Alabama Science, Technology, Engineering, and Mathematics (STEM)

# Grades 11, 12

Adopted 2020

## Foundations of Engineering and Technology

1. **Incorporate safety procedures in handling, operating, and maintaining tools and machinery; handling materials; utilizing personal protective equipment; maintaining a safe work area; and following protocols for fire and electrical safety.** FET.FS.1

2. **Demonstrate effective workplace and employability skills, including communication, awareness of diversity, positive work ethic, problem-solving, time management, and teamwork.** FET.FS.2

3. **Explore the range of careers available in the field and investigate their educational requirements, and demonstrate job-seeking skills including resume-writing and interviewing.** FET.FS.3

4. **Demonstrate digital literacy by using digital and electronic tools appropriately, safely, and ethically.** FET.FS.4

5. **Participate in a Career and Technical Student Organization (CTSO) to increase knowledge and skills and to enhance leadership and teamwork.** FET.FS.5

1. **Describe and follow appropriate safety and health procedures for engineering classroom and laboratory situations.** FET.1

   a. Utilize tools and equipment safely. FET.1.A

   b. Identify environmental safety requirements for specific applications. FET.1.B

2. **Exhibit essential skills required by business and industry in the engineering field.** FET.2

   a. Communicate effectively through writing, speaking, listening, and reading. FET.2.A

   b. Show appropriate interpersonal skills, punctuality, work habits, ethical behavior, and work-appropriate attire. FET.2.B

   c. Create a resume and digital portfolio and participate in a mock interview. FET.2.C

3. **Connect leadership and teamwork skills from CTSO activities with engineering practices.** FET.3
   a. Use standard technical knowledge and skills during CTSO activities. FET.3.A
   b. Exhibit leadership and teamwork skills. FET.3.B
   c. Demonstrate effective collaboration in a diverse group to define and solve engineering problems. FET.3.C

4. **Compare and investigate various aspects of jobs in STEM disciplines and the engineering field, including education requirements, job responsibilities, and potential earnings.** FET.4
   a. Investigate current and future engineering job opportunities. FET.4.A
   b. Analyze positive and negative impacts of engineering on society. FET.4.B
   c. Critique significant contributions of leaders in engineering fields. FET.4.C
   d. Differentiate among engineering, technology, and science. FET.4.D
   e. Identify and discuss the various tools utilized by individuals in STEM disciplines, including engineering. FET.4.E

5. **Apply standard engineering practices and skills to solve problems.** FET.5
   a. Use a variety of appropriate tools throughout the engineering design process. FET.5.A
   b. Present a research-based solution to an engineering problem in a professional manner. FET.5.B
   c. Use terminology and vocabulary relevant to the field of engineering. FET.5.C

6. **Cite evidence and document the steps in an engineering design process.** FET.6
   a. Construct an engineering notebook based upon industry standard best practices. FET.6.A
   b. Display clear standard technical knowledge and skills when categorizing and classifying engineering practices. FET.6.B
   c. Record ideas, sketches, calculations, observations, and summaries of activities. FET.6.C
   d. Compare and contrast the methods of creating written and digital portfolios. FET.6.D

7. **Demonstrate the use of analog and digital precision measuring instruments utilized in engineering.** FET.7
   a. Compare and convert between customary and metric measurement systems. FET.7.A
   b. Apply conversion factors of customary and metric measurements. FET.7.B
   c. Perform measurements using significant digits. FET.7.C

8. **Create basic engineering drawings, including sketches and computer-aided designs (CAD).** FET.8
    a. Produce multi-view sketches and drawings. FET.8.A
    b. Create two-dimensional and three-dimensional appropriate sketches. FET.8.B
9. **Differentiate among components of engineering drawings.** FET.9
10. **Create models and prototypes using CAD techniques and/or appropriate manufacturing tools.** FET.10
11. **Utilize real-world STEM principles to investigate a variety of engineering disciplines.** FET.11
    a. Research and investigate engineering challenges in today's world. FET.11.A
    b. Apply the systems model of input, process, output, feedback, and impact to the engineering design process. FET.11.B
    c. Analyze an engineering design brief. FET.11.C
    d. Collaborate with team members to observe, identify, and modify individual solutions to engineering problems. FET.11.D
    e. Design and/or test a prototype using an engineering design process. FET.11.E
12. **Generate code to solve challenges using appropriate languages.** FET.12

**Applications of Engineering and Technology**

1. **Incorporate safety procedures in handling, operating, and maintaining tools and machinery; handling materials; utilizing personal protective equipment; maintaining a safe work area; and following protocols for fire and electrical safety.** AET.FS.1
2. **Demonstrate effective workplace and employability skills, including communication, awareness of diversity, positive work ethic, problem-solving, time management, and teamwork.** AET.FS.2
3. **Explore the range of careers available in the field and investigate their educational requirements, and demonstrate job-seeking skills including resume-writing and interviewing.** AET.FS.3
4. **Demonstrate digital literacy by using digital and electronic tools appropriately, safely, and ethically.** AET.FS.4
5. **Participate in a Career and Technical Student Organization (CTSO) to increase knowledge and skills and to enhance leadership and teamwork.** AET.FS.5
1. **Apply the design process to problems that can be solved using methods of engineering.** AET.1
2. **Create a project scope which includes, but is not limited to, a Gantt chart, a budget, and a materials list.** AET.2

3. **Design, create, test, and perform calculations on simple machines, gear trains, and sprockets.** AET.3

4. **Investigate the application of multiple energy sources to a variety of systems.** AET.4

5. **Describe the features of and explain the differences between series and parallel circuits.** AET.5

    a. Use Ohms Law to calculate current, voltage, resistance, and power in series and parallel circuits. AET.5.A

6. **Use a multimeter to measure current, voltage, and/or resistance to diagnose and correct problems within a series or parallel circuit.** AET.6

7. **Analyze properties and functionalities of communication technologies.** AET.7

8. **Analyze properties and functionalities of laser and fiber optic technologies.** AET.8

9. **Calculate unknown forces using vectors.** AET.9

    a. Construct free-body diagrams. AET.9.A

    b. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes. AET.9.B

10. **Calculate weight, density, mass, volume, and surface area of common items.** AET.10

11. **Design, create, test, and perform calculations on structural members using real models and computerized simulations.** AET.11

12. **Use 3D modeling software to examine properties and functionality of objects.** AET.12

13. **Design, create, and test fluid power devices powered by hydraulics and pneumatics.** AET.13

    a. Use appropriate vocabulary to identify components of hydraulic and pneumatic systems. AET.13.A

    b. Solve for unknown values using established fluid laws. AET.13.B

14. **Use current programming languages to complete computer-based tasks.** AET.14

15. **Construct the five-number summary for a set of data.** AET.15

    a. Perform measures of central tendency, variance, and standard deviation. AET.15.A

    b. Use the normal curve, when appropriate, to compute probabilities concerning a data set, and relate the normal curve to applications of quality control in manufacturing. AET.15.B

16. **Calculate the probability of single, sequential, and simultaneous events if they are independent, dependent, mutually exclusive and non-mutually exclusive, using tools such as tables and trees and implementing logical operators such as and, or, and not.** AET.16

17. **Solve problems involving linear motion, projectiles, and objects in free-fall using kinematics.** AET.17

    a. Design, create, and test a mechanism to launch a projectile in the field. AET.17.A

    b. Analyze mathematically relevant components of a parabola. AET.17.B

**Capstone of Engineering and Technology**

1. **Incorporate safety procedures in handling, operating, and maintaining tools and machinery; handling materials; utilizing personal protective equipment; maintaining a safe work area; and following protocols for fire and electrical safety.** CET.FS.1

2. **Demonstrate effective workplace and employability skills, including communication, awareness of diversity, positive work ethic, problem-solving, time management, and teamwork.** CET.FS.2

3. **Explore the range of careers available in the field and investigate their educational requirements, and demonstrate job-seeking skills including resume-writing and interviewing.** CET.FS.3

4. **Demonstrate digital literacy by using digital and electronic tools appropriately, safely, and ethically.** CET.FS.4

5. **Participate in a Career and Technical Student Organization (CTSO) to increase knowledge and skills and to enhance leadership and teamwork.** CET.FS.5

1. **Research and explain professional, legal, and ethical responsibilities in the field of engineering, including the need for a diverse, equitable, and inclusive workforce.** CET.1

2. **Use industry standard best practices to document observations, ideas, sketches, calculations, and summaries of activities pertaining to the capstone project in an engineering notebook.** CET.2

3. **Conduct independent technological research throughout the process of an engineering project.** CET.3

    a. Investigate past and current engineering practices related to an engineering project to develop a solution to a problem. CET.3.A

    b. Analyze research and draw conclusions to apply to problems in an engineering project. CET.3.B

4. **Create a formal, narrative proposal for a rigorous and relevant project in the field of engineering.** CET.4
    a. Apply concepts of an engineering design process to a project in the field of engineering. CET.4.A
    b. Describe design constraints, criteria, and trade-offs for a project in the field of engineering in regard to a variety of conditions. CET.4.B
    c. Use an engineering design brief to assist in the creation of a proposal. CET.4.C
    d. Communicate ideas clearly using effective writing practices in a project in the field of engineering. CET.4.D
5. **Apply appropriate design methodologies by using various computer-aided design (CAD) programs to produce plans, diagrams, and working drawings for the construction of models, prototypes, and final products.** CET.5
6. **Demonstrate proper use and selection of tools, materials, procedures, and equipment in the construction of models, prototypes, and final products.** CET.6
7. **Create a report explaining the engineering project, using industry-recognized guidelines to describe it from initiation to completion.** CET.7
8. **Design and present a multimedia presentation describing the capstone project to an appropriate audience.** CET.8
9. **Construct a project portfolio that incorporates all project-related documentation, including the project proposal, research, engineering design notebook, project report, and presentation documentation.** CET.9

**Computer Engineering and Technology**

1. **Incorporate safety procedures in handling, operating, and maintaining tools and machinery; handling materials; utilizing personal protective equipment; maintaining a safe work area; and following protocols for fire and electrical safety.** CPET.FS.1
2. **Demonstrate effective workplace and employability skills, including communication, awareness of diversity, positive work ethic, problem-solving, time management, and teamwork.** CPET.FS.2
3. **Explore the range of careers available in the field and investigate their educational requirements, and demonstrate job-seeking skills including resume-writing and interviewing.** CPET.FS.3
4. **Demonstrate digital literacy by using digital and electronic tools appropriately, safely, and ethically.** CPET.FS.4
5. **Participate in a Career and Technical Student Organization (CTSO) to increase knowledge and skills and to enhance leadership and teamwork.** CPET.FS.5

1. **Analyze the various software development methodologies and describe the pros and cons of each one.** CPET.1
2. **Collect, document, and decompose all requirements for the completed software system.** CPET.2
3. **Identify characteristics of a sound financial model to ensure a project can be developed within the projected budget.** CPET.3
4. **Analyze various infrastructure options including cloud and in-house hosting for the product.** CPET.4
5. **Describe software architecture within applications that makes them vulnerable to cyber-attacks.** CPET.5
    a. Design strategies to counter possible threats to software security. CPET.5.A
6. **Develop configuration management plans and analyze technologies to manage all work products in designing software.** CPET.6
7. **Implement scheduling techniques that will ensure adequate time and resources are allocated to deliver a software project on schedule and on budget.** CPET.7
8. **Develop metrics and procedures that will ensure all requirements are fully implemented to customer's quality standards.** CPET.8
9. **Analyze various testing strategies and design test procedures to ensure desired functionality of software products.** CPET.9
10. **Develop strategies for deploying end products to consumers.** CPET.10
11. **Describe methodologies for tracking defects and planning bug-fix releases.** CPET.11

**Environmental Engineering**

1. **Incorporate safety procedures in handling, operating, and maintaining tools and machinery; handling materials; utilizing personal protective equipment; maintaining a safe work area; and following protocols for fire and electrical safety.** EE.FS.1
2. **Demonstrate effective workplace and employability skills, including communication, awareness of diversity, positive work ethic, problem-solving, time management, and teamwork.** EE.FS.2
3. **Explore the range of careers available in the field and investigate their educational requirements, and demonstrate job-seeking skills including resume-writing and interviewing.** EE.FS.3
4. **Demonstrate digital literacy by using digital and electronic tools appropriately, safely, and ethically.** EE.FS.4

5. **Participate in a Career and Technical Student Organization (CTSO) to increase knowledge and skills and to enhance leadership and teamwork.** EE.FS.5

1. **Examine environmental and physical factors related to safe drinking water.** EE.1
    a. Analyze the relationship between population growth and water resources. EE.1.A
    b. Obtain, evaluate, and share information on ways human health is affected by the quality of drinking water sources. EE.1.B
    c. List the characteristics of clean water. EE.1.C
    d. Explain why clean water is necessary for survival. EE.1.D
    e. Describe common sources of drinking water contamination. EE.1.E

2. **Identify appropriate wastewater treatment processes and designs to eliminate common wastewater contaminants.** EE.2
    a. Explain how water quality is quantitatively measured using chemically and/or biologically based testing processes. EE.2.A
    b. Outline the stages of sewage water treatment used in treatment facilities. EE.2.B
    c. Explain how water treatment plants remove nitrates from contaminated water. EE.2.C
    d. Use an engineering design process to create a water filtration system. EE.2.D
    e. Design and conduct a scientific experiment to test a variable affecting bacteria's ability to decompose oil. EE.2.E

3. **Describe applications that engineers use to manipulate DNA to improve the quality, quantity, and reliability of food resources.** EE.3
    a. Analyze environmentally and socially sustainable and unsustainable food production methods. EE.3.A
    b. Research the meaning and importance of food security. EE.3.B
    c. Describe the structure and function of DNA. EE.3.C
    d. Apply scientific techniques used in molecular biology to observe and/or experiment with plants, analyze results, and create plans that might increase the quality and quantity of food crops. EE.3.D
    e. Justify an argument for or against the use of genetic recombination methods as a means of improving food security. EE.3.E

4. **Analyze how engineers maximize the use and efficiency of renewable fuels and use results of the analysis to design alternative fuel sources.** EE.4
    a. Demonstrate a working knowledge of various sources of energy and their environmental and economic impacts. EE.4.A
    b. Apply stoichiometric principles to the process of photosynthesis to predict and compare the experimental results of oxygen/carbon dioxide production and consumption. EE.4.B
    c. Conduct simulations of real-world situations to predict possible solutions. EE.4.C
    d. Debate the positive and negative aspects of using algae and biological free stocks as a fuel source. EE.4.D
    e. Demonstrate efficient fuel production methods from renewable sources. EE.4.E
    f. Plan various upstream and downstream processing methods to design an effective biofuels manufacturing plant. EE.4.F
5. **Use professional engineering skills and knowledge to pursue opportunities and create sustainable solutions to improve and enhance the quality of life of individuals and society.** EE.5
    a. Explain the educational, professional, and technical skills required for professional engineering practice. EE.5.A
    b. Discuss engineering as a means to create new and improved products, technologies, systems and processes to meet the needs of people and society. EE.5.B
    c. Explain how genetics has influenced engineering disciplines, new interdisciplinary fields, or sub-disciplines. EE.5.C
    d. Explain how engineering challenges are persistent. EE.5.D
    e. Explain the engineer's responsibility to serve the public interest, his/her clients, and the profession with a high degree of honesty, integrity, and accountability. EE.5.E

**Robotic Systems**

1. **Incorporate safety procedures in handling, operating, and maintaining tools and machinery; handling materials; utilizing personal protective equipment; maintaining a safe work area; and following protocols for fire and electrical safety.** RS.FS.1
2. **Demonstrate effective workplace and employability skills, including communication, awareness of diversity, positive work ethic, problem-solving, time management, and teamwork.** RS.FS.2
3. **Explore the range of careers available in the field of Robotics and investigate their educational requirements, and demonstrate job-seeking skills including resume-writing and interviewing.** RS.FS.3
4. **Demonstrate digital literacy by using digital and electronic tools appropriately, safely, and ethically.** RS.FS.4

5. **Participate in a Career and Technical Student Organization (CTSO) to increase knowledge and skills and to enhance leadership and teamwork.** RS.FS.5

1. **Develop a project management plan to include initiating, executing, monitoring, controlling, and closing a robotic systems project.** RS.1
   a. Identify and select methodologies and skills for managing a robotics project. RS.1.A
   b. Participate in the organization and operation of a robotic system engineering project. RS.1.B
   c. Develop a project schedule of work according to established criteria for completing a robotics project. RS.1.C

2. **Apply principles of problem-solving through collaboration and conflict resolution using positive attitudes to produce effective teamwork.** RS.2
   a. Participate in team projects in various roles. RS.2.A
   b. Apply principles of effective problem-solving in teams to collaborate and to resolve conflict. RS.2.B

3. **Utilize STEM concepts in the engineering design process to solve problems in robotic mechanical design.** RS.3
   a. Apply the systems model of input, process, output, feedback, and impact to solve problems in mechanical design. RS.3.A
   b. Use precision measuring instruments to analyze systems and prototypes in mechanical design projects. RS.3.B
   c. Calculate Newton's Laws as they apply to robotics. RS.3.C

4. **Demonstrate knowledge of motors, gears, gear ratios, and gear trains used in robotic systems.** RS.4

5. **Build, test, and present a robotic system.** RS.5
   a. Identify the characteristics and functions of manipulators, accumulators, and end effectors required for a robotic or automated system to function. RS.5.A
   b. Use feedback to refine the design of a robotic or automated system to ensure the quality, efficiency, and manufacturability of the final product. RS.5.B
   c. Present a completed robotic system, including a design, materials, procedure, prototype, and reflection summary, using a variety of media. RS.5.C

6. **Use current software applications to program robot behavior and complete tasks.** RS.6
   a. Program robotic systems to complete an automated task using various sensors. RS.6.A
   b. Create robotic system programs that use variables to store and modify data. RS.6.B
   c. Create robotic system programs that utilize control statement loops and/or conditionals. RS.6.C
   d. Test and debug errors in an algorithm or program that includes sequences and simple loops. RS.6.D

7. **Describe the utilization of programmable control devices and data transfer in automated systems.** RS.7
   a. Identify the systems, components, and processes of a technological system. RS.7.A
   b. Generate a device control flow chart or schematic for an automated manufacturing system. RS.7.B
   c. State the advantages and disadvantages of utilizing various control devices, including those for pressure, heat, volume control, color, weight and timing. RS.7.C
   d. Discuss the various architectures used in developing a programmable logic-controlled system. RS.7.D

**Career Pathway Project in STEM**

1. **Incorporate safety procedures in handling, operating, and maintaining equipment; utilizing materials and protective equipment; maintaining a safe work area; and handling hazardous materials and forces.** CPP.FS.1
2. **Demonstrate effective workplace and employability skills, including communication, awareness of diversity, positive work ethic, problem-solving, time management, and teamwork.** CPP.FS.2
3. **Explore the range of careers available in the field, investigate their educational requirements, and demonstrate job-seeking skills including resume-writing and interviewing.** CPP.FS.3
4. **Demonstrate digital literacy by using digital and electronic tools appropriately, safely, and ethically.** CPP.FS.4
5. **Participate in a Career and Technical Student Organization (CTSO) to increase knowledge and skills and to enhance leadership and teamwork.** CPP.FS.5
1. **Create a formal, narrative proposal that communicates a specific concept, process, or product related to STEM.** CPP.1
2. **Conduct independent research related to a selected project concept.** CPP.2

3. **Write a detailed report on the chosen project, demonstrating correct usage of standard writing format.** CPP.3

4. **Produce an original multimedia presentation based upon project results.** CPP.4

5. **Design a project portfolio that includes documentation of components of the project and demonstrates the validity of the process.** CPP.5

**CTE Lab in STEM**

1. **Incorporate safety procedures in handling, operating, and maintaining equipment; utilizing materials and protective equipment; maintaining a safe work area; and following protocols for fire and electric safety.** LAB.FS.1

2. **Demonstrate effective workplace and employability skills, including communication, awareness of diversity, positive work ethic, problem-solving, time management, and teamwork.** LAB.FS.2

3. **Explore the range of careers available in the field, investigate their educational requirements, and demonstrate job-seeking skills including resume-writing and interviewing.** LAB.FS.3

4. **Demonstrate digital literacy by using digital and electronic tools appropriately, safely, and ethically.** LAB.FS.4

5. **Participate in a Career and Technical Student Organization (CTSO) to increase knowledge and skills and to enhance leadership and teamwork.** LAB.FS.5

1. **Demonstrate expertise in a specific occupation within the career cluster.** LAB.1
   a. Meet benchmarks selected by the instructor from the appropriate curriculum frameworks, based upon the individual student's assessed needs. LAB.1.A

2. **Conduct investigative research on a selected topic related to STEM using approved research methodology; interpret findings; and prepare presentation to defend results.** LAB.2
   a. Select an investigative study referencing prior research and knowledge. LAB.2.A
   b. Collect, organize, and analyze data accurately and precisely. LAB.2.B
   c. Design procedures to test the research. LAB.2.C
   d. Report, display, and defend the results of investigations to audiences that may include professionals and technical experts. LAB.2.D

3. **Demonstrate higher order critical thinking and reasoning skills appropriate for the selected program of study.** LAB.3

    a. Use mathematical and/or scientific skills to solve problems encountered in the chosen occupation. LAB.3.A

    b. Read and interpret information related to the chosen occupation. LAB.3.B

    c. Locate and evaluate key elements of oral and written information. LAB.3.C

    d. Analyze and apply data and/or measurements to solve problems and interpret documents. LAB.3.D

    e. Construct charts, tables, or graphs using functions and data. LAB.3.E

4. **Apply enhanced leadership and professional career skills.** LAB.4

    a. Develop and present a professional presentation offering potential solutions to a current issue. LAB.4.A

    b. Practice leadership and career skills through work-based learning including job placement, job shadowing, entrepreneurship, internship, or by obtaining an industry-recognized credential of value. LAB.4.B

    c. Participate in leadership development opportunities available through the appropriate student organization and/or other professional organizations. LAB.4.C

    d. Demonstrate written and oral communication skills through presentations, public speaking, live/virtual interviews, and/or an employment portfolio. LAB.4.D