Title 7: Education K-12

Part 127: Science Technology Engineering and Mathematics

2014 Engineering

Mississippi Department of Education

Program CIP: 14.0101-Engineering, General

Direct inquiries to

Instructional Design Specialist
Research and Curriculum Unit
P.O. Drawer DX
Mississippi State, MS 39762
662.325.2510

Program Coordinator
Office of Career and Technical Education
Mississippi Department of Education
P.O. Box 771
Jackson, MS 39205
601.359.3461

Published by

Office of Career and Technical Education
Mississippi Department of Education
Jackson, MS 39205

Research and Curriculum Unit
Mississippi State University
Mississippi State, MS 39762

Betsey Smith, Curriculum Manager
Scott Kolle, Project Manager
Jolanda Harris, Educational Technologist

The Research and Curriculum Unit (RCU), located in Starkville, MS, as part of Mississippi State University, was established to foster educational enhancements and innovations. In keeping with the land grant mission of Mississippi State University, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.

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Acknowledgments

The Engineering curriculum was presented to the Mississippi Board of Education on November 14-15, 2013. The following persons were serving on the state board at the time:

Dr. Lynn House, Interim State Superintendent of Education
Dr. O. Wayne Gann, Chair
Mr. Howell "Hal" N. Gage, Vice Chair
Ms. Kami Bumgarner
Mr. William Harold Jones
Dr. John R. Kelly
Mr. Charles McClelland
Mr. Richard Morrison
Ms. Martha "Jackie" Murphy
Mr. Simon F. Weir, II

Jean Massey, Associate Superintendent of Education for the Office of Career and Technical Education, at the Mississippi Department of Education assembled a taskforce committee to provide input throughout the development of the *Engineering Curriculum Framework and Supporting Materials.*

Myra Pannell, Instructional Design Specialist for the Research and Curriculum Unit at Mississippi State University researched and authored this framework.
myra.pannell@rcu.msstate.edu

Also, special thanks are extended to the teachers who contributed teaching and assessment materials that are included in the framework and supporting materials. Members who contributed are as follows:

Stacy Addy, Engineering Instructor, Newton County Schools, Decatur, MS
Sunja Douglas, Engineering Instructor, Choctaw County School District, Ackerman, MS
Andy Gunkel, Engineering Instructor, Gulfport School District, Gulfport, MS
Jim Walker, Engineering Instructor, Madison County Schools, Madison, MS
Amanda Wood, Engineering Instructor, Tupelo Public School District, Tupelo, MS

Appreciation is expressed to the following professionals who provided guidance and insight throughout the development process:

Kendra Taylor, Program Coordinator, Office of Career and Technical Education and Workforce Development, Mississippi Department of Education, Jackson, MS
ktaylor@mde.k12.ms.us

Standards

Standards are superscripted in each unit and are referenced in the appendices. Standards in the *Engineering Curriculum Framework and Supporting Materials* are based on the following:

International Technology and Engineering Educators Association (ITEEA) Standards

The International Technology and Engineering Educators Association (ITEEA) is the professional organization for technology, innovation, design, and engineering educators. The standards referenced in this curriculum are reprinted with permission from the International Technology Education Association, Copyright © 2007, http://www.iteaconnect.org/.

Common Core State Standards Initiative

The Common Core State Standards provide a consistent, clear understanding of what students are expected to learn, so teachers and parents know what they need to do to help them. The standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that our young people need for success in college and careers. With American students fully prepared for the future, our communities will be best positioned to compete successfully in the global economy. Copyright 2010. National Governors Association Center for Best Practices and Council of Chief State School Officers. All rights reserved. States and territories of the United States as well as the District of Columbia that have adopted the Common Core State Standards in whole are exempt from this provision and no attribution to the National Governors Association Center for Best Practices and Council of Chief State School Officers is required. Reprinted from http://www.corestandards.org/.

Mississippi 2010 Science Framework—Physics

Physics provides opportunities for students to develop and communicate an understanding of matter and energy through lab-based activities, mathematical expressions, and concept exploration. Concepts covered in this course include kinematics, dynamics, energy, mechanical and electromagnetic waves, and electricity. Laboratory activities, research, the use of technology, and the effective communication of results through various methods are integral components of this course. The *Engineering Curriculum Framework* is aligned to the physics content in the Mississippi 2010 Science Framework and has been approved by a panel of professional science educators to satisfy academic-equivalent physics credit. The Office of Accreditation has approved the recommendation effective the 2012-2013 school year.

National Educational Technology Standards for Students

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21st Century Skills and Information and Communication Technologies Literacy Standards

In defining 21st-century learning, the Partnership for 21st Century Skills has embraced five content and skill areas that represent the essential knowledge for the 21st century: global awareness; civic engagement; financial, economic, and business literacy; learning skills that encompass problem-solving, critical-thinking, and self-directional skills; and Information and Communication Technology (ICT) literacy.

Preface

Secondary Career and Technical Education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act IV, 2007; and No Child Left Behind Act of 2001).

Mississippi Teacher Professional Resources

The following are resources for Mississippi teachers.

Curriculum, Assessment, Professional Learning, and other program resources can be found at The Research and Curriculum Unit's website: http://www.rcu.msstate.edu

Learning Management System: An online resource

Learning Management System information can be found at the RCU's website, under Professional Learning.

Should you need additional instructions, please call 662.325.2510.

My PLC: An online registration for all professional-development sessions

To register for any session, teachers will need an account in the registration system, MyPLC, https://myplc.rcu.msstate.edu. To create an account, click on the link and navigate to the "Request a Guest ID" link. The ID should be the teacher's first initial and last name and the last four (4) digits of the social security number. Teachers should complete the entire form, which will then be sent to a secure server. Upon activation of the teacher's account, he or she will receive an e-mail with login instructions. The teacher may then browse for the available sessions and register for the desired courses.

Should you need additional instructions, please call 662.325.2510.

Executive Summary

Pathway Description

Engineering is a program in pre-engineering and robotics for high school students. The purpose of the program is to provide students with expanded knowledge of the use of technological skills and to enable them to solve problems by applying knowledge in a technological context. The program is designed to provide students with hands-on experiences related to the application of engineering concepts in the workplace. Students will develop academic and technical skills, 21st century skills, and human relations competencies that accompany technical skills for job success and lifelong learning. Students who complete the program will be better prepared to enter and succeed in engineering programs offered by Mississippi community and junior colleges and institutions of higher education.

Industry Certification

Most engineering programs involve a concentration of study in an engineering specialty along with courses in both mathematics and the physical and life sciences. Many programs also include courses in general engineering. A design course, sometimes accompanied by a computer or laboratory class or both, is part of the curriculum of most programs. General courses not directly related to engineering, such as those in the social sciences or humanities, are also often required. In addition to the standard engineering degree, many colleges offer 2-year or 4-year degree programs in engineering technology. These programs, which usually include various hands-on laboratory classes that focus on current issues in the application of engineering principles, prepare students for practical design and production work, rather than for jobs that require more theoretical and scientific knowledge. Graduates of 4-year technology programs may get jobs similar to those obtained by graduates with a bachelor’s degree in engineering. Engineering

technology graduates, however, are not qualified to register as professional engineers under the same terms as graduates with degrees in engineering. Some employers regard technology program graduates as having skills between those of a technician and an engineer.

Although most engineering jobs require a degree, the Certified SolidWorks Associate (CSWA) industry certification shows competence in using SolidWorks software and can benefit students applying for jobs in the field. Interested students are encouraged to sharpen and expand upon the skills learned in this course in pursuit of this certification.

Assessment

The latest assessment blueprint for the curriculum can be found at

http://www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Student Prerequisites

In order for students to experience success in the Engineering program, the following prerequisites are suggested:

1. C or Higher in Pre-Algebra

   or

2. TABE Math Computation and TABE Math Applied Score (eighth grade or higher)

   or

3. Instructor Approval

Applied Academic Credit

The *Engineering Curriculum Framework* is aligned to the physics content in the Mississippi 2010 Science Framework and has been approved by a panel of professional science educators to satisfy academic-equivalent physics credit. The Office of Accreditation has approved the

recommendation effective the 2012-2013 school year. The Institution of Higher Learning the student attends will decide if the equivalent credit can be awarded as a science.

Licensure Requirements

The most current teacher licensure information can be found at http://www.mde.k12.ms.us/educator-licensure.

Professional Learning

If you have specific questions about the content of any of training sessions provided, please contact the Research and Curriculum Unit at 662.325.2510 and ask for a professional-learning specialist.

Course Outlines

Option 1 – Four One-Carnegie-Unit Courses

This curriculum consists of four one-credit courses, which should be completed in the following sequence:

1. **Engineering Fundamentals—Course Code: 994002**
2. **Engineering Design—Course Code: 994003**
3. **Systems in Engineering—Course Code: 994004**
4. **Applied Engineering Concepts—Course Code: 994005**

Course Description: Engineering Fundamentals

Engineering Fundamentals teaches students the history of engineering and the careers associated with the field. The students will also learn the foundations and fundamentals of engineering and materials, as well as the engineering design process and the steps one follows for successful design planning. Additionally, students are introduced to the advanced concepts of 3-D sketching and modeling with CAD software.

Course Description: Engineering Design

Engineering Design introduces students to the field of robotics in engineering. It also focuses on several fields of engineering specialization.

Course Description: Systems in Engineering

Systems in Engineering is a comprehensive course that focuses on the following four systems: electrical, fluid, mechanical, and thermal. It also introduces students to flexible manufacturing systems, or how robotics and drafting work together to create products.

Course Description: Applied Engineering Concepts

Applied Engineering Concepts teaches students advanced robotic concepts. Students will also learn valuable workforce readiness skills and prepare for jobs in the field of engineering.

Engineering Fundamentals—Course Code: 994002

Unit	Unit Name	Hours
1	Orientation, Ethics, and Safety	5
2	Engineering Design Process, History, and Careers	10
3	Industrial Engineering Focus	20
4	Civil Engineering Focus	20
5	Sketching and Modeling	85
Total		140

Engineering Design—Course Code: 994003

Unit	Unit Name	Hours
6	Introduction to Robotics[1]	80
7	Environmental Engineering Focus	20
8	Electrical Engineering Focus	20
9	Computer Engineering Focus	20
		140

Systems in Engineering—Course Code: 994004

Unit	Unit Name	Hours
10	The Four Systems: Electrical Systems[1]	30
11	The Four Systems: Fluid Systems[1]	30
12	The Four Systems: Mechanical Systems[1]	30
13	The Four Systems: Thermal Systems[1]	30
14	Flexible Manufacturing System (FMS)[1]	20
Total		140

Applied Engineering Concepts—Course Code: 994005

Unit	Unit Name	Hours
15	Advanced Robotics[1]	120
16	Workforce Readiness	20
Total		140

[1] This unit focuses on content from the mechanical engineering field.

Option 2 – Two Two-Carnegie-Unit Courses

This curriculum consists of two two-credit courses, which should be completed in the following sequence:

1. **Engineering I—Course Code: 994000**

2. **Engineering II—Course Code: 994001**

Course Description: Engineering I
Engineering I teaches students the history of engineering and the careers associated with the field. The students will also learn the foundations and fundamentals of engineering and materials, as well as the engineering design process and the steps one follows for successful design planning. Additionally, students are introduced to the advanced concepts of 3-D sketching and modeling with CAD software. The course introduces students to the field of robotics in engineering. It also focuses on several fields of engineering specialization.

Course Description: Engineering II
Engineering II is a comprehensive course that focuses on the following four systems: electrical, fluid, mechanical, and thermal. It also introduces students to flexible manufacturing systems, or how robotics and drafting work together to create products. Additionally, the course teaches students advanced robotic concepts. Students will also learn valuable workforce readiness skills and prepare for jobs in the field of engineering.

Engineering I—Course Code: 994000

Unit	Unit Name	Hours
1	Orientation, Ethics, and Safety	5
2	Engineering Design Process, History, and Careers	10
3	Industrial Engineering Focus	20
4	Civil Engineering Focus	20
5	Sketching and Modeling	85
6	Introduction to Robotics[2]	80
7	Environmental Engineering Focus	20
8	Electrical Engineering Focus	20
9	Computer Engineering Focus	20
Total		280

Engineering II—Course Code: 994001

Unit	Unit Name	Hours
10	The Four Systems: Electrical Systems[2]	30
11	The Four Systems: Fluid Systems[2]	30
12	The Four Systems: Mechanical Systems[2]	30
13	The Four Systems: Thermal Systems[2]	30

[2] This unit focuses on content from the mechanical engineering field.

14	Flexible Manufacturing System (FMS)[2]	20
15	Advanced Robotics[2]	120
16	Workforce Readiness	20
Total		280

Research Synopsis

Introduction

Engineers apply principles of science, mathematics, and technology to develop economical solutions for society. Whether it is working on scientific discoveries or commercial applications, engineering employees are expected to pursue continuing education as technology evolves. Engineering professionals are typically required to obtain a bachelor's degree. Licensing requirements for engineers usually include a professional degree and at least 3–4 years of practical work experience. The 2010-2020 occupational employment projections and wage estimates for Mississippi were used to determine where large employment needs would be in the population over a 10-year period. The research also includes information from industry publications, the Mississippi Department of Education, institutions of higher learning, and community and junior colleges regarding articulation agreements and degree requirements. The pathways were affirmed through existing Mississippi curriculum blueprints and the expectations provided in the industry interviews.

Needs of the Future Workforce

The field of engineering offers a wide variety of specialized occupations many of which only require preparation by means of on-the-job training or the attainment of an associate's degree. This field is also growing throughout the U.S. which means there will be job opportunities within the state and across the nation (SWIB, 2013).

Table 1.1: Current and Projected Occupation Report

Description	Jobs, 2008	Projected Jobs, 2018	Change (Number)	Change (Percent)	Average Hourly Earning
Aerospace Engineering and Operators Technicians	30	40	10	33.3	$26.28
Automotive Service Technicians and Mechanics	7,080	7,910	830	11.7	$15.55
Civil Engineering Technicians	1,350	1,560	210	15.6	$16.94
Electrical and Electronic Engineering Technicians	1,200	1,290	90	7.5	$25.39
Engineering Managers	1,220	1,370	150	12.3	$48.30
Engineers, all others	420	460	40	9.5	$44.67
Environmental Engineering Technicians	150	210	60	40.0	$19.68
Geological and Petroleum Technicians	70	70	0	0.0	$29.41
Industrial Engineering Technicians	420	470	50	11.9	$22.74
Mechanical Engineering Technicians	380	400	20	5.3	$24.08
Surveying and Mapping Technicians	780	940	160	20.5	$15.29

Source: Mississippi Department of Employment Security; www.mdes.ms.gov (accessed February 18, 2013).

Perkins IV Requirements

The Engineering curriculum meets Perkins IV requirements of high-skill, high-wage, and/or high-demand occupations by introducing students to and preparing students for occupations. It also offers students a program of study including secondary, postsecondary, and IHL courses that will prepare them for occupations in these fields. Additionally, the Engineering curriculum is integrated with the Common Core State Standards (CCSS). Lastly, the Engineering curriculum focuses on ongoing and meaningful professional development for teachers as well as relationships with industry.

Curriculum

The following national standards were referenced in each course of the curriculum:

- International Technology and Engineering Education Association (ITEEA) Standards
- 21st Century Skills and Information and Communication Technologies Literacy Standards
- Common Core State Standards (CCSS) Initiative
- National Educational Technology Standards (NETS) for Students
- MS Science Framework for Physics

Industry and instructor comments, along with current research, were considered by the curriculum team during the revision process, and changes were made as needed and appropriate. Many of the skills and topics noted in the research were already included in the curriculum framework.

Academic Credit

If academic credit is awarded, please review the Research and Curriculum Unit link at https://www.rcu.msstate.edu/MDE/PathwaystoSuccess.aspx.

Click "*Curriculum Enhancement List"*. Check this site often as it is updated frequently.

Academic Infusion

The Engineering content has been aligned with the Mississippi 2010 Science Framework for Physics.

Assessment

The latest assessment blueprint for the curriculum can be found at http://www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Best Practices

Innovative Instructional Technologies

Recognizing that today's students are digital learners, the classroom should be equipped with tools that will teach them in the way they need to learn. The Engineering curriculum includes teaching strategies that incorporate current technology. Each classroom should incorporate one teacher desktop or laptop as well as student computers in a networked environment. It is suggested that each classroom be equipped with an interactive white board and projector, intensifying the interaction between students and teachers during class. Teachers are encouraged to make use of the latest online communication tools such as wikis, blogs, and podcasts. They are also encouraged to teach using the content delivery system Blackboard, which introduces students to education in an online environment and places the responsibility of learning on the student.

Differentiated Instruction

Students learn in a variety of ways. Some are visual learners, needing only to read information and study it to succeed. Others are auditory learners, thriving best when information is read aloud to them. Still others are tactile learners, needing to participate actively in their learning experiences. Add a student's background, emotional health, and circumstances, and a very unique learner emerges. To combat this, the Engineering curriculum is written to include many projects which allow students to choose the type of product they will produce or to perform a certain task. By encouraging various teaching and assessment strategies, students with various learning styles can succeed.

Career and Technical Education Student Organizations

There are organizations for students that would be relevant to this curriculum. Teachers are encouraged to charter one of these organizations if one is not already available to students. The suggested organization for this course is Technology Student Association (TSA). Contact information for this and other related organizations is listed under “Professional Organizations” in this document.

Articulation

The latest articulation information for Secondary to Postsecondary can be found at the Mississippi Community College Board (MCCB) website http://www.mccb.edu/

Conclusion

Based on the previous information, the Engineering curriculum will be filled with opportunities to develop workforce skills. Widely used teaching strategies such as cooperative learning, problem-based learning, and demonstration will also be included. These will help to prepare students for the hands-on environment they will likely experience upon entering the workforce. The curriculum document will be updated regularly to reflect the needs of the engineering workforce.

Professional Organizations

International Technology and Engineering Educators Association (ITEEA)
1914 Association Drive, Suite 201
Reston, VA 20191-1539
703.860.2100
http://www.iteea.org

SkillsUSA
14001 SkillsUSA Way
Leesburg, VA 20176
703.777.8810
http://www.skillsusa.org/

Technology Student Association
1914 Association Drive
Reston, VA 20191-1540
888.860.9010
http://www.tsaweb.org/

Using This Document

Suggested Time on Task
This section indicates an estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75–80% of the time in the course.

Competencies and Suggested Objectives
A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies. The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.

Integrated Academic Topics, 21st Century Skills and Information and Communication Technology Literacy Standards, ACT College Readiness Standards, and Technology Standards for Students
This section identifies related academic topics as required in the Subject Area Testing Program (SATP) in Algebra I, Biology I, English II, and U.S. History from 1877, which are integrated into the content of the unit. Research-based teaching strategies also incorporate ACT College Readiness standards. This section also identifies the 21st Century Skills and Information and Communication Technology Literacy skills. In addition, national technology standards for students associated with the competencies and suggested objectives for the unit are also identified.

References
A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested, and the list may be modified or enhanced based on needs and abilities of students and on available resources. Again, these resources are suggested, and the list may be modified or enhanced based on needs and abilities of students and on available resources.

Unit 1: Orientation, Ethics, and Safety

Competencies and Suggested Objectives
1. Identify course expectations, school policies, and program policies related to this course. DOK4, STL1, STL2 a. Identify school rules, policy and procedures. b. Identify and establish classroom guidelines and procedures. c. Review course standards and affiliated national standards.
2. Demonstrate proper use and care for laboratory equipment. DOK2, STL6 a. Identify, describe, and demonstrate the importance of safety and the proper use of lab equipment. b. Describe the operating procedures for the equipment utilized in the course. c. Compare and contrast safety issues in the classroom to safety issues in industry.
3. Recognize the importance of ethical teamwork in the field of engineering. DOK 1, STL4, STL6, STL10 a. Discuss ethics, etiquette, and morality as they are related to the workplace.

Scenario

Safety List

Unit 1

No scenario required for orientation units.

Unit 2: Engineering Design Process, History, and Careers

Competencies and Suggested Objectives
1. Recognize the need for a design process. DOK 1, STL8, STL9, STL10, STL11 a. Discuss the design process. b. Trace the steps of the design process along the development of an engineered product.
2. Explore the history of engineering, its major achievements, and key figures. DOK 1, STL1, STL2, STL4, STL7 a. Identify the characteristics of engineers. b. Identify the key contributors in the field of engineering. c. Identify historical engineering designs, and tell what effects they have on society.
3. Investigate careers within the field of engineering. DOK 1, STL3, STL4, STL6 a. Investigate the different fields of engineering and careers within each.

Scenario

Design Process

Unit 2

You are an engineer for a company that is now under new management. Your new boss wants to examine the current products for quality control and cost efficiency. You are assigned a product to evaluate. Follow the design process to determine whether or not this product needs any improvements. Write an analysis report based on your findings.

Unit 3: Industrial Engineering Focus

Competencies and Suggested Objectives
1. Describe educational and occupational opportunities in the field of industrial engineering. DOK1, STL3, STL4, STL19 a. Discuss the field of industrial engineering. b. Determine the educational requirements for an industrial engineer.
2. Recognize career opportunities within the field of industrial engineering. DOK3, STL3, STL5, STL6, STL10, STL13, STL19 a. Discover the different career pathways within industrial engineering. b. Discuss the roles that industrial engineers play in society. c. Recognize industrial engineering career activities by participating in a real-world workplace scenario.

Scenario

Rock-a-Bye Baby

Unit 3

You are an industrial engineer in Onset Manufacturing facility. Onset Manufacturing manufactures baby cribs. The general manager has discussed with you his concern about the cycle time to manufacture a crib. He requested that you make recommendations on how to decrease the cycle time. In your review of the processes to manufacture a crib, you notice that the process to bolt the front panel to the legs of the crib is time consuming. Investigate installing a robot to assist with this process. Compile your results and comparative analysis, including type of robot, cost, and time-saving information, for your recommendations to the general manager. Present your recommendations through multimedia or some other product.

Unit 4: Civil Engineering Focus

Competencies and Suggested Objectives
1. Describe educational and occupational opportunities in the field of civil engineering. DOK1, STL3, STL5, STL6, STL10, STL13, STL19, STL20 a. Discuss the field of civil engineering. b. Determine the educational requirements for a civil engineer.
2. Recognize career opportunities within the field of civil engineering. DOK3, STL3, STL5, STL6, STL10, STL13, STL19, STL20 a. Discover the different career pathways within civil engineering. b. Discuss the roles that civil engineers play in society. c. Recognize civil engineering career activities by participating in a real-world workplace scenario.

Scenario

London Bridge, Please Don't Fall Down!

Unit 4

A bridge collapse can be a major disaster. Bridges that cannot hold enough weight to do their intended job can be a serious public safety issue. And if they collapse, they can also cause economic damage due to costly rebuilding and people and companies scrambling to figure out how to circumvent the months of traffic impacts.

You are a civil engineer in your hometown. You have been asked to design and oversee the building of a new river bridge. You investigate how different bridge designs are ideal for different situations. Do some bridge designs hold more weight than others? Do they require more materials? What is the strongest bridge that can be built for the least amount of materials? To test your ideas, try your hand at building and testing a couple of bridges. (For this civil engineering project, try making your bridges out of popsicle sticks, basal wood, or straws.) Present your design and defend its strength to the board of supervisors in your town.

Unit 5: Sketching and Modeling

Competencies and Suggested Objectives
1. Create 2-D and 3-D models with CAD software. DOK2, STL1, STL2, STL8, STL9, STL10, STL11, STL17 a. Identify drafting and design applications in business and industry. b. Identify terms and concepts related to drafting and design. c. Distinguish between the types of drawing views: Orthographic, isometric, and perspective. d. Identify and design 2-D and 3-D engineering drawings.
2. Construct 3-D models with CAD software. DOK3, STL1, STL2, STL8, STL9, STL10, STL11, STL17 a. Construct 3-D part and assembly models with 3-D CAD software b. Design a 3-D model and apply appropriate analysis tools to the model. c. Design a 3D model to create for rapid prototyping in a 3D printer.

Scenario

3D CAD Game

Unit 5

You are a CAD Designer. Road Games Inc. is a company that specializes in designing small, compact games that people can take with them on trips. You have been recently employed in the creative concepts department of the company.

Design a travel game that uses pegs and a ¾" x 3 ½" x 3 ½" wood board. Dice can be used in the game, but are not required. Your boss expects you to produce rough sketches of five different ideas, a refined sketch for the best idea, a 3D model, a prototype, and a detail drawing for the game board.

Unit 6: Introduction to Robotics

Competencies and Suggested Objectives
1. Explore concepts associated with physical principles of engineering. DOK2, STL1, STL8, STL9, STL10, STL11, STL17 a. Identify the engineering design cycle. b. Recognize the importance of maintain an engineering notebook. c. Demonstrate how physics affects robots by exploring topics such as weight, torque, mass, and center of gravity.
2. Explore mechanisms and simple machines to create working robots. DOK2, STL1, STL2, STL8, STL9, STL10, STL11, STL17 a. Define and describe principles relating to Newton's Laws of Motion. b. Distinguish the principles of physics involved in gears and gear trains. c. Recognize fundamentals of rotational dynamics, torque, motors, and angular velocity. d. Analyze power as it relates to robotics. e. Recognize the fundamentals of degrees of freedom as it relates to robotics arms.
3. Explore concepts associated with computer programming as it relates to robotics. DOK3, STL1, STL2, STL8, STL9, STL10, STL11, STL12, STL17 a. Recognize the fundamentals of computer programming. b. Develop programming concepts like loops, statements, variables, and constants. c. Identify different types of sensors. d. Differentiate between open and closed loop control. e. Create programs with advanced functions to simplify the control of the robot. f. Analyze remote control and limit switches. g. Apply concepts learned to end effectors to produce changes in their environment.
4. Demonstrate advanced robotics programming. DOK3, STL1, STL2, STL8, STL9, STL10, STL11, STL12, STL17 a. Apply concepts learned to create a robot that will, follow a line, pick and place an object, and store and interpret sensor information. b. Create and operate a closed-loop end effector.

Scenario

Go, Robot, Go!

Unit 6

You are working on a competition robot with two other students. Your job is to compile the best program for your robot to run for a specified autonomous and driver control periods. You will need to be able to program your robot to pick and place specified objects for 60 seconds autonomously and then do the same for driver control. Your robot will be required to use at least one sensor and on limit switch. You will download your program to your competition robot and test it. The member whose program works the best will be used for the competition.

Unit 7: Environmental Engineering Focus

Competencies and Suggested Objectives
1. Describe educational and occupational opportunities in the field of environmental engineering. DOK1, STL3, STL5, STL6, STL10, STL13, STL15, STL16 a. Discuss the field of environmental engineering. b. Determine the educational requirements for an environmental engineer.
2. Recognize career opportunities within the field of environmental engineering. DOK2, STL3, STL5, STL6, STL10, STL13, STL15, STL16 a. Discover the different career pathways within environmental engineering. b. Discuss the roles that environmental engineers play in society. c. Recognize environmental engineering career activities by participating in a real-world workplace scenario.

Scenario

"This Water Tastes Funny"

Unit 7

You are an environmental engineer in your hometown. You have been notified that a tanker truck carrying 30,000 gallons of pesticide has just wrecked, spilling pesticide into a creek which leads to your town's drinking water source. The pesticide is known to cause skin irritation, nausea, vomiting, and nervous system problems. You and your engineering firm have been tasked with removing the hazardous material from the drinking water source. Outline the steps you would take to solve this problem, including identifying the risks to citizens, and present your findings to the board of supervisors.

Unit 8: Electrical Engineering Focus

Competencies and Suggested Objectives
1. Describe educational and occupational opportunities in the field of electrical engineering. DOK1, STL3, STL5, STL6, STL10, STL12, STL13, STL16, STL19 a. Discuss the field of electrical engineering. b. Determine the educational requirements for an electrical engineer.
2. Recognize career opportunities within the field of electrical engineering. DOK3, STL3, STL5, STL6, STL10, STL12, STL13, STL16, STL19 a. Discover the different career pathways within electrical engineering. b. Discuss the roles that electrical engineers play in society. c. Recognize electrical engineering career activities by participating in a real-world workplace scenario.

Scenario

Welcome to the Neighborhood!

Unit 8

You are an electrical engineer at a large engineering firm. You and your team have been tasked with finding the best way to send electricity to a new neighborhood in town. Outline the steps you would take to discover what needs to be done to most efficiently bring power to the neighborhood. Present your solution to the lead engineer.

Unit 9: Computer Engineering Focus

Competencies and Suggested Objectives
1. Describe educational and occupational opportunities in the field of computer engineering. DOK1, STL1, STL2, STL3, STL5, STL6, STL10, STL12, STL13, STL17 a. Discuss the field of computer engineering. b. Determine the educational requirements for a computer engineer.
2. Recognize career opportunities within the field of computer engineering. DOK3, STL1, STL2, STL3, STL5, STL6, STL10, STL12, STL13, STL17 a. Discover the different career pathways within computer engineering. b. Discuss the roles that computer engineers play in society. c. Recognize computer engineering career activities by participating in a real-world workplace scenario.

Scenario

Engineering My Wi-Fi

Unit 9

You are a computer engineer for a high profile company that provides Wi-Fi hotspots across the country in public places. You are faced the task of helping solve Wi-Fi issues with the typical business traveler, who uses a laptop and a PDA and requires Internet connectivity while on the move across the country.

Explore the various barriers of widespread Wi-Fi availability. Present research ideas on how to make Wi-Fi availability to a business traveler seamless as they move across the country. What challenges to make authentication, security at free hotspots, coverage, and network performance need to be overcome to make this possible for the typical business traveler.

Once you have researched and decided on a course of action, present your findings in a multimedia presentation.

Unit 10: Electrical Systems

Competencies and Suggested Objectives
1. Examine electrical systems in engineering. DOK2, STL1, STL2, STL3, STL5, STL6, STL9, STL10, STL12, STL13, STL16, STL19 a. Differentiate between the concepts of "electricity" and "electronics". b. Identify the following electrical components: resistor, capacitor, transistor, breadboard, multimeter. c. Identify different types of electricity. d. Describe conductors, semiconductors, and insulators. e. Describe and electric circuit. f. Distinguish between parallel and series circuits.
2. Examine principles of magnetism, electric fields, and electricity. DOK2, STL1, STL2, STL3, STL5, STL6, STL9, STL10, STL12, STL13, STL16, STL19 a. Analyze and explain the relationship between electricity and magnetism (Characteristics of static charge and how a static charge is generated; Electric field, electric potential, current, voltage, and resistance as related to Ohm's Law.) b. Calculate resistance with voltage and current. c. Evaluate schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential. d. Analyze and explain the relationship between magnetic fields and electrical current by induction, generators, and electric motors.

Scenario

Electrical Engineer

Unit 10

You are an electrical engineer that has been contacted by a large corporation to increase profit margins by reducing energy cost. You must identify energy wasters by studying the current electrical schematics of the facilities. Once you have identified where and how the current electrical system needs to be upgraded to reduce energy cost, you will draw new schematics for each facility that will outline where and how the current electrical system needs to be upgraded to reduce energy cost, you will draw new schematics for each facility that will outline where and how the current electrical system needs to be upgraded to reduce energy cost and thus increase profit margins. Once all designs have been completed you will use a multimedia presentation or other medium to present your finding to the company's board of directors.

Unit 11: Fluid Systems

Competencies and Suggested Objectives
1. Examine fluid systems in engineering. DOK2, STL1, STL2, STL3, STL4, STL5, STL6, STL9, STL10, STL12, STL13, STL 15, STL16, STL20 a. Examine how Newton's laws of motion are applied in fluid systems. b. Differentiate between mass and weight. c. Differentiate between pneumatics and hydraulic devices and functions. d. Identify pneumatic hardware components (i.e. nail guns, vacuum tubes, air wrenches). e. Investigate atmospheric and vacuum pressure. f. Demonstrate how pressure differences are related to force.

Scenario

Low Pressure

Unit 11

You are a civil engineer and there is a new subdivision in your town that has low water pressure. You must identify the cause of the low water pressure by examining the current piping in the subdivision. You quickly realize that the piping used to supply water to the individual houses is too large thus causing low water pressure inside the homes. Once you have identified where and how to correct the problem, present your findings along with a breakdown of the cost of repairs to the mayor and the city board aldermen through a multimedia presentation or other medium.

Unit 12: Mechanical Systems

Competencies and Suggested Objectives
1. Examine mechanical systems in engineering. DOK1, STL1, STL2, STL3, STL5, STL6, STL9, STL10, STL12, STL13, STL18, STL19, STL20 a. Examine Newton's Laws of Motion as related to mechanisms. b. Differentiate between mass and weight. c. Calculate force, rate, work, and mass using Newton's Laws of Motion. d. Identify and describe mechanisms used in daily life.
2. Examine and classify levers. DOK2, STL1, STL2, STL3, STL5, STL6, STL9, STL10, STL12, STL13, STL18, STL19, STL20 a. Identify first class levers and examine their uses in everyday applications. b. Demonstrate the relationship between the fulcrum, force, and load in a first class lever. c. Construct a model of a first class lever. d. Identify second class levers and examine their uses in everyday applications. e. Differentiate between first and second class levers by demonstrating the relationship between the fulcrum, force, and load in the second class lever. f. Construct a model of a second class lever. g. Identify third class levers and examine their uses in everyday application. h. Differentiate between first, second, and third class levers by demonstrating the relationship between the fulcrum, force, and load in the third class lever. i. Construct a model of a third class lever.

Scenario

Levers

Unit 12

You are a quality control engineer in a large furniture factory. You are faced with the fact that too much time is being lost on the transport of chair arms from one location to the next. You must find a way to save time during this process. It quickly become apparent to you that if all of the chair arms were placed on palates as they were constructed then on person could come around and transport twenty chair arms at once instead of being moved one at a time. You decide to break down the cost of hand dollies versus the amount of time that will be saved by using these first class levers. Use a multimedia presentation to present your findings to your plant manager.

Unit 13: Thermal Systems

Competencies and Suggested Objectives
1. Investigate and summarize the principles of thermodynamics. DOK2, STL1, STL2, STL3, STL5, STL6, STL9, STL10, STL12, STL13, STL14, STL15, STL16 a. Define and differentiate between heat, energy, entropy, and temperature. b. Examine how heat energy is transferred from higher temperature to lower temperature until equilibrium is reached. c. Examine the laws of thermodynamics (Zeroth, First, Second, and Third). d. Examine temperature and thermal energy as related to molecular motion (conduction, convection, and radiation) and the states of matter (solid, liquid, and gas). e. Investigate problems involving specific heat and heat capacity.
2. Examine thermal systems in engineering. DOK1, STL1, STL2, STL3, STL5, STL6, STL9, STL10, STL12, STL13, STL14, STL15, STL16 a. Investigate the laws of thermodynamics as related to heat engines, refrigerators, and thermal efficiency. b. Apply the laws of thermodynamics to careers in engineering.

Scenario

Industrial Engineer

Unit 13

You are an industrial engineer at a power plant. The power plant needs to burn lignite to produce energy. The problem that you are facing is that the fires produced by the lignite are not hot enough to produce the amount of energy needed for the plant to function at optimum production. You decide to increase the amount of oxygen into the boiler room in order to make the fires burn hotter. Once you have decided on your course of action, you will use a multimedia presentation (or other product) to present your plan to the board of directors.

Unit 14: FMS—Flexiable Manufacturing Systems

Competencies and Suggested Objectives
1. Design and write a program for controlling a robot. DOK3, STL1, STL2, STL3, STL5, STL6, STL8, STL9, STL10, STL12, STL13, STL17, STL19 a. Analyze the factors for implementing robots in modern factories. b. Evaluate safety issues of working with robots in manufacturing. c. Analyze how robots are programmed for specific functions.
2. Design and create an object using NC code. DOK3, STL1, STL2, STL3, STL5, STL6, STL8, STL9, STL10, STL12, STL13, STL17, STL19 a. Evaluate safety issues of programming and controlling a CNC machine. b. Analyze the components of the CNC machine and their uses. c. Calculate how CNC machines are programmed.
3. Set up the FMS cell using the robot and CNC machine. DOK3, STL1, STL2, STL3, STL5, STL6, STL8, STL9, STL10, STL12, STL13, STL17, STL19 a. Evaluate the hazards of FMS operations. b. Exhibit how the CNC machine and robot work together.

Scenario

Increase Productivity

Unit 14

You are a supervisor at a sign factory that specializes in making restroom signs. You are faced with cutting costs and increasing manufacturing at your company. You must convert some of the company lines to automated systems. You decide that the best course of action is to install a Flexible Manufacturing System (FMS). You create a portfolio containing pertinent information about how FMS systems improve the level of control over a production cycles by reducing dependence of human communication and by reducing the number of unknown variables in the operation. Present your findings to the factory owner.

Unit 15: Advanced Robotics

Competencies and Suggested Objectives
1. Perform advanced robotic concepts associated with object manipulators. DOK3, STL1, STL2, STL8, STL9, STL10, STL11, STL12, STL17 a. Design a functional robot incorporating an object manipulator using provided software and hardware. b. Construct a functional robot incorporating an object manipulator using provided software and hardware. c. Program a functional object manipulator robot using provided software and hardware.
2. Perform advanced robotic concepts associated with single stage lifts. DOK3, STL1, STL2, STL8, STL9, STL10, STL11, STL12, STL17 a. Design a functional robot incorporating a single stage lift using provided software and hardware. b. Construct a functional robot incorporating a single stage lift using provided software and hardware. c. Program a functional single stage lift robot using provided software and hardware.
3. Perform advanced robotic concepts associated with accumulators. DOK3, STL1, STL2, STL8, STL9, STL10, STL11, STL12, STL17 a. Design a functional robot incorporating an accumulator using provided software and hardware. b. Construct a functional robot incorporating an accumulator using provided software and hardware. c. Program a functional accumulator robot using provided software and hardware.
4. Perform advanced robotic concepts associated with four bar mechanisms. DOK3, STL1, STL2, STL8, STL9, STL10, STL11, STL12, STL17 a. Design a functional robot incorporating a four bar mechanism using provided software and hardware. b. Construct a functional robot incorporating a four bar mechanism using provided software and hardware. c. Program a functional four bar mechanism robot using provided software and hardware. d. Use a web 2.0 tool to outline the successes and failures associated with designing the robot.

Scenario

Tennis Lessons Made Easy

Unit 15

You have been going by the tennis courts and have observed children taking lessons from the pro. After the lesson there are 50 tennis balls that have been hit against the back fence and the child must go and pick up the balls before the lesson can be continued. You think there has to be a better way of picking up the tennis balls and have decided to build an accumulator that can pick up tennis balls. Design, build, and program an accumulator that can pick up as many tennis balls as possible in two minutes.

Unit 16: Workforce Readiness

Competencies and Suggested Objectives
1. Develop employability skills that will prepare students for the world of work. DOK 4, STL3, STL4, STL6 a. Discover postsecondary opportunities. b. Examine examples of correctly formatted job applications, resumes, and job interviews in preparation of creating these materials. c. Complete a job application. d. Prepare a resume. e. Participate in a mock job interview. f. Identify desirable workplace expectations. g. Recognize diversity in the workplace.

Scenario

Get a Job

Unit 16

You are a recent graduate and you are ready to begin your job search. Using the Internet and other sources, find a job you would like to apply for. Prepare a résumé and a cover letter for this position. Participate in a mock interview for the position.

Instructors, be sure students:

- Find a job for which they are qualified
- Prepare and edit a résumé
- Prepare and edit a cover letter
- Participate in a mock interview
- Dress appropriately for the mock interview

Student Competency Profile

Student Name: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student, and it can serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Unit 1: Orientation, Ethics, and Safety		
	1.	Identify course expectations, school policies, and program policies related to this course.
	2.	Demonstrate proper use and care for laboratory equipment.
	3.	Recognize the importance of ethical teamwork in the field of engineering.
Unit 2: Engineering Design Process, History, and Careers		
	1.	Recognize the need for a design process.
	2.	Explore the history of engineering, its major achievements, and key figures.
	3.	Investigate careers within the field of engineering.
Unit 3: Industrial Engineering Focus		
	1.	Describe educational and occupational opportunities in the field of industrial engineering.
	2.	Recognize career opportunities within the field of industrial engineering.
Unit 4: Civil Engineering Focus		
	1.	Describe educational and occupational opportunities in the field of civil engineering.
	2.	Recognize career opportunities within the field of civil engineering.
Unit 5: Sketching and Modeling		
	1.	Construct 3-D models with CAD software.
	2.	Create 2-D and 3-D models with CAD software.
Unit 6: Introduction to Robotics		
	1.	Explore concepts associated with physical principles of engineering.
	2.	Explore mechanisms and simple machines to create working robots.
	3.	Explore concepts associated with computer programming as it relates to robotics.
	4.	Demonstrate advanced robotics programming.
Unit 7: Environmental Engineering Focus		
	1.	Describe educational and occupational opportunities in the field of environmental engineering.

	2.	Recognize career opportunities within the field of environmental engineering.
Unit 8: Electrical Engineering Focus		
	1.	Describe educational and occupational opportunities in the field of electrical engineering.
	2.	Recognize career opportunities within the field of electrical engineering.
Unit 9: Computer Engineering Focus		
	1.	Describe educational and occupational opportunities in the field of computer engineering.
	2.	Recognize career opportunities within the field of computer engineering.
Unit 10: Electrical Systems		
	1.	Examine electrical systems in engineering.
	2.	Examine principles of magnetism, electric fields, and electricity.
Unit 11: Fluid Systems		
	1.	Examine fluid systems in engineering.
Unit 12: Mechanical Systems		
	1.	Examine mechanical systems in engineering.
	2.	Examine and classify levers.
Unit 13: Thermal Systems		
	1.	Investigate and summarize the principles of thermodynamics.
	2.	Examine thermal systems in engineering.
Unit 14: FMS−Flexiable Manufacturing Systems		
	1.	Design and write a program for controlling a robot.
	2.	Design and create an object using NC code.
	3.	Set up the FMS cell using the robot and CNC machine.
Unit 15: Advanced Robotics		
	1.	Perform advanced robotic concepts associated with object manipulators.
	2.	Perform advanced robotic concepts associated with single stage lifts.
	3.	Perform advanced robotic concepts associated with accumulators.
	4.	Perform advanced robotic concepts associated with four bar mechanisms.
Unit 16: Workforce Readiness		
	1.	Develop employability skills that will prepare students for the world of work.

Appendix A: Unit References

Unit 1

Connexions. (2012, September 16). *Connexions*. Retrieved May 31, 2013, from http://cnx.org/content/m13760/latest/

Gomez, A. G., Oakes, W. C., Leone, L. L., & Gruender, J. L. (2006). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press.

Karsnitz, J. R., O'Brien, S., & Hutchinson, J. P. (2009). *Engineering design: An introduction*. Clifton Park, NY: Delmar Cengage Learning.

Orsak, G. C. (2004). *Engineering: Our digital future*. Upper Saddle River, NJ: Pearson Prentice Hall.

Unit 2

Discover engineering. (2013). *Discover Engineering*. Retrieved May 31, 2013, from http://www.discoverengineering.org/

Gomez, A. G., Oakes, W. C., Leone, L. L., & Gruender, J. L. (2006). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press.

Karsnitz, J. R., O'Brien, S., & Hutchinson, J. P. (2009). *Engineering design: An introduction*. Clifton Park, NY: Delmar Cengage Learning.

NASA engineering design challenge. (2008, February 22). *NASA*. Retrieved May 31, 2013, from http://www.nasa.gov/audience/foreducators/plantgrowth/reference/Eng_Design_5-12.html

Orsak, G. C. (2004). *Engineering: Our digital future*. Upper Saddle River, NJ: Pearson Prentice Hall.

The engineering design process. (2013). *The Engineering Design Process*. Retrieved May 31, 2013, from http://www.sciencebuddies.org/engineering-design-process/engineering-design-process-steps.shtml

The engineering design process. (2013). *The Engineering Design Process*. Retrieved May 31, 2013, from http://www.teachengineering.org/engrdesignprocess.php

The history of engineering design. (2011, June 15). *YouTube*. Retrieved May 31, 2013, from http://www.youtube.com/watch?v=Hner3FAiRnA

U.S. Bureau of Labor Statistics. (2013). *U.S. Bureau of Labor Statistics*. Retrieved May 31, 2013, from http://www.bls.gov/

Unit 3

Career Cornerstone Center: Careers in Science, Technology, Engineering, Math and Medicine. (2013). *Career Cornerstone Center: Careers in Science, Technology, Engineering, Math and Medicine*. Retrieved May 31, 2013, from http://www.careercornerstone.org/industrial/industrial.htm

Gomez, A. G., Oakes, W. C., Leone, L. L., & Gruender, J. L. (2006). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press.

Industrial & Systems Engineering Mississippi State University Bagley College of Engineering |. (2013). *Industrial Systems Engineering Mississippi State University Bagley College of Engineering RSS*. Retrieved May 31, 2013, from http://www.ise.msstate.edu/

Industrial engineering. (2010, June 01). *YouTube*. Retrieved May 31, 2013, from http://www.youtube.com/watch?v=WMbJuTlajsw

Industrial engineering. (2013). *Engineering.com*. Retrieved May 31, 2013, from http://www.engineering.com/Library/ArticlesPage/tabid/85/ArticleID/179/Industrial-Engineering.aspx

Karsnitz, J. R., O'Brien, S., & Hutchinson, J. P. (2009). *Engineering design: An introduction*. Clifton Park, NY: Delmar Cengage Learning.

Orsak, G. C. (2004). *Engineering: Our digital future*. Upper Saddle River, NJ: Pearson Prentice Hall.

U.S. Bureau of Labor Statistics. (2013). *U.S. Bureau of Labor Statistics*. Retrieved May 31, 2013, from http://www.bls.gov/

Unit 4

About civil engineering. (2013). *About Civil Engineering*. Retrieved May 31, 2013, from http://www.asce.org/About-Civil-Engineering/

Avoiding disaster: The right bridge design. (2013). *Avoiding Disaster: The Right Bridge Design*. Retrieved May 31, 2013, from http://www.sciencebuddies.org/science-fair-projects/project_ideas/CE_p024.shtml

Gomez, A. G., Oakes, W. C., Leone, L. L., & Gruender, J. L. (2006). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press.

Karsnitz, J. R., O'Brien, S., & Hutchinson, J. P. (2009). *Engineering design: An introduction*. Clifton Park, NY: Delmar Cengage Learning.

Orsak, G. C. (2004). *Engineering: Our digital future*. Upper Saddle River, NJ: Pearson Prentice Hall.

ScienceDaily: Civil engineering news. (2013). *ScienceDaily*. Retrieved May 31, 2013, from http://www.sciencedaily.com/news/matter_energy/civil_engineering/

U.S. Bureau of Labor Statistics. (2013). *U.S. Bureau of Labor Statistics*. Retrieved May 31, 2013, from http://www.bls.gov/

Unit 5

3D CAD design software SolidWorks. (2013). *SolidWorks*. Retrieved May 31, 2013, from http://www.solidworks.com/

Gomez, A. G., Oakes, W. C., Leone, L. L., & Gruender, J. L. (2006). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press.

Karsnitz, J. R., O'Brien, S., & Hutchinson, J. P. (2009). *Engineering design: An introduction*. Clifton Park, NY: Delmar Cengage Learning.

Orsak, G. C. (2004). *Engineering: Our digital future*. Upper Saddle River, NJ: Pearson Prentice Hall.

Welcome to our SolidWorks tutorials. (2013). *Cudacountry SolidWorks Tutorials*. Retrieved May 31, 2013, from http://www.cudacountry.net/html/solidworks_toc.htm

Unit 6

Gomez, A. G., Oakes, W. C., Leone, L. L., & Gruender, J. L. (2006). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press.

Intelitek. (2013). *Intelitek*. Retrieved May 31, 2013, from http://www.intelitek.com/

Karsnitz, J. R., O'Brien, S., & Hutchinson, J. P. (2009). *Engineering design: An introduction*. Clifton Park, NY: Delmar Cengage Learning.

LearnMate. (2013). *LearnMate*. Retrieved May 31, 2013, from http://www.learnmate.com/

Orsak, G. C. (2004). *Engineering: Our digital future*. Upper Saddle River, NJ: Pearson Prentice Hall.

VEX Robotics. (2013). *VEX Robotics*. Retrieved May 31, 2013, from http://www.vexrobotics.com/

Unit 7

Careers in environmental engineering and environmental science. (2013). *Careers in Environmental Engineering and Environmental Science*. Retrieved May 31, 2013, from http://www.aaees.org/careers.php

Environmental engineer. (2013). *Environmental Engineer*. Retrieved May 31, 2013, from http://www.sciencebuddies.org/science-fair-projects/science-engineering-careers/EnvEng_environmentalengineer_c001.shtml

Gomez, A. G., Oakes, W. C., Leone, L. L., & Gruender, J. L. (2006). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press.

Karsnitz, J. R., O'Brien, S., & Hutchinson, J. P. (2009). *Engineering design: An introduction*. Clifton Park, NY: Delmar Cengage Learning.

Orsak, G. C. (2004). *Engineering: Our digital future*. Upper Saddle River, NJ: Pearson Prentice Hall.

Pesticide spill curriculum overview. (2013). *Welcome to Hydroville!* Retrieved May 31, 2013, from http://www.hydroville.org/spill

U.S. Bureau of Labor Statistics. (2013). *U.S. Bureau of Labor Statistics*. Retrieved May 31, 2013, from http://www.bls.gov/

What does an environmental engineer do? (2013). *NCSU Biological Agricultural Engineering*. Retrieved May 31, 2013, from https://www.bae.ncsu.edu/academic/environmental_work.php

Unit 8

Career Cornerstone Center: Careers in science, technology, engineering, math and medicine. (2013). *Career Cornerstone Center: Careers in Science, Technology, Engineering, Math and Medicine*. Retrieved May 31, 2013, from http://www.careercornerstone.org/eleceng/eleceng.htm

Gomez, A. G., Oakes, W. C., Leone, L. L., & Gruender, J. L. (2006). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press.

Karsnitz, J. R., O'Brien, S., & Hutchinson, J. P. (2009). *Engineering design: An introduction*. Clifton Park, NY: Delmar Cengage Learning.

Orsak, G. C. (2004). *Engineering: Our digital future*. Upper Saddle River, NJ: Pearson Prentice Hall.

U.S. Bureau of Labor Statistics. (2013). *U.S. Bureau of Labor Statistics*. Retrieved May 31, 2013, from http://www.bls.gov/

Unit 9

Computer engineering. (2013). *Try Engineering*. Retrieved May 31, 2013, from http://www.tryengineering.org/become.php?major=Computer+Engineering

Gomez, A. G., Oakes, W. C., Leone, L. L., & Gruender, J. L. (2006). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press.

Karsnitz, J. R., O'Brien, S., & Hutchinson, J. P. (2009). *Engineering design: An introduction*. Clifton Park, NY: Delmar Cengage Learning.

Orsak, G. C. (2004). *Engineering: Our digital future*. Upper Saddle River, NJ: Pearson Prentice Hall.

U.S. Bureau of Labor Statistics. (2013). *U.S. Bureau of Labor Statistics*. Retrieved May 31, 2013, from http://www.bls.gov/

What is computer engineering? (2010, April 15). *YouTube*. Retrieved May 31, 2013, from http://www.youtube.com/watch?v=RI4AoP3OGdI

Unit 10

Gomez, A. G., Oakes, W. C., Leone, L. L., & Gruender, J. L. (2006). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press.

Karsnitz, J. R., O'Brien, S., & Hutchinson, J. P. (2009). *Engineering design: An introduction*. Clifton Park, NY: Delmar Cengage Learning.

Orsak, G. C. (2004). *Engineering: Our digital future*. Upper Saddle River, NJ: Pearson Prentice Hall.

LearnMate. (2013). *LearnMate*. Retrieved May 31, 2013, from http://www.learnmate.com/

Intelitek. (2013). *Intelitek*. Retrieved May 31, 2013, from http://www.intelitek.com/

Unit 11

Gomez, A. G., Oakes, W. C., Leone, L. L., & Gruender, J. L. (2006). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press.

Karsnitz, J. R., O'Brien, S., & Hutchinson, J. P. (2009). *Engineering design: An introduction*. Clifton Park, NY: Delmar Cengage Learning.

Orsak, G. C. (2004). *Engineering: Our digital future*. Upper Saddle River, NJ: Pearson Prentice Hall.

LearnMate. (2013). *LearnMate*. Retrieved May 31, 2013, from http://www.learnmate.com/

Intelitek. (2013). *Intelitek*. Retrieved May 31, 2013, from http://www.intelitek.com/

Unit 12

Gomez, A. G., Oakes, W. C., Leone, L. L., & Gruender, J. L. (2006). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press.

Karsnitz, J. R., O'Brien, S., & Hutchinson, J. P. (2009). *Engineering design: An introduction*. Clifton Park, NY: Delmar Cengage Learning.

Orsak, G. C. (2004). *Engineering: Our digital future*. Upper Saddle River, NJ: Pearson Prentice Hall.

LearnMate. (2013). *LearnMate*. Retrieved May 31, 2013, from http://www.learnmate.com/

Intelitek. (2013). *Intelitek*. Retrieved May 31, 2013, from http://www.intelitek.com/

Unit 13

Gomez, A. G., Oakes, W. C., Leone, L. L., & Gruender, J. L. (2006). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press.

Karsnitz, J. R., O'Brien, S., & Hutchinson, J. P. (2009). *Engineering design: An introduction*. Clifton Park, NY: Delmar Cengage Learning.

Orsak, G. C. (2004). *Engineering: Our digital future*. Upper Saddle River, NJ: Pearson Prentice Hall.

LearnMate. (2013). *LearnMate*. Retrieved May 31, 2013, from http://www.learnmate.com/

Intelitek. (2013). *Intelitek*. Retrieved May 31, 2013, from http://www.intelitek.com/

Unit 14

Gomez, A. G., Oakes, W. C., Leone, L. L., & Gruender, J. L. (2006). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press.

Karsnitz, J. R., O'Brien, S., & Hutchinson, J. P. (2009). *Engineering design: An introduction*. Clifton Park, NY: Delmar Cengage Learning.

Orsak, G. C. (2004). *Engineering: Our digital future*. Upper Saddle River, NJ: Pearson Prentice Hall.

LearnMate. (2013). *LearnMate*. Retrieved May 31, 2013, from http://www.learnmate.com/

Intelitek. (2013). *Intelitek*. Retrieved May 31, 2013, from http://www.intelitek.com/

Unit 15

Gomez, A. G., Oakes, W. C., Leone, L. L., & Gruender, J. L. (2006). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press.

Intelitek. (2013). *Intelitek*. Retrieved May 31, 2013, from http://www.intelitek.com/

Karsnitz, J. R., O'Brien, S., & Hutchinson, J. P. (2009). *Engineering design: An introduction*. Clifton Park, NY: Delmar Cengage Learning.

LearnMate. (2013). *LearnMate*. Retrieved May 31, 2013, from http://www.learnmate.com/

Orsak, G. C. (2004). *Engineering: Our digital future*. Upper Saddle River, NJ: Pearson Prentice Hall.

VEX Robotics. (2013). *VEX Robotics*. Retrieved May 31, 2013, from http://www.vexrobotics.com/

Unit 16

Gomez, A. G., Oakes, W. C., Leone, L. L., & Gruender, J. L. (2006). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press.

How to write career documents to influence your reader. (2013). *The Undercover Recruiter*. Retrieved May 31, 2013, from http://theundercoverrecruiter.com/how-write-career-documents-influence-your-reader/

Job shadow. (201). *Read about your career options: Shadow real jobs online.* Retrieved May 31, 2013, from http://www.jobshadow.com/

Karsnitz, J. R., O'Brien, S., & Hutchinson, J. P. (2009). *Engineering design: An introduction*. Clifton Park, NY: Delmar Cengage Learning.

Orsak, G. C. (2004). *Engineering: Our digital future*. Upper Saddle River, NJ: Pearson Prentice Hall.

U.S. Bureau of Labor Statistics. (2013). *U.S. Bureau of Labor Statistics*. Retrieved May 31, 2013, from http://www.bls.gov/

Virtual Job Shadow. (2013). *Interactive career exploration*. Retrieved May 31, 2013, from http://www.virtualjobshadow.com/

Appendix B: Industry Standards

International Technology and Engineering Education Association (ITEEA)—Standards for Technological Literacy

Industry Standards Crosswalk for Engineering

	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16
Standards for Technological Literacy																	
STL1		x	x			x	x			x	x	x	x	x	x	x	
STL2		x	x			x	x			x	x	x	x	x	x	x	
STL3			x	x	x			x	x	x	x	x	x	x	x		x
STL4		x	x	x								x					x
STL5				x	x			x	x	x	x	x	x	x	x		
STL6		x	x	x	x			x	x	x	x	x	x	x	x		x
STL7			x														
STL8			x			x	x								x	x	
STL9			x			x	x				x	x	x	x	x	x	
STL10		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
STL11			x			x	x									x	
STL12							x		x	x	x	x	x	x	x	x	
STL13				x	x			x	x	x	x	x	x	x	x		
STL14														x			
STL15								x				x		x			
STL16								x	x		x	x		x			
STL17						x	x			x					x	x	
STL18													x				
STL19				x	x				x		x		x		x		
STL20					x							x	x				

International Technology and Engineering Education Association (ITEEA)—Standards for Technological Literacy

STL1 Students will develop an understanding of the characteristics and scope of technology.
STL2 Students will develop an understanding of the core concepts of technology.
STL3 Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
STL4 Students will develop an understanding of the cultural, social, economic, and political effects of technology.
STL5 Students will develop an understanding of the effects of technology on the environment.
STL6 Students will develop an understanding of the role of society in the development of and use of technology.
STL7 Students will develop an understanding of the influence of technology on history.
STL8 Students will develop an understanding of the attributes of design.
STL9 Students will develop an understanding of engineering design.
STL10 Students will develop an understanding of the role of troubleshooting, research and development, inventions and innovation, and experimentation in problem solving.
STL11 Students will develop the abilities to apply the design process.
STL12 Students will develop the abilities to use and maintain technological products and systems.
STL13 Students will develop the abilities to assess the impact of products and systems.

STL14 Students will develop an understanding of and be able to select and use medical technologies.
STL15 Students will develop an understanding of and be able to select and use agricultural and related biotechnologies.
STL16 Students will develop an understanding of and be able to select and use energy and power technologies.
STL17 Students will develop an understanding of and be able to select and use information and communication technologies.
STL18 Students will develop an understanding of and be able to select and use transportation technologies.
STL19 Students will develop an understanding of and be able to select and use manufacturing technologies.
STL20 Students will develop an understanding of and be able to select and use construction technologies.

Appendix C: 21st Century Skills[3]

21st Century Crosswalk for Engineering

	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16
21st Century Standards																	
CS1			x	x	x			x	x	x	x	x	x	x	x		x
CS2		x		x	x		x	x	x	x	x	x	x	x	x	x	x
CS3		x															x
CS4		x						x									x
CS5								x									x
CS6			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
CS7			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
CS8		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x
CS9						x	x			x	x	x	x	x	x	x	x
CS10						x	x			x	x	x	x	x	x	x	x
CS11				x	x	x	x	x	x	x	x	x	x	x	x	x	x
CS12						x	x				x	x	x	x	x	x	x
CS13				x	x	x	x	x	x	x	x	x	x	x	x	x	x
CS14			x			x	x				x	x	x	x	x	x	x
CS15				x	x	x	x	x	x	x	x	x	x	x	x	x	x
CS16		x				x	x				x	x	x	x	x	x	x

CSS1-21st Century Themes

CS1 Global Awareness

1. Using 21st century skills to understand and address global issues
2. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
3. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business, and Entrepreneurial Literacy

1. Knowing how to make appropriate personal economic choices
2. Understanding the role of the economy in society
3. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

1. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
2. Exercising the rights and obligations of citizenship at local, state, national, and global levels
3. Understanding the local and global implications of civic decisions

CS4 Health Literacy

1. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
2. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
3. Using available information to make appropriate health-related decisions

[3] *21st century skills.* (n.d.). Washington, DC: Partnership for 21st Century Skills.

4. Establishing and monitoring personal and family health goals
5. Understanding national and international public health and safety issues

CS5 Environmental Literacy

1. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems.
2. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.).
3. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions.
4. Take individual and collective action toward addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues).

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation

1. Think Creatively
2. Work Creatively with Others
3. Implement Innovations

CS7 Critical Thinking and Problem Solving

1. Reason Effectively
2. Use Systems Thinking
3. Make Judgments and Decisions
4. Solve Problems

CS8 Communication and Collaboration

1. Communicate Clearly
2. Collaborate with Others

CSS3-Information, Media and Technology Skills

CS9 Information Literacy

1. Access and Evaluate Information
2. Use and Manage Information

CS10 Media Literacy

1. Analyze Media
2. Create Media Products

CS11 ICT Literacy

1. Apply Technology Effectively

CSS4-Life and Career Skills

CS12 Flexibility and Adaptability

1. Adapt to change
2. Be Flexible

CS13 Initiative and Self-Direction

1. Manage Goals and Time
2. Work Independently

3. Be Self-directed Learners

CS14 Social and Cross-Cultural Skills

1. Interact Effectively with others
2. Work Effectively in Diverse Teams

CS15 Productivity and Accountability

1. Manage Projects
2. Produce Results

CS16 Leadership and Responsibility

1. Guide and Lead Others
2. Be Responsible to Others

Appendix D: Common Core Standards

Common Core Crosswalk for English/Language Arts (11-12)																	
	Units	**Unit 1**	**Unit 2**	**Unit 3**	**Unit 4**	**Unit 5**	**Unit 6**	**Unit 7**	**Unit 8**	**Unit 9**	**Unit 10**	**Unit 11**	**Unit 12**	**Unit 13**	**Unit 14**	**Unit 15**	**Unit 16**
Common Core Standards																	
RST.11.1.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
RST.11.2.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
RST.11.3.			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
RST.11.4.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
RST.11.5.			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
RST.11.7.			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
RST.11.8.			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
RST.11.9.			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
RST.11.10.			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
WHST.11.1.			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
WHST.11.4.			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
WHST.11.5.			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
WHST.11.6.			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
WHST.11.7.			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
WHST.11.8.			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
WHST.11.9.			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
WHST.11.10.			x			x	x									x	x

Reading Standards for Literature (11-12)

College and Career Readiness Anchor Standards for *Reading Literature*

Key Ideas and Details

RL.11.1. Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.

RL.11.2. Determine two or more themes or central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to produce a complex account; provide an objective summary of the text.

RL.11.3. Analyze the impact of the author's choices regarding how to develop and relate elements of a story or drama (e.g., where a story is set, how the action is ordered, how the characters are introduced and developed).

Craft and Structure

RL.11.4. Determine the meaning of words and phrases as they are used in the text, including figurative and connotative meanings; analyze the impact of specific word choices on meaning and tone, including words with multiple meanings or language that is particularly fresh, engaging, or beautiful. (Include Shakespeare as well as other authors.)

RL.11.5. Analyze how an author's choices concerning how to structure specific parts of a text (e.g., the choice of where to begin or end a story, the choice to provide a comedic or tragic resolution) contribute to its overall structure and meaning as well as its aesthetic impact.

RL.11.6. Analyze a case in which grasping point of view requires distinguishing what is directly stated in a text from what is really meant (e.g., satire, sarcasm, irony, or understatement).

Integration of Knowledge and Ideas

RL.11.7. Analyze multiple interpretations of a story, drama, or poem (e.g., recorded or live production of a play or recorded novel or poetry), evaluating how each version interprets the source text. (Include at least one play by Shakespeare and one play by an American dramatist.)

RL.11.8. (Not applicable to literature)

RL.11.9. Demonstrate knowledge of eighteenth-, nineteenth- and early-twentieth-century foundational works of American literature, including how two or more texts from the same period treat similar themes or topics.

Range of Reading and Level of Text Complexity

RL.11.10. By the end of grade 11, read and comprehend literature, including stories, dramas, and poems, in the grades 11–CCR text complexity band proficiently, with scaffolding as needed at the high end of the range.
By the end of grade 12, read and comprehend literature, including stories, dramas, and poems, at the high end of the grades 11–CCR text complexity band independently and proficiently.

Reading Standards for Informational Text (11-12)

College and Career Readiness Anchor Standards for *Informational Text*

Key Ideas and Details

RI.11.1. Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.

RI.11.2. Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text.

RI.11.3. Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text.

Craft and Structure

RI.11.4. Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10).

RI.11.5. Analyze and evaluate the effectiveness of the structure an author uses in his or her exposition or argument, including whether the structure makes points clear, convincing, and engaging.

RI.11.6. Determine an author's point of view or purpose in a text in which the rhetoric is particularly effective, analyzing how style and content contribute to the power, persuasiveness, or beauty of the text.

Integration of Knowledge and Ideas

RI.11.7. Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.

RI.11.8. Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning (e.g., in U.S. Supreme Court majority opinions and dissents) and the premises, purposes, and arguments in works of public advocacy (e.g., The Federalist, presidential addresses).

RI.11.9. Analyze seventeenth-, eighteenth-, and nineteenth-century foundational U.S. documents of historical and literary significance (including The Declaration of Independence, the Preamble to the Constitution, the Bill of Rights, and Lincoln's Second Inaugural Address) for their themes, purposes, and rhetorical features.

Range of Reading and Level of Text Complexity

RI.11.10. By the end of grade 11, read and comprehend literary nonfiction in the grades 11–CCR text complexity band proficiently, with scaffolding as needed at the high end of the range.
By the end of grade 12, read and comprehend literary nonfiction at the high end of the grades 11–CCR text complexity band independently and proficiently.

College and Career Readiness Anchor Standards for *Writing*

Text Types and Purposes

W.11.1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences claim(s), counterclaims, reasons, and evidence.

b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level, concerns, values, and possible biases.

c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

e. Provide a concluding statement or section that follows from and supports the argument presented.

W.11.2. Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

a. Introduce a topic; organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use appropriate and varied transitions and syntax to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

d. Use precise language, domain-specific vocabulary, and techniques such as metaphor, simile, and analogy to manage the complexity of the topic.

e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

W.11.3. Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

a. Engage and orient the reader by setting out a problem, situation, or observation and its significance, establishing one or multiple point(s) of view, and introducing a narrator and/or characters; create a smooth progression of experiences or events.

b. Use narrative techniques, such as dialogue, pacing, description, reflection, and multiple plot lines, to develop experiences, events, and/or characters

c. Use a variety of techniques to sequence events so that they build on one another to create a coherent whole and build toward a particular tone and outcome (e.g., a sense of mystery, suspense, growth, or resolution).

d. Use precise words and phrases, telling details, and sensory language to convey a vivid picture of the experiences, events, setting, and/or characters.
e. Provide a conclusion that follows from and reflects on what is experienced, observed, or resolved over the course of the narrative.

Production and Distribution of Writing

W.11.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)

W.11.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (Editing for conventions should demonstrate command of Language standards 1–3 up to and including grades 11–12 on page 54.)

W.11.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

Research to Build and Present Knowledge

W.11.7. 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.

W.11.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

W.11.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.

a. Apply grades 11–12 Reading standards to literature (e.g., "Demonstrate knowledge of eighteenth-, nineteenth- and early-twentieth-century foundational works of American literature, including how two or more texts from the same period treat similar themes or topics").

b. Apply grades 11–12 Reading standards to literary nonfiction (e.g., "Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning [e.g., in U.S. Supreme Court Case majority opinions and dissents] and the premises, purposes, and arguments in works of public advocacy [e.g., The Federalist, presidential addresses]").

Range of Writing

W.11.10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

College and Career Readiness Anchor Standards for *Speaking and Listening*

Comprehension and Collaboration

SL.11.1. Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

a. Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.

b. Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed.

c. Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives.

d. Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task.

SL.11.2. Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

SL.11.3. Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used.

Presentation of Knowledge and Ideas

SL.11.4. Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.

SL.11.5. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

SL.11.6. Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate. (See grades 11–12 Language standards 1 and 3 on page 54 for specific expectations.)

College and Career Readiness Anchor Standards for *Language*

Conventions of Standard English

L.11.1. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

a. Apply the understanding that usage is a matter of convention, can change over time, and is sometimes contested.

b. Resolve issues of complex or contested usage, consulting references (e.g., Merriam-Webster's Dictionary of English Usage, Garner's Modern American Usage) as needed.

L.11.2. Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

a. Observe hyphenation conventions.

b. Spell correctly.

Knowledge of Language

L.11.3. Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.

a. Vary syntax for effect, consulting references (e.g., Tufte's Artful Sentences) for guidance as needed; apply an understanding of syntax to the study of complex texts when reading.

Vocabulary Acquisition and Use

L.11.4. Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11–12 reading and content, choosing flexibly from a range of strategies.

a. Use context (e.g., the overall meaning of a sentence, paragraph, or text; a word's position or function in a sentence) as a clue to the meaning of a word or phrase.

b. Identify and correctly use patterns of word changes that indicate different meanings or parts of speech (e.g., conceive, conception, conceivable).

c. Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, its etymology, or its standard usage.

d. Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).

L.11.5. Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.

a. Interpret figures of speech (e.g., hyperbole, paradox) in context and analyze their role in the text.
b. Analyze nuances in the meaning of words with similar denotations.

L.11.6. Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Reading Standards for Literacy in History/Social Studies (11-12)

Key Ideas and Details

RH.11.1 Cite specific textual evidence to support analysis of primary and secondary sources, connecting insights gained from specific details to an understanding of the text as a whole.

RH.11.2. Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas

RH.11.3. Evaluate various explanations for actions or events and determine which explanation best accords with textual evidence, acknowledging where the text leaves matters uncertain

Craft and Structure

RH.11.4. Determine the meaning of words and phrases as they are used in a text, including analyzing how an author uses and refines the meaning of a key term over the course of a text (e.g., how Madison defines faction in Federalist No. 10).

RH.11.5. Analyze in detail how a complex primary source is structured, including how key sentences, paragraphs, and larger portions of the text contribute to the whole.

RH.11.6. Evaluate authors' differing points of view on the same historical event or issue by assessing the authors' claims, reasoning, and evidence.

Integration of Knowledge and Ideas

RH.11.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.

RH.11.8. Evaluate an author's premises, claims, and evidence by corroborating or challenging them with other information.

RH.11.9. Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources.

Range of Reading and Level of Text Complexity

RH.11.10. By the end of grade 12, read and comprehend history/social studies texts in the grades 11–CCR text complexity band independently and proficiently.

Reading Standards for Literacy in Science and Technical Subjects (11-12)

Key Ideas and Details

RST.11.1. Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

RST.11.2. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

RST.11.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

Craft and Structure

RST.11.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics.

RST.11.5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

RST.11.6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.

Integration of Knowledge and Ideas

RST.11.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

RST.11.8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

RST.11.9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Range of Reading and Level of Text Complexity

RST.11.10. By the end of grade 12, read and comprehend science/technical texts in the grades 11–CCR text complexity band independently and proficiently.

Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects (11-12)

Text Types and Purposes

WHST.11.1. Write arguments focused on discipline-specific content.

a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.

b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.

c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST.11.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole;

include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.

e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

WHST.11.3. (Not applicable as a separate requirement)

Production and Distribution of Writing

WHST.11.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.11.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

WHST.11.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

Research to Build and Present Knowledge

WHST.11.7. 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.

WHST.11.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each

source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

WHST.11.9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing

WHST.11.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Common Core Crosswalk for Mathematics (11-12)																	
	Units	**Unit 1**	**Unit 2**	**Unit 3**	**Unit 4**	**Unit 5**	**Unit 6**	**Unit 7**	**Unit 8**	**Unit 9**	**Unit 10**	**Unit 11**	**Unit 12**	**Unit 13**	**Unit 14**	**Unit 15**	**Unit 16**
Common Core Standards																	
N-Q.1.			x		x	x	x	x	x	x	x	x	x	x	x	x	
N-Q.2.			x		x	x	x	x	x	x	x	x	x	x	x	x	
N-Q.3.			x		x	x	x	x	x	x	x	x	x	x	x	x	
G-CO.1.						x	x									x	
G-CO.2.							x									x	
G-CO.3.						x											
G-CO.4.						x											
G-CO.5.						x											
G-CO.6.						x											
G-CO.7.						x											
G-CO.8.						x											
G-CO.12.						x											
G-CO.13.						x											
G-SRT.2.						x											
G-GMD.4.						x											
G-MG.3.						x											

Mathematics (High School)

Number and Quantity

The Real Number System

N-RN.1. Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.

N-RN.2. Rewrite expressions involving radicals and rational exponents using the properties of exponents.

N-RN.3. Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Quantities

N-Q.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.

N-Q.2. Define appropriate quantities for the purpose of descriptive modeling.

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

The Complex Number System

N-CN.1. Know there is a complex number i such that i2= –1, and every complex number has the form a + bi with a and b real.

N-CN.2. Use the relation i2= –1 and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

N-CN.3. (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.

N-CN.4. (+) Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number.

N-CN.5. (+) Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. For example, $(–1 + \sqrt{3}\ i)3= 8$ because $(–1 + \sqrt{3}\ i)$ has modulus 2 and argument 120°.

N-CN.6. (+) Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.

N-CN.7. Solve quadratic equations with real coefficients that have complex solutions.

N-CN.8. (+) Extend polynomial identities to the complex numbers. For example, rewrite x2+ 4 as (x + 2i)(x – 2i).

N-CN.9. (+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.

Vector and Matrix Quantities

N-VM.1. (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|, ||v||, v).

N-VM.2. (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.

N-VM.3. (+) Solve problems involving velocity and other quantities that can be represented by vectors.

N-VM.4. (+) Add and subtract vectors

N-VM.4.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.

N-VM.4.b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.

N-VM.4.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.

N-VM.5. (+) Multiply a vector by a scalar.

N-VM.5.a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as $c(vx, vy) = (cvx, cvy)$.

N-VM.5.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 $c < 0$).

N-VM.6. (+) Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.

N-VM.7. (+) Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.

N-VM.8. (+) Add, subtract, and multiply matrices of appropriate dimensions.

N-VM.9. (+) Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties

N-VM.10. (+) Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.

N-VM.11. (+) Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.

N-VM.12. (+) Work with 2×2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.

Algebra

Seeing Structure in Expressions

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

A-SSE.1.a. Interpret parts of an expression, such as terms, factors, and coefficients.

A-SSE.1.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.

A-SSE.2. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

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

A-SSE.3.a. Factor a quadratic expression to reveal the zeros of the function it defines.

A-SSE.3.b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.

A-SSE.3.c. Use the properties of exponents to transform expressions for exponential functions.

A-SSE.4. Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments.

Arithmetic with Polynomials and Rational Expressions

A-APR.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

A-APR.2. Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x).

A-APR.3. Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

A-APR.4. Prove polynomial identities and use them to describe numerical relationships.

A-APR.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.

A-APR.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-APR.7. (+) Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.

Creating Equations

A-CED.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.

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

A-CED.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-CED.4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V=IR to highlight resistance R.

Reasoning with Equations and Inequalities

A-REI.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.

A-REI.2. Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

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

A-REI.4. Solve quadratic equations in one variable.

A-REI.4.a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form (x – p)2= q that has the same solutions. Derive the quadratic formula from this form.

A-REI.4.b. Solve quadratic equations by inspection (e.g., for x2= 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real numbers a and b.

A-REI.5. Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

A-REI.6. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

A-REI.7. Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line y = –3x and the circle x2+y2= 3.

A-REI.8. (+) Represent a system of linear equations as a single matrix equation in a vector variable.

A-REI.9. (+) Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using technology for matrices of dimension 3 × 3 or greater).

A-REI.10. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

A-REI.11. Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

A-REI.12.Graph the solutions to a linear inequality in two variables as a half plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Functions

Interpreting Functions

F-IF.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).

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

F-IF.3. Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by $f(0) = f(1) = 1$, $f(n+1) = f(n) + f(n-1)$ for $n \geq 1$.

F-IF.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.

F-IF.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.

F-IF.6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

F-IF.7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

F-IF.7.a. Graph linear and quadratic functions and show intercepts, maxima, and minima.

F-IF.7.b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.

F-IF.7.c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

F-IF.7.d. (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.

F-IF.7.e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

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

F-IF.8.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.

F-IF.8.b. Use the properties of exponents to interpret expressions for exponential functions.

F-IF.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.

Building Functions

F-BF.1. Write a function that describes a relationship between two quantities.

F-BF.1.a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

F-BF.1.b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.

F-BF.1.c. (+) Compose functions. For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time.

F-BF.2. Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.

F-BF.3. Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

F-BF.4. Find inverse functions.

F-BF.4.a. Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse.

F-BF.4.b. (+) Verify by composition that one function is the inverse of another.

F-BF.4.c. (+) Read values of an inverse function from a graph or a table, given that the function has an inverse.

F-BF.4.d. (+) Produce an invertible function from a non-invertible function by restricting the domain.

F-BF.5. (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.

Linear, Quadratic, and Exponential Models

F-LE.1. Distinguish between situations that can be modeled with linear functions and with exponential functions.

F-LE.1.a. Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.

F-LE.1.b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

F-LE.1.c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another

F-LE.2. Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

F-LE.3. Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.

F-LE.4. For exponential models, express as a logarithm the solution to ab ct = d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.

F-LE.5. Interpret the parameters in a linear or exponential function in terms of a context.

Trigonometric Functions

F-TF.1. Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.

F-TF.2. Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.

F-TF.3. (+) Use special triangles to determine geometrically the values of sine, cosine, tangent for $\pi/3$, $\pi/4$ and $\pi/6$, and use the unit circle to express the values of sine, cosine, and tangent for $\pi - x$, $\pi + x$, and $2\pi - x$ in terms of their values for x, where x is any real number.

F-TF.4. (+) Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.

F-TF.5. Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.

F-TF.6. (+) Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.

F-TF.7. (+) Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context.

F-TF.8. Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to find $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ given $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ and the quadrant of the angle.

F-TF.9. (+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.

Geometry

Congruence

G-CO.1. Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.

G-CO.2. Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).

G-CO.3. Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.

G-CO.4. Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.

G-CO.5. Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.

G-CO.6. Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.

G-CO.7. Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.

G-CO.8. Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.

G-CO.9. Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.

G-CO.10. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180°; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.

G-CO.11. Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.

G-CO.12. Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.

G-CO.13. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

Similarity, Right Triangles, and Trigonometry

G-SRT.1. Verify experimentally the properties of dilations given by a center and a scale factor:

G-SRT.1.a. A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.

G-SRT.1.b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.

G-SRT.2. Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.

G-SRT.3. Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.

G-SRT.4. Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.

G-SRT.5. Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

G-SRT.6. Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.

G-SRT.7. Explain and use the relationship between the sine and cosine of complementary angles.

G-SRT.8. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

G-SRT.9. (+) Derive the formula $A = 1/2\ ab \sin(C)$ for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.

G-SRT.10. (+) Prove the Laws of Sines and Cosines and use them to solve problems.

G-SRT.11. (+) Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).

Circles

G-C.1. Prove that all circles are similar.

G-C.2. Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.

G-C.3. Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.

G-C.4. (+) Construct a tangent line from a point outside a given circle to the circle.

G-C.5. Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.

Expressing Geometric Properties with Equations

G-GPE.1. Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.

G-GPE.2. Derive the equation of a parabola given a focus and directrix.

G-GPE.3. (+) Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.

G-GPE.4. Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point $(1, \sqrt{3})$ lies on the circle centered at the origin and containing the point (0, 2).

G-GPE.5. Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).

G-GPE.6. Find the point on a directed line segment between two given points that partitions the segment in a given ratio.

G-GPE.7. Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.

Geometric Measurement and Dimension

G-GMD.1. Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.

G-GMD.2. (+) Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.

G-GMD.3. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.

G-GMD.4. Identify the shapes of two-dimensional cross-sections of three dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

Modeling with Geometry

G-MG.1. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).

G-MG.2. Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).

G-MG.3. Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).

Statistics and Probability

Interpreting Categorical and Quantitative Data

S-ID.1. Represent data with plots on the real number line (dot plots, histograms, and box plots).

S-ID.2. Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.

S-ID.3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).

S-ID.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.

S-ID.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.

S-ID.6. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

S-ID.6.a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

S-ID.6.b. Informally assess the fit of a function by plotting and analyzing residuals.

S-ID.6.c. Fit a linear function for a scatter plot that suggests a linear association.

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

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

S-ID.9. Distinguish between correlation and causation.

Making Inferences and Justifying Conclusions

S-IC.1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

S-IC.2. Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?

S-IC.3. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.

S-IC.4. Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.

S-IC.5. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.

S-IC.6. Evaluate reports based on data.

Conditional Probability and the Rules of Probability

S-CP.1. Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not").

S-CP.2. Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.

S-CP.3. Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.

S-CP.4. Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.

S-CP.5. Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.

S-CP.6. Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model.

S-CP.7. Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answer in terms of the model.

S-CP.8. (+) Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(B|A) = P(B)P(A|B), and interpret the answer in terms of the model.

S-CP.9. (+) Use permutations and combinations to compute probabilities of compound events and solve problems.

Using Probability to Make Decisions

S-MD.1. (+) Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.

S-MD.2. (+) Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.

S-MD.3. (+) Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. For example, find the theoretical probability distribution for the number of correct answers obtained by guessing on all five questions of a multiple-choice test where each question has four choices, and find the expected grade under various grading schemes.

S-MD.4. (+) Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. For example, find a current data distribution on the number of TV sets per household in the United States, and calculate the expected number of sets per household. How many TV sets would you expect to find in 100 randomly selected households?

S-MD.5. (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.

> S-MD.5.a. Find the expected payoff for a game of chance. For example, find the expected winnings from a state lottery ticket or a game at a fast-food restaurant.
>
> S-MD.5.b. Evaluate and compare strategies on the basis of expected values. For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident.

S-MD.6. (+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).

S-MD.7. (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).

Appendix E: National Educational Technology Standards for Students (NETS-S)

NETS Crosswalk for Engineering																	
	Unit	**Unit 1**	**Unit 2**	**Unit 3**	**Unit 4**	**Unit 5**	**Unit 6**	**Unit 7**	**Unit 8**	**Unit 9**	**Unit 10**	**Unit 11**	**Unit 12**	**Unit 13**	**Unit 14**	**Unit 15**	**Unit 16**
NETS Standards																	
T1			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
T2		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
T3			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
T4			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
T5		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
T6		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

T1 Creativity and Innovation
T2 Communication and Collaboration
T3 Research and Information Fluency
T4 Critical Thinking, Problem Solving, and Decision Making
T5 Digital Citizenship
T6 Technology Operations and Concepts

T1 Creativity and Innovation
Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

a. Apply existing knowledge to generate new ideas, products, or processes.
b. Create original works as a means of personal or group expression.
c. Use models and simulations to explore complex systems and issues.
d. Identify trends and forecast possibilities.

T2 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. Students do the following:

a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
c. Develop cultural understanding and global awareness by engaging with learners of other cultures.
d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency
Students apply digital tools to gather, evaluate, and use information. Students do the following:

a. Plan strategies to guide inquiry.
b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
d. Process data and report results.

T4 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. Students do the following:

a. Identify and define authentic problems and significant questions for investigation.
b. Plan and manage activities to develop a solution or complete a project.
c. Collect and analyze data to identify solutions and/or make informed decisions.
d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

a. Advocate and practice safe, legal, and responsible use of information and technology.
b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
c. Demonstrate personal responsibility for lifelong learning.
d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

a. Understand and use technology systems.
b. Select and use applications effectively and productively.
c. Troubleshoot systems and applications.
d. Transfer current knowledge to learning of new technologies.

Appendix F: Academic Standards

Mississippi Science Framework Competencies

MS Physics Standards for Engineering

	Unit	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16
MS Science Standards																	
1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.			x	x	x	x	x	x	x	x	x	x	x	x	x	x	
2. Develop an understanding of concepts related to forces and motion.						x	x		x		x	x	x	x	x	x	
3. Develop an understanding of concepts related to work and energy.				x	x	x	x	x	x		x	x	x	x	x	x	
4. Discuss the characteristics and properties of light and sound.							x		x		x	x	x	x	x	x	
5. Apply an understanding of magnetism, electric fields, and electricity.			x	x				x	x	x	x	x	x	x	x	x	
6. Analyze and explain concepts of nuclear physics.																	