Georgia Mathematics

Differential Equations

Mathematical Practices

0 Display perseverance and patience in problem-solving. Demonstrate skills and strategies needed to succeed in mathematics, including critical thinking, reasoning, and effective collaboration and expression. Seek help and apply feedback. Set and monitor goals. DE.MP

- 0.1 Make sense of problems and persevere in solving them. DE.MP.1
- 0.2 Reason abstractly and quantitatively. DE.MP.2
- 0.3 Construct viable arguments and critique the reasoning of others. DE.MP.3
- 0.4 Model with mathematics. DE.MP.4
- 0.5 Use appropriate tools strategically. DE.MP.5
- 0.6 Attend to precision. DE.MP.6
- 0.7 Look for and make use of structure. DE.MP.7
- 0.8 Look for and express regularity in repeated reasoning. DE.MP.8

Mathematical Modeling

1 Apply mathematics to real-life situations; model real-life phenomena using mathematics. DE.MM.1

- 1.1 Explain contextual, mathematical problems using a mathematical model. DE.MM.1.1
- 1.2 Create mathematical models to explain phenomena that exist in the natural sciences, social sciences, liberal arts, fine and performing arts, and/or humanities contexts. DE.MM.1.2
- 1.3 Using abstract and quantitative reasoning, make decisions about information and data from a contextual situation. DE.MM.1.3
- 1.4 Use various mathematical representations and structures with this information to represent and solve real-life problems. DE.MM.1.4

Abstract Reasoning

2 Solve contextual, mathematical problems involving first-order differential equations to explain real-life phenomena. DE.AR.2

- 2.1 Classify differential equations by order and linearity. DE.AR.2.1
- 2.2 Solve separable differential equations for general solutions and initial value problems. DE.AR.2.2
- 2.3 Solve first-order linear differential equations and initial value problems using integrating factors. DE.AR.2.3

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2.4 Use modeling or numerical methods to approximate solutions of first-order differential equations in context. DE.AR.2.4

2.5 Draw direction fields containing solutions curves for first-order differential equations by hand and using modeling. DE.AR.2.5

2.6 Solve first-order linear differential equations that apply to various real-world models including falling bodies, mixtures, population and the logistic equation, continuously compounded interest, and other physics applications. DE.AR.2.6

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3 Solve contextual, mathematical problems involving second and higher order differential equations to explain real-life phenomena. DE.AR.3

3.1 Determine whether a first- or second-order differential equation has a unique solution over a given interval by applying the Existence and Uniqueness Theorem. DE.AR.3.1

3.2 Solve second-order linear homogeneous and non-homogeneous differential equations by finding characteristic equations, using the method of undetermined coefficients and variation of parameters. DE.AR.3.2

3.3 Solve second-order differential equations that apply to various real-world models. DE.AR.3.3

3.4 Use vector function notation when discussing the structure of solution sets for homogeneous systems as it pertains to the Wronskian. DE.AR.3.4

3.5 Determine the existence and uniqueness of solutions for second-order linear differential equations, determine a fundamental set of solutions, and verify that two solutions form a fundamental set by taking the Wronskian. DE.AR.3.5

3.6 Determine the structure of solution set to higher-order differential equations, apply the basic Existence and Uniqueness Theorem to higher-order differential equations, and use the generalizations of the Wronksian for higher order differential equations. DE.AR.3.6

3.7 Solve higher-order constant coefficient homogeneous differential equations. DE.AR.3.7

3.8 Solve special case non-homogeneous second order ordinary differential equations including Cauchy-Euler Equations. DE.AR.3.8

3.9 Find a second linearly dependent solution using reduction of order when given a solution to a non-homogeneous second-order differential equation. DE.AR.3.9

3.10 Determine ordinary points, recurrence relations, and change the index as they relate to series solutions to ordinary differential equations. DE.AR.3.10

3.11 Find series solutions to first and second-order non-linear initial value problems. DE.AR.3.11

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4 Solve contextual, mathematical problems involving systems of differential equations to explain real-life phenomena. DE.AR.4

4.1 Determine whether a contextual situation results in a system of differential equations and apply the basic existence and uniqueness results for the corresponding initial value problems. DE.AR.4.1

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4.2 Solve constant coefficient homogeneous systems using eigenvalues and eigenvectors. Solve systems with real, distinct eigenvalues, as well as those with repeated and imaginary eigenvalues. DE.AR.4.2

4.3 Draw phase portraits for solutions of homogeneous systems with constant coefficients. DE.AR.4.3

4.4 Solve non-homogeneous systems of ordinary differential equations using the method of undetermined coefficients and variation of parameters. DE.AR.4.4

4.5 Determine which non-linear systems are locally linear and identify the behavior of the system about each critical point. DE.AR.4.5

4.6 Plot locally linear systems. DE.AR.4.6

4.7 Use population models derived from locally linear systems. DE.AR.4.7

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5 Solve contextual, mathematical problems using Laplace transforms to explain real-life phenomena. DE.AR.5

5.1 Use the integral definition to perform Laplace transforms for functions. DE.AR.5.1

5.2 Use a Laplace table to accurately and efficiently identify Laplace transforms. DE.AR.5.2

5.3 Perform inverse Laplace transforms using a variety of techniques. DE.AR.5.3

5.4 Solve first- and second-order differential equations using Laplace transforms that apply to fields such as electrical and mechanical engineering. DE.AR.5.4

5.5 Write piecewise functions as compositions of step (Heaviside) functions. DE.AR.5.5

5.6 Find the general uniqueness and existence of solutions for step functions, and use Laplace transforms to find solutions to step functions. DE.AR.5.6

5.7 Find the Laplace transform of the Dirac delta function. DE.AR.5.7

5.8 Solve linear systems of differential equations using Laplace transforms. DE.AR.5.8