Georgia Mathematics

Engineering Calculus

Adopted 2021

Mathematical Practices

MP. 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. Code Expectation EC.MP

1. **Make sense of problems and persevere in solving them.** EC.MP.1
2. **Reason abstractly and quantitatively.** EC.MP.2
3. **Construct viable arguments and critique the reasoning of others.** EC.MP.3
4. **Model with mathematics.** EC.MP.4
5. **Use appropriate tools strategically.** EC.MP.5
6. **Attend to precision.** EC.MP.6
7. **Look for and make use of structure.** EC.MP.7
8. **Look for and express regularity in repeated reasoning.** EC.MP.8

Mathematical Modeling

1. **Apply mathematics to real-life situations; model real-life phenomena using mathematics.** EC.MM.1
    1. Explain contextual, mathematical problems using a mathematical model. EC.MM.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. EC.MM.1.2
    3. Using abstract and quantitative reasoning, make decisions about information and data from a contextual situation. EC.MM.1.3
    4. Use various mathematical representations and structures with this information to represent and solve real-life problems. EC.MM.1.4

Abstract Reasoning – Impact of Engineering in Mathematics

2. **Using the engineering design process, apply mathematical concepts and procedures to solve problems in engineering contexts and research the impact of engineering and technological advancement on mathematics and society.** EC.AR.2
    1. Build new mathematical knowledge through problem solving that involves the engineering design process. EC.AR.2.1
    2. Solve problems that arise in mathematics and in engineering contexts. EC.AR.2.2
    3. Apply and adapt a variety of appropriate strategies to solve problems. EC.AR.2.3
    4. Use visual and written communication to organize, record, and articulate coherent, mathematical thinking and to express basic design elements. EC.AR.2.4
    5. Monitor and reflect on the process of mathematical problem solving and interpret solutions that arise in engineering contexts. EC.AR.2.5
    6. Produce multiple representations for mathematics presented in engineering contexts. EC.AR.2.6
    7. Select, apply, and translate among mathematical representations to solve problems that arise in engineering contexts. EC.AR.2.7
    8. Use mathematical representations to model and interpret physical and engineering phenomena. EC.AR.2.8
    9. Demonstrate fundamentals of technical sketching using computer-generated visuals in appropriate mathematical scaling. EC.AR.2.9
    10. Present a technical design, using computer-generated model, for an assigned design project utilizing the appropriate scientific units (US standards and SI units). EC.AR.2.10
    11. Use connections among mathematics, technology, and engineering in contextual situations. EC.AR.2.11
    13. Describe the issues of necessity that have influenced innovation and technological development. EC.AR.2.13
    14. Explain the impact of key persons and historical events and their impact on engineering and society. EC.AR.2.14
    15. Investigate the educational requirements and professional expectations associated with engineering career paths. EC.AR.2.15

Abstract Reasoning – Algebra in Engineering

3. **Using the engineering design process, express spatial and functional relationships with vectors, functions, and analytic geometry in three dimensions, and use these relationships to solve real-life, mathematical problems and to explain engineering-based phenomena.** EC.AR.3
    1. Determine the equations of lines and surfaces using vectors and 3D graphing. EC.AR.3.1
    2. Apply dot and cross products of vectors to express equations of planes, parallelism, perpendicularity, angles. EC.AR.3.2
    3. Describe the role of vectors in engineering applications, such as modeling the velocity of moving objects or static forces on structures and objects. EC.AR.3.3
    4. Evaluate matrices and apply their properties to solve problems expressed as matrix equations. EC.AR.3.4
    5. Compute limits of scalar and vector-valued functions. EC.AR.3.5
    6. Identify and graph level curves of multivariate functions. EC.AR.3.6
    7. Find the regions of continuity of multivariate functions. EC.AR.3.7

Abstract Reasoning – Partial Differentiation in Engineering

4. **Define, describe, and represent the differentiation of functions of two independent variables and differential vectors to solve contextual, mathematical problems and to explain engineering-based phenomena.** EC.AR.4
    1. Compute the first and second partial derivatives of a function. EC.AR.4.1
    2. Use the general chain rule to determine the partial derivatives of composite functions. EC.AR.4.2
    3. Compute and apply the gradient of multivariable functions. EC.AR.4.3
    4. Solve engineering optimization problems by applying partial differentiation or Lagrange multipliers. EC.AR.4.4
    5. Utilize partial derivatives in developing the appropriate system balances in engineering problems. EC.AR.4.5

Abstract Reasoning – Integration in Engineering

5. **Interpret integrals of functions of two independent variables and of vector functions to solve contextual, mathematical problems and to explain engineering-based phenomena.** EC.AR.5
    1. Manipulate integrals by changing the order of integration, introducing variable substitutions, or changing to curvilinear coordinates. EC.AR.5.1
    2. Evaluate and apply line integrals that are independent of path. EC.AR.5.2
    3. Apply properties of integrals to calculate and represent area, volume, or mass. EC.AR.5.3
    4. Use integrals of vectors to define and apply the gradient, divergence, and the curl. EC.AR.5.4
    5. Interpret the theorems of Green, Stokes, and Gauss and apply them to the study of real-world phenomena. EC.AR.5.5