MATHEMATICS COURSE SYLLABUS

Course Title: Computer Programming in JAVA

Department: Mathematics

Primary Course Materials: JAVA Methods: Object Oriented Programming and Data Structures by Maria Litvin

Course Description: This is a yearlong course in Computer Science. Topics of study include algorithms, truth tables, binary, octal, and hexadecimal arithmetic, Boolean algebra and logic gates. The course covers Java language syntax and style, classes and interfaces, conditional and iterative statements, strings and arrays. The emphasis is on Object-Oriented Programming (OOP), searching and sorting algorithms, recursion, data structures, and the design and implementation of larger programs. Prerequisite: Advanced Algebra H2 or permission of the department.

Essential Questions: What features make Java Special?
- What do classes and methods do and why are they important to functional decomposition?
- How does an algorithm compare to a mathematical model in physics or engineering?
- What is recursion?
- What is the difference between style and syntax?
- What are arrays and how are they helpful?
- How does Java allow a program to read and write to the harddrive?
- How do we create software projects with GUI?

Course Objectives: To recognize the social and ethical implications of computer use.
To understand the basic hardware components of a computer and their function.
To design and implement solutions to problems by writing, running, and debugging computer programs.
To use and implement commonly used algorithms and data structures.
To develop and select appropriate algorithms and data structures to solve problems.
To code fluently in an object-oriented paradigm using the programming language Java, and to be able to use standard Java library classes.

Common Goals:

Thinking and Communicating

1) Read information critically to develop understanding of concepts, topics and issues.
2) Write clearly, factually, persuasively and creatively in Standard English.
3) Speak clearly, factually, persuasively and creatively in Standard English.
4) Use computers and other technologies to obtain, organize and communicate information and to solve problems.
5) Conduct research to interpret issues or solve complex problems using a variety of data and information sources.

Gain and Apply Knowledge in and across the Disciplines

6) Gain and Apply Knowledge in:
   a) Literature and Language
   b) Mathematics
   c) Science and Technology
   d) Social Studies, History and Geography
   e) Visual and Performing Arts
   f) Health and Physical Education
Work and Contribute

7) ☑ Demonstrate personal responsibility for planning one’s future academic and career options.
8) ☐ Participate in a school or community service activity.
9) ☑ Develop informed opinions about current economic, environmental, political and social issues affecting Massachusetts, the United States and the world and understand how citizens can participate in the political and legal system to affect improvements in these areas.

Learning Standards from the Massachusetts Curriculum Framework:

A chart is attached identifying which of the standards from the Massachusetts Curriculum Frameworks will be assessed in this course.

Additional Learning Objectives Beyond the Curriculum Framework:
Students will learn algorithm and program design in an Object-Oriented environment using Java.

Content Outline: The following is a content outline of the major topics covered in this course.

I. Object-Oriented Program Design
   A. Program Design
      1. Read and understand a problem description, purpose, and goals
      2. Apply data abstraction and encapsulation
      3. Read and understand class specifications and relationships
      4. Understand and implement a given class hierarchy
      5. Identify reusable components from existing code
   B. Class Design
      1. Design and implement a class
      2. Choose appropriate data representation and algorithms
      3. Apply functional decomposition
      4. Extend a given class using inheritance
   C. Java Library Classes
   D. Design as an Exam Topic

II. Program Implementation
   A. Implementation Techniques
      1. Methodology
   B. Programming Constructs
      1. Primitive types vs. Objects
      2. Declaration
      3. Console Output
      4. Control

III. Program Analysis
   A. Testing
      1. Test classes and libraries in isolation
      2. Identify boundary cases and generate appropriate test data
      3. Employ techniques such as using a debugger, adding extra output statement, or hand-tracing code
   B. Debugging
   C. Understand and modify existing code
   D. Extend existing code using inheritance
   E. Understand error handling
   F. Reason about programs
      1. Pre – and post – conditions
      2. Assertions
G. Analysis of algorithms
   1. Informal comparisons of running times
   2. Exact calculation of statement execution counts
H. Numerical representations and limits
   1. Representations of numbers in different bases
   2. Limitations of finite representations

IV. Standard Data Structures
A. Simple data types
B. Classes
C. Lists
D. Arrays

V. Standard Algorithms
A. Operations on data structures previously listed
   1. Traversals
   2. Insertions
   3. Deletions
B. Searching
   1. Sequential
   2. Binary
C. Sorting
   1. Selection
   2. Insertion
   3. Mergesort

VI. Computing in Context
A. System reliability
B. Privacy
C. Legal issues and intellectual property
D. Social and ethical ramifications of computer use
### Major Evaluation Strategies:

<table>
<thead>
<tr>
<th>Name of Assessment</th>
<th>Type of Assessment</th>
<th>Common Goals Assessed</th>
<th>Standards Assessed</th>
<th>Other Objectives Assessed</th>
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Learning Standards from the Massachusetts Curriculum Framework:
Learning Standards for Grades 5-6

**NUMBER SENSE AND OPERATIONS**
Understand numbers, ways of representing numbers, relationships among numbers, and number systems
Understand meanings of operations and how they relate to one another
Compute fluently and make reasonable estimates

*Students engage in problem solving, communicating, reasoning, connecting, and representing as they:*

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
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<tbody>
<tr>
<td>6.N.1</td>
<td>Demonstrate an understanding of positive integer exponents, in particular, when used in powers of ten, e.g., 102, 105.</td>
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<tr>
<td>6.N.2</td>
<td>Demonstrate an understanding of place value to billions and thousandths.</td>
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<tr>
<td>6.N.3</td>
<td>Represent and compare very large (billions) and very small (thousandths) positive numbers in various forms such as expanded notation without exponents, e.g., 9,724 = 9 (\times) 1000 + 7 (\times) 100 + 2 (\times) 10 + 4.</td>
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<td>6.N.4</td>
<td>Demonstrate an understanding of fractions as a ratio of whole numbers, as parts of unit wholes, as parts of a collection, and as locations on the number line.</td>
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<td>6.N.5</td>
<td>Identify and determine common equivalent fractions, mixed numbers, decimals, and percents.</td>
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<td>6.N.6</td>
<td>Find and position integers, fractions, mixed numbers, and decimals (both positive and negative) on the number line.</td>
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<tr>
<td>6.N.7</td>
<td>Compare and order integers (including negative integers), and positive fractions, mixed numbers, decimals, and percents.</td>
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<tr>
<td>6.N.8</td>
<td>Apply number theory concepts—including prime and composite numbers, prime factorization, greatest common factor, least common multiple, and divisibility rules for 2, 3, 4, 5, 6, 9, and 10—to the solution of problems.</td>
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<td>6.N.9</td>
<td>Select and use appropriate operations to solve problems involving addition, subtraction, multiplication, division, and positive integer exponents with whole numbers, and with positive fractions, mixed numbers, decimals, and percents.</td>
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<td>6.N.10</td>
<td>Use the number line to model addition and subtraction of integers, with the exception of subtracting negative integers.</td>
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<td>6.N.11</td>
<td>Apply the Order of Operations for expressions involving addition, subtraction, multiplication, and division with grouping symbols (+, −, ×, ÷).</td>
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<td>6.N.12</td>
<td>Demonstrate an understanding of the inverse relationship of addition and subtraction, and use that understanding to simplify computation and solve problems.</td>
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<td>6.N.13</td>
<td>Accurately and efficiently add, subtract, multiply, and divide (with double-digit divisors) whole numbers and positive decimals.</td>
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<tr>
<td>6.N.14</td>
<td>Accurately and efficiently add, subtract, multiply, and divide positive fractions and mixed numbers. Simplify fractions.</td>
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<tr>
<td>6.N.15</td>
<td>Add and subtract integers, with the exception of subtracting negative integers.</td>
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<tr>
<td>6.N.16</td>
<td>Estimate results of computations with whole numbers, and with positive fractions, mixed numbers, decimals, and percents. Describe reasonableness of estimates.</td>
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</table>
PATTERNS, RELATIONS, AND ALGEBRA
Understand patterns, relations, and functions
Represent and analyze mathematical situations and structures using algebraic symbols
Use mathematical models to represent and understand quantitative relationships
Analyze change in various contexts

Students engage in problem solving, communicating, reasoning, connecting, and representing as they:

- 6.P.1 Analyze and determine the rules for extending symbolic, arithmetic, and geometric patterns and progressions, e.g., ABBCCC; 1, 5, 9, 13...; 3, 9, 27....

- 6.P.2 Replace variables with given values and evaluate/simplify, e.g., 2(m) + 3 when m = 4, 1

- 6.P.3 Use the properties of equality to solve problems, e.g., if n + 7 = 13, then n = 13 – 7, therefore n = 6; if 3 ∥ n = 15, then 1/3 ∥ 3 ∥ n = 1/3 ∥ 15, therefore n = 5.1

- 6.P.4 Represent real situations and mathematical relationships with concrete models, tables, graphs, and rules in words and with symbols, e.g., input-output tables.


- 6.P.6 Produce and interpret graphs that represent the relationship between two variables in everyday situations.

- 6.P.7 Identify and describe relationships between two variables with a constant rate of change. Contrast these with relationships where the rate of change is not constant.

GEOMETRY
Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships
Specify locations and describe spatial relationships using coordinate geometry and other representational systems
Apply transformations and use symmetry to analyze mathematical situations
Use visualization, spatial reasoning, and geometric modeling to solve problems

Students engage in problem solving, communicating, reasoning, connecting, and representing as they:

- 6.G.1 Identify polygons based on their properties, including types of interior angles, perpendicular or parallel sides, and congruence of sides, e.g., squares, rectangles, rhombuses, parallelograms, trapezoids, and isosceles, equilateral, and right triangles.

- 6.G.2 Identify three-dimensional shapes (e.g., cubes, prisms, spheres, cones, and pyramids) based on their properties, such as edges and faces.

- 6.G.3 Identify relationships among points, lines, and planes, e.g., intersecting, parallel, perpendicular.

- 6.G.4 *Graph points and identify coordinates of points on the Cartesian coordinate plane (all four quadrants).

- 6.G.5 Find the distance between two points on horizontal or vertical number lines.

- 6.G.6 Predict, describe, and perform transformations on two-dimensional shapes, e.g., translations, rotations, and reflections.

- 6.G.7 Identify types of symmetry, including line and rotational.

- 6.G.8 Determine if two shapes are congruent by measuring sides or a combination of sides and angles, as necessary; or by motions or series of motions, e.g., translations, rotations, and reflections.

- 6.G.9 Match three-dimensional objects and their two-dimensional representations, e.g., nets, projections, and perspective drawings.

*Although this standard is important and appropriate for this grade span, it will not be included in the state assessment program at the 5–6 grade span at the present time.
## MEASUREMENT
Understand measurable attributes of objects and the units, systems, and processes of measurement
Apply appropriate techniques, tools, and formulas to determine measurements

**Students engage in problem solving, communicating, reasoning, connecting, and representing as they:**

<table>
<thead>
<tr>
<th>6.M.1</th>
<th>Apply the concepts of perimeter and area to the solution of problems. Apply formulas where appropriate.</th>
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<tr>
<td>6.M.2</td>
<td>Identify measure, describe, classify, and construct various angles, triangles, and quadrilaterals.</td>
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<tr>
<td>6.M.3</td>
<td>Solve problems involving proportional relationships and units of measurement, e.g., same system unit conversions, scale models, maps, and speed.</td>
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<tr>
<td>6.M.4</td>
<td>Find areas of triangles and parallelograms. Recognize that shapes with the same number of sides but different appearances can have the same area. Develop strategies to find the area of more complex shapes.</td>
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<tr>
<td>6.M.5</td>
<td>Identify, measure, and describe circles and the relationships of the radius, diameter, circumference, and area (e.g., d = 2r, p = C/d), and use the concepts to solve problems</td>
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<tr>
<td>6.M.6</td>
<td>Find volumes and surface areas of rectangular prisms.</td>
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<tr>
<td>6.M.7</td>
<td>Find the sum of the angles in simple polygons (up to eight sides) with and without measuring the angles.</td>
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## DATA ANALYSIS, STATISTICS, AND PROBABILITY
Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them
Select and use appropriate statistical methods to analyze data
Develop and evaluate inferences and predictions that are based on data
Understand and apply basic concepts of probability

**Students engage in problem solving, communicating, reasoning, connecting, and representing as they:**

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<tr>
<th>6.D.1</th>
<th>Describe and compare data sets using the concepts of median, mean, mode, maximum and minimum, and range.</th>
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<tr>
<td>6.D.2</td>
<td>Construct and interpret stem-and-leaf plots, line plots, and circle graphs.</td>
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<td>6.D.3</td>
<td>Use tree diagrams and other models (e.g., lists and tables) to represent possible or actual outcomes of trials. Analyze the outcomes.</td>
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<td>6.D.4</td>
<td>Predict the probability of outcomes of simple experiments (e.g., tossing a coin, rolling a die) and test the predictions. Use appropriate ratios between 0 and 1 to represent the probability of the outcome and associate the probability with the likelihood of the event.</td>
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