## Computer Science Foundations:

The Computer Science Foundations course is an introductory, high school computer science course. Its standards provide a structured progression from the middle school elective course while also offering a distinct learning opportunity for students who did not take the middle school elective course. The course emphasizes the academic depth of computer science with concepts and skills that would prepare students for advanced and specialized courses. Computational thinking is seen through its application in complex systems and designs of computing technologies. Students view various stakeholders within their work, evident in program development, cybersecurity safeguards, and technology usage. Advanced concepts within machine learning and Artificial Intelligence are addressed. Additionally, students acquire practical skills relevant to daily and professional life, including troubleshooting network issues and project management. Moreover, the course encourages students to analyze the societal, environmental, and ethical impacts of current and emerging technologies, fostering a deeper understanding of computing’s broader and direct implications in society.

### Algorithms and Programming (AP)

#### CSF.AP.1 The student will apply computational thinking to address a computational problem.

1. Identify real-world problems that are classification and prediction problems.
2. Decompose a problem or process into sub-components.
3. Implement abstractions to improve program modularity, reusability, and readability.
4. Identify computing-based solutions to address a computational problem.

#### CSF.AP.2 The student will use the iterative design process to create, test, and refine programs using a text-based programming language.

1. Create programs using a text-based programming language.
2. Document programs to improve the ability to trace, test, and debug.
3. Trace the execution of an algorithm and predict its results.
4. Analyze the outcomes of programs to identify logic and syntax errors.
5. Use multiple test cases to verify and refine the program.
6. Revise and improve an algorithm to resolve errors or produce desired outcomes.
7. Use version control and incorporate user feedback to refine program.

#### CSF.AP.3 The student will plan and implement algorithms and programs that include loops, variables, and compound and nested control structures using a text-based programming language.

1. Read and interpret algorithms and programs expressed using plain language, pseudocode, and text-based programming languages.
2. Create design documents using plain language, pseudocode, or diagrams.
3. Read and write algorithms and programs that accept multiple input values, use variables, and produce output.
4. Read and write algorithms and programs that include predefined functions and procedures with parameters and returns.
5. Compare several implementations of the same algorithm using different control structures.

#### CSF.AP.4 The student will design programs that use and manipulate data.

1. Determine appropriate data structures to address program specifications.
2. Apply basic computations on numeric and non-numeric data types.
3. Read and write programs that create, store, and manipulate primitive data.
4. Read and write programs that create, store, and manipulate linear collections of primitive data types: arrays or list.
5. Read and write programs that use relational, logical, and arithmetic expressions.
6. Read and write programs that traverse and manipulate data structures.

#### CSF.AP.5 The student will define and describe neural network learning algorithms.

1. Define and describe neural network learning algorithms.
2. Illustrate and describe a neural network structure.
3. Identify and discuss examples of computing technologies that utilize neural networks.
4. Compare and contrast a decision tree learning algorithm and a neural network learning algorithm.

#### CSF.AP.6 The student will investigate different coding languages.

1. Identify and describe characteristics of block-based and text-based coding languages.
2. Analyze the advantages and disadvantages of block-based and text-based coding languages.
3. Analyze the advantages and disadvantages of various text-based coding languages.

#### CSF.AP.7 The student will use search algorithms and sort algorithms.

1. Define the concept and role of a search algorithm.
2. Define the concept and role of a sort algorithm.
3. Compare and contrast bubble sort, quick sort, and merge sort.
4. Compare and contrast linear search and binary search.
5. Evaluate and determine the best search or sort algorithm to use based on intended results.

**CSF.AP.8 The student will work collaboratively in an iterative design process to solve problems, including peer review and feedback.**

* + 1. Identify project management frameworks and methodologies that emphasize iteration.
    2. Discuss the significance of communication and methods of communication when working collaboratively.
    3. Distribute roles and responsibilities and adhere to predetermined timeline and/or project scope.
    4. Collaboratively plan, design, and revise programs.
    5. Provide constructive feedback through peer review.
    6. Use project management tools to support collaboration.
    7. Justify and explain design choices, including constraints, and audiences.
    8. Reflect and discuss collaborative experience with team.

### Computing Systems (CSY)

#### CSF.CSY.1 The student will explain the use of abstraction to hide underlying implementation of computing systems embedded in everyday objects.

* 1. Provide real-world examples of abstraction in computing.
  2. Explain the role of abstraction to simplify complex systems.
  3. Identify and describe levels of abstraction between application software, system software, and hardware layers.

#### CSF.CSY.2 The student will illustrate how computers create visual representations.

1. Describe how computers receive visual data from various sensors and tools.
2. Describe image processing techniques to include filtering, segmentation, and feature extraction.
3. Explain how computers use pattern recognition and classify data to interpret and make decisions.
4. Discuss ethical considerations related to the use of visual data and computer vision technologies.

#### CSF.CSY.3 The student will illustrate how computers can use visual representations of the world to solve problems.

1. Describe the parts of a network diagram and how they are related.
2. Explain the relationship between nodes, links, and other components of graphs.
3. Explain how a computer can solve a maze, find a route on a map, and use reasoning to solve problems.

#### CSF.CSY.4 The student will describe and explain the methods in which computers learn through the use of machine learning.

1. Compare and contrast the learning process of humans and computers.
2. Identify mathematical models used by supervised learning to produce classifications and predictions.

### Cybersecurity (CYB)

#### CSF.CYB.1 The student will evaluate the methods of protecting data and computing systems, considering the context of the user and other stakeholders, with the level of cybersecurity risk.

1. Describe ways data and computing systems can be threatened by malware, ransomware, social engineering, phishing, and other cyberattacks.
2. Compare strategies to protect data and computing systems from malware, ransomware, social engineering, phishing, and other cyberattacks.

#### CSF.CYB.2 The student will identify and describe typical targets and perpetrators of cyberattacks.

1. Identify common targets and perpetrators of cyberattacks.
2. Identify ways data is automatically collected and generated that may or may not be evident to users.
3. Describe potential vulnerabilities when using publicly available networks.
4. Assess the impact of cyber threats on systems and people with diverse backgrounds, technical knowledge, or threat profiles.

#### CSF.CYB.3 The student will compare various security measures, considering tradeoffs between the usability and security of a computing system.

1. Evaluate tradeoffs between usability and security.
2. Analyze scenarios to determine tradeoffs between usability and security.
3. Propose recommendations for optimizing balance between usability and security in a given computing system.

### Data and Analysis (DA)

#### CSF.DA.1 The student will identify and explain specific examples of real-world problems that can be effectively addressed using data analysis.

1. Describe the types of data that business, industry, and government entities collect and maintain.
2. Identify privacy and consumer protection issues that impact data representation.
3. Identify real-world problems that can be addressed through data analysis.
4. Compare two real-world datasets to identify how the values of features are encoded and represented.
5. Formulate questions to decompose a problem and develop a data project plan.

#### CSF.DA.2 The student will evaluate data collection and storage practices, including their impact on the stakeholders involved.

1. Identify methods for collecting and storing data of different data sizes.
2. Evaluate the technical and ethical implications of collecting and storing data from the perspectives of users, programmers, companies, and communities.
3. Identify impacts of bias in data collection and storage practices.
4. Analyze the impact of data quality, quantity, diversity, and other factors on the accuracy and reliability of data visualizations.
5. Research emerging technologies that have the capability to construct reasoning from stakeholder data.

#### CSF.DA.3 The student will investigate data collection practices and the role of consent, transparency, and responsible data handling.

1. Evaluate the quality of training data: completeness, accuracy, consistency, and relevance.
2. Analyze and discuss the ethical implications and social and economic impact of training data choices.

**CSF.DA.4** **The student will differentiate between the use of training data and reasoning models.**

1. Explain the use of training data and the role it has in the development of machine learning models.
2. Explain the use of reasoning models and the role it has in the development of machine learning models.
3. Identify and discuss the similarities and differences between training data and reasoning models in artificial intelligence systems.

#### CSF.DA.5 The student will utilize data analysis to solve computational problems that make an impact and create solutions.

1. Formulate questions that require data collection.
2. Identify appropriate data to address predetermined question.
3. Define the stages of the data cycle and the interrelationship between each stage.
4. Identify and explain constraints of a data-driven approach.
5. Create a computational artifact of the data analysis results.

### Impacts of Computing (IC)

#### CSF.IC.1 The student will research and hypothesize the societal, environmental, and ethical impacts of present and future computing technologies.

1. Identify the societal impacts of computing technologies and the various aspects of daily life and industry.
2. Evaluate the effect of advances in information technology on the economy, environment, and ethics, including advancements of Artificial Intelligence (AI), quantum computing, and emerging technologies.
3. Examine the environmental impact of computing technologies.
4. Propose strategies to address the ethical impacts and potential challenges of computing technologies.

#### CSF.IC.2 The student will examine the impact of screen-related distractions on productivity.

1. Identify digital tools and applications designed to monitor or regulate screen time usage.
2. Evaluate the impact of screen time management on productivity and well-being.
3. Examine and discuss the impact of screen time and social media on academic or workplace performance.

#### CSF.IC.3 The student will identify historical advancements in computer science and their parallels with changes in society.

1. Examine correlations between historical developments in computing technologies and changes in society.
2. Appraise contributions of pioneers in the field of computer science.
3. Explore the impact of Moore’s Law on scientific and mathematical advancements.

#### CSF.IC.4 The student will explore computer science careers in Virginia and globally.

1. Research and explain the preparation and job outlook for computer science careers.
2. Examine current and future computer science career pathways involving emerging technologies.

### Networks and the Internet (NI)

#### CSF.NI.1 The student will model the transmission of data across computing networks and the Internet.

1. Identify the roles of computing devices: routers, switches, servers, and clients.
2. Explain the role of Internet protocols: Hypertext Transfer Protocol Secure (HTTPS) and Transmission Control Protocol/Internet Protocol (TCP/IP) to provide reliable and secure data.
3. Analyze and create network topology diagrams.
4. Model how computing devices communicate via networks using TCP/IP protocols.
5. Identify common problems that impact network functionality.
6. Identify solutions to resolve common network issues.