whatsmyip.com); validating communication with a remote system (e.g., ping); tracing path of communication to a remote system (e.g., traceroute); and releasing and renewing IP addresses (e.g., ipconfig /renew).		
CSRB.Y1.8.2 Research and describe common networking concepts at an introductory level	CSRB.Y2.8.2 Compare and contrast network connectivity options for different types of robotics platforms and communications methods within various robotics systems, including but not limited to, controller area network (CAN) busses	CSRB.Y3.8.2 Utilize a network-connected robot
NOTE: Networking concepts may include, but are not limited to, different types of networks (e.g., local area network (LAN), wide area network (WAN)); various common topologies; the role of a MAC address; local versus public IP and how they are assigned; Internet Protocol version 4 (IPv4) and Internet Protocol version 6 (IPv6) addressing schemes; role of Domain Name System (DNS); the hierarchical nature of networks; purpose of virtual private networks (VPN); signal carriers for networks (e.g., copper, fiber optic, radio); purpose of firewalls; network access roles (e.g., employee versus guest, staff versus student); role of internet service providers (ISP); wireless connectivity; client-server relationship versus peer-to-peer (P2P); role of common internet protocols; and secure versus insecure protocols.		
CSRB.Y1.8.3 Research and describe modems, network interface cards, routers (e.g., consumer, industrial), switches, and wireless access points, and identify their purposes within a network	*Continuation of this standard is not specifically included or excluded*	*Continuation of this standard is not specifically included or excluded*
CSRB.Y1.8.4 Describe the importance of creating and using common rules for communication and the utilization of common network protocols	*Continuation of this standard is not specifically included or excluded*	*Continuation of this standard is not specifically included or excluded*
NOTE: Discussions of common rules for communications may include, but are not limited to, the Open Systems Interconnection (OSI) Model and packet communication. Common network protocols may include, but are not limited to, DNS, Hypertext Transfer Protocol (HTTP)/ Secure Hypertext Transfer Protocol (HTTPS), Simple Mail Transfer Protocol (SMTP)/Post Office Protocol (POP)/Internet Message Access Protocol (IMAP), and Telnet/Secure Shell (SSH).		

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Strand: Computers and Communications

Content Cluster 9: Students will utilize appropriate hardware and software.

Year 1 - Level 1 / Level 2	Year 2 - Level 3 / Level 4	Year 3 - Advanced
CSRB.Y1.9.1 Compare and contrast computer programming paradigms (e.g., functional, imperative, object-oriented)	*Continuation of this standard is not specifically included or excluded*	*Continuation of this standard is not specifically included or excluded*
CSRB.Y1.9.2 Research, describe, and utilize at an appropriate level: ● debugging strategies ● integrated development environments (IDE) ● source-code editors ● version control strategies	CSRB.Y2.9.2 Use collaboration tools and version control systems in a group software project of appropriate complexity CSRB Y2: Use collaborative tools and processes to configure level-appropriate robotic hardware components	CSRB.Y3.9.2 Use collaborative tools and processes to configure level-appropriate robotic hardware components
NOTE CSRB Y2-Y3: Collaborative tools may include, but are not limited to, IDEs and 3D modeling software. Robotic hardware component configuration may include, but is not limited to, assembly, calibration, and troubleshooting.		
CSRB.Y1.9.3 Classify layers of software (e.g., applications, drivers, firmware, operating systems) utilized within various platforms (e.g., Android, ChromeOS, iOS, Linux, macOS, Windows)	CSRB.Y2.9.3 Analyze the importance and effect of updating firmware and drivers within robotic systems	*Continuation of this standard is not specifically included or excluded*
CSRB.Y1.9.4 Identify and describe the purpose of hardware components within various personal computing platforms	CSRB.Y2.9.4 Utilize robotic hardware components to create level-appropriate robotic systems and subsystems	CSRB.Y3.9.4 Utilize robotic hardware components to create level-appropriate robotic systems and subsystems
NOTE: Hardware components include, but are not limited to, central processing units (CPU), chassis, cooling components, graphics cards, input/output devices, memory, motherboards, power supplies, and storage devices. NOTE CSRB Y2-Y3: Robotic hardware components may include, but are not limited to, actuators, effectors, microcontrollers, motors, power supplies, programmable logic controllers, and sensors.		

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This standard is not specifically required until Year 2	CSRB.Y2.9.5 Discuss and apply autonomous and manual robotic control by coding in various robotic programming languages (e.g., C++, Karel, Python)	CSRB.Y3.9.5 Apply autonomous and manual robotic control by coding in various robotic programming languages (e.g., C++, Karel, Python)
This standard is not specifically required until Year 2	CSRB.Y2.9.6 Compare and contrast different types of industry-relevant robotic systems (e.g., 3-axis, 6-axis, AMR, cobot, delta, SCARA, T-700)	CSRB.Y3.9.6 Analyze different industry-relevant robotic systems and their various applications (e.g., 3-axis, 6-axis, AMR, cobot, delta, SCARA, T-700)
This standard is not specifically required until Year 2	CSRB.Y2.9.7 Utilize breadboarding in the creation of a level-appropriate closed-loop robot	CSRB.Y3.9.7 Utilize breadboarding and prototyping in the creation of a level-appropriate closed-loop robot
This standard is not specifically required until Year 2	CSRB.Y2.9.8 Utilize hardware diagnostic tools to design, test, and troubleshoot robotic systems and subsystems	CSRB.Y3.9.8 Utilize hardware diagnostic tools to design, test, and troubleshoot robotic systems and subsystems
This standard is not specifically required until Year 2	CSRB.Y2.9.9 Discuss hardware and software requirements and limitations of various robotics systems	CSRB.Y3.9.9 Analyze hardware and software requirements and limitations of various robotics systems

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Strand: Professionalism and Impacts of Computing

Content Cluster 10: Students will analyze the impacts of technology and professionalism within the computing community.

Year 1 - Level 1 / Level 2	Year 2 - Level 3 / Level 4	Year 3 - Advanced
CSRB.Y1.10.1 Research and describe the risks and risk mitigation strategies associated with the utilization and implementation of social media and other digital technology implications	*Continuation of this standard is not specifically included or excluded*	CSRB.Y3.10.1 Discuss etiquette and professionalism as related to communication in industry
NOTE: Risks include, but are not limited to, cyberbullying, identity theft, impersonation, and social engineering attacks. Implications may include, but are not limited to, employability, legal, physical, psychological, and social access. NOTE CSRB Y3: Discussion may include, but is not limited to, professional platforms and career-related websites, such as LinkedIn, Glassdoor, Monster, Indeed, and Dice.		
This standard is not specifically required until Year 2	CSRB.Y2.10.2 Research and describe issues related to creating and enforcing cyber-related laws and regulations (e.g., ethical challenges, policy vacuum, privacy versus security, unintended consequences)	*Continuation of this standard is not specifically included or excluded*
CSRB.Y1.10.3 Research and describe the potential benefits associated with the utilization and implementation of social media and other digital technologies	*Continuation of this standard is not specifically included or excluded*	*Continuation of this standard is not specifically included or excluded*
NOTE: Potential benefits may include, but are not limited to, brand building, crowdsourcing, personal promotion awareness, and project funding.		
CSRB.Y1.10.4 Research and describe the relationship between access and security (e.g., active and passive data, convenience, data mining, digital marketing, online wallets, privacy, theft of personal information)	CSRB.Y2.10.4 Identify the ethical implications encountered in the curation, management, and monetization of data (e.g., harvesting, information overload, knowledge management repositories, sharing, summarizing)	CSRB.Y3.10.4 Discuss ethical implications encountered in the robotics industry that relate to intellectual property, non-compete clauses, and non-disclosure agreements
This standard is not specifically required until Year 2	CSRB.Y2.10.5 Explain advantages and disadvantages of various software life cycle processes (e.g., Agile, spiral, waterfall)	*Continuation of this standard is not specifically included or excluded*

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CSRB.Y1.10.6 Research the history of computing devices and their impact on society	*Continuation of this standard is not specifically included or excluded*	*Continuation of this standard is not specifically included or excluded*
CSRB.Y1.10.7 Research and identify diverse careers and career opportunities (e.g., accessibility, availability, demand) that are influenced by computer science and the technical and soft skills needed for each	CSRB.Y2.10.7 Demonstrate industry-relevant technical and soft skills	CSRB.Y3.10.7 Demonstrate industry-relevant technical and soft skills
NOTE CSRB Y2-Y3: Industry-relevant soft skills include, but are not limited to, communication, perseverance, scheduling, and teamwork.		
This standard is not specifically required until Year 2	CSRB.Y2.10.8 Discuss effective professional collaborative project management tools	CSRB.Y3.10.8 Utilize and model effective professional project management
NOTE CSRB Y2: Project management tools may include, but are not limited to, Gantt chart, Gemba Walk, strengths-weaknesses-opportunities-threats (SWOT) analysis, Trello, and other Lean thinking strategies.		
This standard is not specifically required until Year 2	CSRB.Y2.10.9 Identify the components of a quality professional digital portfolio	CSRB.Y3.10.9 Evaluate the quality and impact of a professional digital portfolio
This standard is not specifically required until Year 2	CSRB.Y2.10.10 Create and maintain a digital collection of self-created work	CSRB.Y3.10.10 Create and maintain a professional digital portfolio comprised of self-created work
NOTE CSCE Y2-Y3: Self-created works may include, but are not limited to, diagrams, media, project reports, and source code.		

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Strand: Professionalism and Impacts of Computing

Content Cluster 11: Students will demonstrate understanding of storytelling with data and appropriately communicate about technical information.

Year 1 - Level 1 / Level 2	Year 2 - Level 3 / Level 4	Year 3 - Advanced
CSRB.Y1.11.1 Communicate basic technical information effectively to diverse audiences including, but not limited to, non-technical audience members	CSRB.Y2.11.1 Communicate robotics concepts to diverse audiences including, but not limited to, non-technical audience members	CSRB.Y3.11.1 Communicate robotics concepts to diverse audiences including, but not limited to, non-technical audience members
NOTE: Technical information may include, but is not limited to, collecting or collected data, computing hardware, cyber hygiene, networking concepts, programming paradigms, and troubleshooting concepts.		
CSRB.Y1.11.2 Describe and utilize the concepts of storytelling with data	CSRB.Y2.11.2 Utilize level-appropriate robotic system data for storytelling	CSRB.Y3.11.2 Utilize level-appropriate robotic system data for storytelling
NOTE: Storytelling concepts may include, but are not limited to, identifying the knowledge level of the intended audience; developing a compelling narrative; creating appealing visualizations appropriate for the intended audience and that enhance the narrative; remaining objective and avoiding biases; and avoiding the censoring of data.		
CSRB.Y1.11.3 Describe the following common types of data bias: ● confirmation bias ● confounding variables ● outliers ● overfitting/underfitting ● selection bias	*Continuation of this standard is not specifically included or excluded*	*Continuation of this standard is not specifically included or excluded*
CSRB.Y1.11.4 Compare and contrast causation and correlation	*Continuation of this standard is not specifically included or excluded*	*Continuation of this standard is not specifically included or excluded*
CSRB.Y1.11.5 Compare and contrast interpreting data, inferring using data, and implicating with data	*Continuation of this standard is not specifically included or excluded*	*Continuation of this standard is not specifically included or excluded*
This standard is not specifically required until Year 2	CSRB.Y2.11.6 Communicate conditions of a robotic system in terms of performance, diagnostics, troubleshooting, and repair	CSRB.Y3.11.6 Communicate conditions of a robotic system in terms of performance, diagnostics, troubleshooting, and repair

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