MOORESTOWN TOWNSHIP PUBLIC SCHOOLS
MOORESTOWN, NEW JERSEY

Moorestown High School
Mathematics

AP Computer Science Principles
Grades 10-12

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Course Description and Fundamental Concepts

The objective of this course is to prepare students for the Advanced Placement (AP) Computer Science Principles examination. It is an ambitious course designed to expose students to the essential ideas of computer science with a focus on how computing can impact the world. Along with the fundamentals of computing, students will learn to analyze data, information, or knowledge represented for computational use; create technology that has a practical impact; and gain a broader understanding of how computer science impacts people and society. The major areas of study in the AP Computer Science Principles course are organized around five big ideas, which are essential to studying computer science: Creative Development, Data, Algorithms and Programming, Computer Systems and Networks, and The Impact of Computing.

New Jersey Student Learning Standards (NJSLS)

Subject/Content Standards
Include grade appropriate subject/content standards that will be addressed

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8.1.12.CS Computing Systems

8.1.12.CS.1: Describe ways in which integrated systems hide underlying implementation details to simplify user experiences.

8.1.12.CS.2: Model interactions between application software, system software, and hardware.
8.1.12.CS.3: Compare the functions of application software, system software, and hardware.

8.1.12.CS.4: Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors

8.1.12.NI Networks and the Internet

8.1.12.NI.1: Evaluate the scalability and reliability of networks, by describing the relationship between routers, switches, servers, topology, and addressing.

8.1.12.NI.2: Evaluate security measures to address various common security threats.
8.1.12.NI.3: Explain how the needs of users and the sensitivity of data determine the level of security implemented.
8.1.12.NI.4: Explain how decisions on methods to protect data are influenced by whether the data is at rest, in transit, or in use.

8.1.12.IC Impacts of Computing

8.1.12.IC.1: Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.
8.1.12.IC.2: Test and refine computational artifacts to reduce bias and equity deficits.
8.1.12.IC.3: Predict the potential impacts and implications of emerging technologies on larger social, economic, and political structures, using evidence from credible sources.

8.1.12.DA Data and Analysis

8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.

8.1.12.DA.2: Describe the trade-offs in how and where data is organized and stored.
8.1.12.DA.3: Translate between decimal numbers and binary numbers.
8.1.12.DA.4: Explain the relationship between binary numbers and the storage and use of data in a computing device.

8.1.12.DA.5: Create data visualizations from large data sets to summarize,communicate,and support different interpretations of real-world phenomena.

8.1.12.DA.6: Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.

8.1.12.AP Algorithms and Programming

8.1.12.AP.1: Design algorithms to solve computational problems using a combination of original and existing algorithms.

8.1.12.AP.2: Create generalized computational solutions using collections instead of repeatedly using simple variables.

8.1.12.AP.3: Select and combine control structures for a specific application based upon performance and readability, and identify trade-offs to justify the choice.
8.1.12.AP.4: Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue.

8.1.12.AP.5: Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.
8.1.12.AP.6: Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs.

8.1.12.AP.7: Collaboratively design and develop programs and artifacts for broad audiences by incorporating feedback from users.
8.1.12.AP.8: Evaluate and refine computational artifacts to make them more usable and accessible.
8.1.12.AP.9: Collaboratively document and present design decisions in the development of complex programs.

8.2.12.ED Engineering Design

8.2.12.ED.1: Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.
8.2.12.ED.2: Create scaled engineering drawings for a new product or system and make modifications to increase optimization based on feedback.
8.2.12.ED.3: Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis.
8.2.12.ED.4: Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience.

8.2.12.ED.5: Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics).
8.2.12.ED.6: Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor).

8.2.12.ITH Interaction of Technology and Humans
8.2.12.ITH.1: Analyze a product to determine the impact that economic, political, social, and/or cultural factors have had on its design, including its design constraints.
8.2.12.ITH.2: Propose an innovation to meet future demands supported by an analysis of the potential costs, benefits, trade-offs, and risks related to the use of the innovation. 8.2.12.ITH.3: Analyze the impact that globalization, social media, and access to open source technologies has had on innovation and on a society's economy, politics, and culture.

8.2.12.NT Nature of Technology
8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product. 8.2.12.NT.2: Redesign an existing product to improve form or function.

8.2.12.ETW Effects of Technology on the Natural World
8.2.12.ETW.1: Evaluate ethical considerations regarding the sustainability of environmental resources that are used for the design, creation, and maintenance of a chosen product. 8.2.12.ETW.2: Synthesize and analyze data collected to monitor the effects of a technological product or system on the environment. 8.2.12.ETW.3: Identify a complex, global environmental or climate change issue, develop a systematic plan of investigation, and propose an innovative sustainable solution.

8.2.12.EC Ethics and Culture
8.2.12.EC.1: Analyze controversial technological issues and determine the degree to which individuals, businesses, and governments have an ethical role in decisions that are made. 8.2.12.EC.2: Assess the positive and negative impacts of emerging technologies on developing countries and evaluate how individuals, non-profit organizations, and governments have responded. 8.2.12.EC.3: Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience. 8.2.12.ETW.4: Research historical tensions between environmental and economic considerations as driven by human needs and wants in the development of a technological product and present the competing viewpoints.

N-RN The Real Number System
A. Extend the properties of exponents to rational exponents.
2. Rewrite expressions involving radicals and rational exponents using the properties of exponents.

N-Q Quantities
A. Reason quantitatively and use units to solve problems.

1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

2. Define appropriate quantities for the purpose of descriptive modeling.

3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

N-VM Vector and Matrix Quantities

B. Perform operations on vectors.

4. Add and subtract vectors.

a. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.

b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.

c. Understand vector subtraction $v - w$ as $v + (-w)$, where $-w$ is the additive inverse of w, with the same magnitude as w and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise.

5. Multiply a vector by a scalar.

a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as $c(v_x, v_y) = (cv_x, cv_y)$.

b. Compute the magnitude of a scalar multiple cv using $\|cv\| = |c|v$. Compute the direction of cv knowing that when $|c|v \neq 0$, the direction of cv is either along v (for $c > 0$) or against v (for $c < 0$).

C. Perform operations on matrices and use matrices in applications.

6. Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.

7. Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.

8. Add, subtract, and multiply matrices of appropriate dimensions.

A-SSE Seeing Structure in Expressions

A. Interpret the structure of expressions

1. Interpret expressions that represent a quantity in terms of its context.

a. Interpret parts of an expression, such as terms, factors, and coefficients.

b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret $P(1+r)^n$ as the product of P and a factor not depending on P

B. Write expressions in equivalent forms to solve problems

3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

c. Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15^t can be rewritten as $(1.15^{1/12})^{12t} \approx 1.012^{12t}$ to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

A-APR Arithmetic with Polynomials and Rational Expressions

A. Perform arithmetic operations on polynomials

1. Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.

C. Use polynomial identities to solve problems

5. Know and apply the Binomial Theorem for the expansion of $(x + y)^n$ in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle.

D. Rewrite rational expressions

6. Rewrite simple rational expressions in different forms; write $a(x)/b(x)$ in the form $q(x) + r(x)/b(x)$, where $a(x)$, $b(x)$, $q(x)$, and $r(x)$ are polynomials with the degree of $r(x)$ less than the degree of $b(x)$, using inspection, long division, or, for the more complicated examples, a computer algebra system.

A-CED Creating Equations

A. Create equations that describe numbers or relationships

1. Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.

2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.

A-REI Reasoning with Equations and Inequalities

A. Understand solving equations as a process of reasoning and explain the reasoning

1. Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

B. Solve equations and inequalities in one variable

3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

4. Solve quadratic equations in one variable.

F-IF Interpreting Functions

A. Understand the concept of a function and use function notation

1. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).

2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

B. Interpret functions that arise in applications in terms of the context

4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.

5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.

C. Analyze functions using different representations

8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

b. Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)^{12t}$, $y = (1.2)^{t/10}$, and classify them as representing exponential growth or decay.

9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

S-ID Interpreting Categorical and Quantitative Data

A. Summarize, represent, and interpret data on a single count or measurement variable

4. Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.

B. Summarize, represent, and interpret data on two categorical and quantitative variables

5. Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.

C. Interpret linear models

7. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

8. Compute (using technology) and interpret the correlation coefficient of a linear fit.

9. Distinguish between correlation and causation.

21st-Century Skills and Technology Integration (Standard 8)
List appropriate units below for which strands (A through F) will be addressed

Standard 8.1 (K-12)		Educational Technology: *All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.*
Unit Addressed	**Strand Letter**	**Standard Description**
Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	**Strand A**	**Technology Operations and Concepts:** *Students demonstrate a sound understanding of technology concepts, systems, and operations.*
Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	**Strand B**	**Creativity and Innovation:** *Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.*
Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	**Strand C**	**Communication and Collaboration:** *Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others.*
Units 1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	**Strand D**	**Digital Citizenship:** *Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior.*
Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	**Strand E**	**Research and Information Fluency:** *Students apply digital tools to gather, evaluate, and use information.*
Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	**Strand F**	**Critical thinking, problem-solving, and decision making:** *Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.*

Career Ready Practices ([Standard 9](#))
List appropriate units below for which CRPs will be addressed

Unit Addressed	Standard #	Standard Description
Unit 9	**CRP1**	*Act as a responsible and contributing citizen and employee.*
Units 1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	**CRP2**	*Apply appropriate academic and technical skills.*
	CRP3	*Attend to personal health and financial well-being.*
Unit 9	**CRP4**	*Communicate clearly and effectively and with reason.*
Unit 9	**CRP5**	*Consider the environmental, social and economic impacts of decisions.*
Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	**CRP6**	*Demonstrate creativity and innovation.*
Units 9	**CRP7**	*Employ valid and reliable research strategies.*
Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	**CRP8**	*Utilize critical thinking to make sense of problems and persevere in solving them.*
Unit 9	**CRP9**	*Model integrity, ethical leadership, and effective management.*
Unit 9	**CRP10**	*Plan education and career paths aligned to personal goals.*
Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	**CRP11**	*Use technology to enhance productivity.*
Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	**CRP12**	*Work productively in teams while using cultural global competence*

Visual & Performing Arts Integration (Standard 1)

List appropriate units below for which standards (1.1 through 1.4) may be addressed

Unit Addressed	Standard #	Standard Description
Unit 9	**Standard 1.1**	**The Creative Process:** *All students will demonstrate an understanding of the elements and principles that govern the creation of works of art in dance, music, theatre, and/or visual art.*
	Standard 1.2	**History of the Arts and Culture:** *All students will understand the role, development, and influence of the arts throughout history and across cultures.*
Unit 9	**Standard 1.3**	**Performing/Presenting/Producing:** *All students will synthesize those skills, media, methods, and technologies appropriate to creating, performing, and/or presenting works of art in dance, music, theatre, and/or visual art.*
Unit 9	**Standard 1.4**	**Aesthetic Responses & Critique Methodologies:** *All students will demonstrate and apply an understanding of arts philosophies, judgment, and analysis to works of art in dance, music, theatre, and/or visual art.*

Other Interdisciplinary Content Standards

List appropriate units below for any other content/standards that may be addressed

Unit Addressed	Content / Standard #	Standard Description
Unit 9	**WHST.9-12.2**	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
Unit 9	**WHST.9-12.7**	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Pacing Guide (All Dates are approximate based on the school calendar)

Unit/ Topic	Month (w/Approx number of Teaching Days)
UNIT 1 Ruby - Introduction **UNIT 2** Ruby - The Ruby Workbench	**September** (~19 days)
UNIT 3 Code Academy: Units 1-9	**October** (~19 days)
UNIT 4 Ruby - The Sieve of Eratosthenes	**November** (~16 days)
UNIT 5 Ruby - A Journey of a Thousand Miles	**December** (~15 days)
UNIT 6 Ruby - Divide and Conquer **UNIT 7** Ruby - When Words Collide	**January** (~18 days)
UNIT 8 Ruby - Bit by Bit	**February** (~18 days)
UNIT 9 Performance Task - Create **UNIT 10** Ruby - The War of the Words	**March** (~15-20 days)
UNIT 11 Ruby - Now for Something Completely Different	**April** (~15-20 days)
UNIT 12 Ruby - Ask Dr. Ruby **UNIT 13** Ruby - The Music of the Spheres	**May** (~18 days)
UNIT 14 Ruby - The Traveling Salesman	**June** (~15 days)

Units

Contact the Content Supervisor for unit details.