Engineering

Program CIP: 14.1901

Ordering Information

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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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Dr. Hank M. Bounds, Executive Secretary
Mr. Claude Hartley, Chair
Mr. William Harold Jones, Vice Chair
Mr. Howell "Hal" N. Gage
Dr. O. Wayne Gann
Ms. Rebecca Harris
Mr. Charles McClelland
Ms. Sondra Parker Caillavet
Ms. Rosetta Richards
Dr. David Sistrunk

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Finally, standards in the *Engineering Curriculum Framework and Supporting Materials* are based on the following:

International Technology Education Association (ITEA) Standards
The International Technology Education Association (ITEA) 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/.

Applied Academic Credit Benchmarks
Mississippi Department of Education 2007 Mississippi Mathematics and Physics Framework Revised

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.

National Educational Technology Standards for Students
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ACT College Readiness Standards

The College Readiness Standards are sets of statements intended to help students understand what is expected of them in preparation for the ACT. These standards are integrated into teaching and assessment strategies throughout the curriculum framework.

Preface

Secondary vocational–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).

Engineering Executive Summary

Program Description

Engineering is a program in pre-engineering 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

Engineering: 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.

All states and the District of Columbia require licensure for engineers who offer their services directly to the public. Engineers who are licensed are called Professional Engineers (PEs). This licensure generally requires a degree from an ABET-accredited engineering program, 4 years of relevant work experience, and successful completion of a state examination. Recent graduates can start the licensing process by taking the examination in two stages. The initial Fundamentals of Engineering (FE) examination can be taken upon graduation. Engineers who pass this examination commonly are called Engineers in Training (EIT) or Engineer Interns (EIs). After acquiring suitable work experience, EITs can take the second examination, the Principles and Practice of Engineering exam.

Assessment

Students will be assessed using the Engineering MS-CPAS2 test. The MS-CPAS2 blueprint can be found at http://info.rcu.msstate.edu/services/curriculum.asp. If there are questions regarding assessment of this program, please contact the STEM instructional design specialist at the Research and Curriculum Unit at 662.325.2510.

Student Prerequisites

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

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

Proposed Applied Academic Credit

Applied Mathematics content from the curriculum was aligned to the 2007 Mississippi Mathematics Framework Revised Academic Benchmarks. It is proposed that upon the completion of this program, students will earn 1/2 Applied Mathematics credit that can be used for graduation requirements.

Applied Physics content from the curriculum was aligned to the 2010 Mississippi Science Framework Revised Academic Benchmarks. It is proposed that upon the completion of this program, students will earn 1/2 Applied Physics credit that can be used for graduation requirements.

The applied academic credit has not been approved by the Mississippi Commission on School Accreditation or by the State Board of Education. If there are questions regarding applied academic credit, please contact the Coordinator of Workforce Education at the Research and Curriculum Unit at 662.325.2510.

Licensure Requirements

The 985 licensure endorsement is needed to teach the Engineering program. The requirements for the 985 licensure endorsement are listed below:

1. Applicant must have earned a 4-year degree (bachelor's degree) or higher from an accredited institution of higher education. The degree must be in engineering, mathematics, or an appropriate field of science and must be approved by the MDE program coordinator.
2. Applicant must enroll immediately in the Vocational Instructor Preparation (VIP) or the Redesign Education Program (REP).
3. Applicant must complete the individualized Professional Development Plan (PDP) requirements of the VIP or REP prior to the expiration date of the 3-year vocational license.
4. Applicant must successfully complete an MDE-approved computer literacy certification exam.
5. Applicant must successfully complete certification for an online learning workshop, module, or course that is approved by the MDE.

6. Applicant must successfully complete an Engineering certification workshop, module, or course that is approved by the MDE.

Note: If an applicant meets all requirements listed above, that applicant will be issued a 985 endorsement—a 5-year license. If the applicant does not meet all requirements, the applicant may be issued a 3-year endorsement (license), and all requirements must be satisfied prior to the ending date of that license.

Exception: LEAs converting to this pathway from existing programs in Technology Applications (with teachers currently licensed and endorsed #994 Technology Applications) may continue to employ those teachers and seek 985 endorsement for them although they do not meet the above stated requirement for a 4-year degree in certain major fields of study. These teachers must satisfy all other requirements stated above. All other teachers must meet the requirements for this endorsement.

Professional Learning

The professional learning itinerary for the middle school or individual pathways can be found at http://redesign.rcu.msstate.edu. If you have specific questions about the content of each training session provided, please contact the Research and Curriculum Unit at 662.325.2510, and ask for the Professional Learning Specialist.

Course Outlines

Program CIP Code: 14.1901

This curriculum framework is divided into four one-Carnegie-unit courses as outlined below. The first two courses are comprised of units from Engineering Year 1. The last two courses are comprised of units from Engineering Year 2.

Option 1 – Four One-Carnegie-Unit Courses

Course Description: 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. This course also teaches technical writing, presenting, and project management.

Course Description: Engineering Design teaches students the engineering design process, the steps one follows for successful design planning. Students are also introduced to the advanced concepts of 3-D sketching and modeling with CAD software. This course also focuses on quality control and the benefits of engineering failure.

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

Course Description: Applied Engineering Concepts teaches students the concepts of digital electronic control system technology, focusing on electronics, gates, and truth tables. Students will also learn valuable workforce readiness skills and participate in a self-directed project that focuses on concepts associated with engineering.

Engineering Fundamentals (One Carnegie Unit) - Course Code: 994002

Unit		Title	Hours
1		Orientation and Safety	8
2		Engineering History, Ethics, and Careers	12
3		Writing, Presenting, and Project Management	20
4		Introduction to Robotics	100
			140

Engineering Design (One Carnegie Unit) - Course Code: 994003

Unit		Title	Hours
5		Engineering Design Process	40
6		Sketching and Modeling	60
7		Production, Quality Control, and Engineering Failure	40
			140

Systems in Engineering (One Carnegie Unit) - Course Code: 994004

Unit		Title	Hours
8		The Four Systems	80
9		CIM—Computer Integrated Manufacturing	60
			140

Applied Engineering Concepts (One Carnegie Unit) - Course Code: 994005

Unit		Title	Hours
10		Advanced Robotics	100
11		Digital Electronic Control System Technology	20
12		Workforce Readiness	20
			140

Option 2 – Two Two-Carnegie-Unit Courses

Course Description: 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. This course also teaches technical writing, presenting, and project management. It also teaches students the engineering design process, the steps one follows for successful design planning. Students are also introduced to the advanced concepts of 3-D sketching and modeling with CAD software. This course also focuses on quality control and the benefits of engineering failure.

Course Description: Engineering II is a comprehensive course that focuses on the four systems: electrical, fluid, mechanical, and thermal. It also introduces students to Computer Integrated Manufacturing, or how robotics and drafting work together to create products. This course teaches students the concepts of digital electronic control system technology, focusing on electronics, gates, and truth tables. Students will also learn valuable workforce readiness skills and participate advanced concepts of programming robotic equipment.

Engineering I (Two Carnegie Units) - Course Code: 994000

Unit		Title	Hours
1		Orientation and Safety	8
2		Engineering History, Ethics, and Careers	12
3		Writing, Presenting, and Project Management	20
4		Introduction to Robotics	100
5		Engineering Design Process	40
6		Sketching and Modeling	60
7		Production, Quality Control, and Engineering Failure	40
			280

Engineering II (Two Carnegie Units) - Course Code: 994001

Unit		Title	Hours
8		The Four Systems	80
9		CIM—Computer Integrated Manufacturing	60
10		Advanced Robotics	100
11		Digital Electronic Control System Technology	20
12		Workforce Readiness	20
			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, commercial applications, or places to live and lay, engineering employees are expected to pursue continuing education as technology evolves. Engineering professionals are required to obtain a bachelor's degree. Licensing requirements for engineers include a professional degree and at least 3–4 years of practical work experience.

Employment Outlook
Based on the employment projections from the Department of Labor, the need for these types of jobs will continue.

Occupational Title	Employment 2006	Projected Employment 2016	Change 2006–2016	
			Number	Percent
Engineers	8,180	10,070	1,890	23.1%
Drafters, Engineering, and Mapping Technicians	6,670	7,730	1,060	15.9%

Based on the salary data from the Department of Labor, these positions in the engineering industry provide an annual mean wage of $67,530.

Industry Certifications

Engineering

All states and the District of Columbia require licensure for engineers. The licensure requires students to graduate from an Accreditation Board for Engineering and Technology (ABET) accredited college or university. Upon graduation and 4 years of work experience, engineers are required to successfully complete the Professional Engineers (PE) licensure exam.

Industry Data
Results from the interviews indicate that employers are looking for people who can problem solve and work in multiple areas if needed. Literacy and work ethic are important. A bachelor's degree in engineering is required for almost all entry-level engineering jobs. Engineers are usually trained in one branch of engineering with a strong emphasis in mathematics and physical science. Graduate training is essential for engineering faculty positions and many research and development programs. In addition to the standard engineering degree, employers are looking for workers who possess a 2-year engineering or technology degree. These employers state that they need graduates who can read, create, and revise blueprints. Additionally, future employees need a strong background in math and computer skills.

Articulation
The following articulation plan is in place for the Engineering Pathway.

Engineering	PS Civil Tech	DDT 1113/4 – Fundamentals of Drafting DDT 1313 – Principles of CAD

Course Outlines

Program CIP Code: 14.1901

This curriculum framework is divided into four one-Carnegie-unit courses as outlined below. The first two courses are comprised of units from Engineering Year 1. The last two courses are comprised of units from Engineering Year 2.

Engineering Fundamentals (One Carnegie Unit)

Unit		Title	Hours
1		Orientation and Safety	8
2		Engineering History, Ethics, and Careers	12
3		Writing, Presenting, and Project Management	20
4		Introduction to Robotics	100
			140

Engineering Design (One Carnegie Unit)

Unit		Title	Hours
5		Engineering Design Process	40
6		Sketching and Modeling	60
7		Production, Quality Control, and Engineering Failure	40
			140

Systems in Engineering (One Carnegie Unit)

Unit		Title	Hours
8		The Four Systems	80
9		CIM—Computer Integrated Manufacturing	60
			140

Applying Engineering Concepts (One Carnegie Unit)

Unit		Title	Hours
10		Advanced Robotics	100
11		Digital Electronic Control System Technology	20
12		Workforce Readiness	20
			140

Using This Document

Unit Number and Title

Suggested Time on Task
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.

Suggested Teaching Strategies
This section of each unit indicates research-based strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies that reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.

Suggested Assessment Strategies
This section indicates research-based strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.

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.

Engineering Fundamentals

Unit 1: Orientation and Safety

Competency 1: Identify course expectations, school policies, and program policies related to this course. DOK 1, STL1, STL2

Suggested Enduring Understandings

1. Students will understand the importance of school policies and procedures.
2. Students will understand classroom guidelines and expectations.

Suggested Essential Questions

1. Why is it important to follow the rules and regulations put in place by the school district?
2. How are the teacher's expectations of your classroom performance and your personal expectations similar? How do they differ?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Identify school rules, policy and procedures. (DOK 1)	a. Using the school handbook, read and discuss school district policies and procedures. Emphasize the district's Internet acceptable use policy. Engage the students in a teacher-led conversation/debate about the pros and cons of the school's Internet acceptable use policy. E1, E2, W2, CS3, CS4, CS5, T1	a. Create and issue a quiz about the rules and regulations with a 100% passing requirement. Use the **Student Orientation Documents Checklist** to ensure required documents are returned with a parent's or guardian's signature. Use the **Group Participation Rubric** to assess the students' involvement.
b. Identify and establish classroom guidelines and procedures. DOK 1	b. Display the classroom discipline plan, procedures, calendar, emergency information, and other important documents in a prominent place. Discuss classroom rules and procedures. Introduce and discuss all safety procedures for the classroom, the building, and the lab. Make sure students understand the proper emergency procedures. Have students demonstrate the proper emergency procedures to follow during an emergency evacuation or drill. E1, E2,W2, CS3, CS4, T1	b. Use the **Group Participation Rubric** to access the students' teamwork skills and involvement.
c. Review course standards and affiliated	c. Have students complete a pretest on technology literacy skills; Science, Technology,	c. Evaluate with a written pretest.

national standards. DOK 1	Engineering, and Mathematics; 21st Century Skills; and Information and Communication Technologies to determine what current knowledge they have in these areas. Create a PowerPoint slide show that explains the units that will be taught in the class. Incorporate slides that relate the units to possible career fields. Have students research local industries that use the methods, technologies, and so forth that are covered in this class. The students should then report their research in a one-page paper. E1, M5, CS3, T6	Use the **Writing Rubric** to assess writing skills.
d. Review the comparison of self- and classroom expectations. DOK 1	d. Create and review a syllabus that explains the course content along with the grading system, class attendance, policy and procedures for completing missing/ late assignments, and student organization expectations. Have each student explain what he or she plans to achieve from the course and how each plans to achieve it. Engage students in a classroom discussion comparing and contrasting course expectations and self-expectations. Have the students create a class oath that incorporates everyone's expectations. Post the oath in the classroom for a daily reminder to all. E2, CS4, CS5,T4	d. Teacher observation

Competency 2: Demonstrate proper use and care for laboratory equipment. DOK 2, STL6

Suggested Enduring Understandings

1. Students will understand the value in practicing proper safety skills and techniques.
2. Students will understand the connection of the importance of safety in the classroom and the work setting.
3. Students will understand that safety is important for themselves and others.

Suggested Essential Questions

1. What are the dangers of not following safety guidelines?
2. How do safety procedures in the classroom relate to the real world?
3. Why is safety necessary in the classroom?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Identify, describe, and demonstrate the importance of safety and the proper use of lab equipment. DOK 1	a. Identify and discuss the use of proper precautions when using the equipment in the laboratory. Group students, and have them analyze the **Safety Scenarios—What Would You Do?** Provided in the curriculum. Have the students answer the questions and then rank the items listed in the scenario from the least important (No. 7) to the most important (No. 1). Have the students describe how each item will be used to assist with	a. Use the **Group Participation Rubric** to assess the students' teamwork skills and involvement.

		their survival. E1, R5 CS3, CS4, CS5, T1, T2, T3, T4	
b.	Describe the operating procedures for the equipment utilized in the course. DOK 1	b. Identify and discuss the location of laboratory equipment and its resources. Discuss the role and responsibility of the teacher and the students. Have the students list the equipment that is used in this course and describe a minimum of five safety rules that apply to any workstation. R5, CS3, CS4, T2	b. Teacher observation
c.	Compare and contrast safety issues in the classroom to safety issues in industry. DOK 2	c. Using a multimedia presentation, Internet access, and so forth, discuss the relationship between classroom safety and real-world safety. Have students research the safety guidelines in industry (OSHA). Then have students select an engineering field that they are interested in and illustrate and present how OSHA standards are used in a safety procedure in that field (poster, skit, 3-D visual, etc.). (Reference: http://www.osha.gov) Invite a local engineer or employee of local industry to be a guest speaker and discuss workplace safety issues in comparison to classroom safety. Encourage the speaker and students to discuss workplace safety issues and how they impact business and industry economically. M5, R5, S1, W1, CS3, CS4, T2, T3, T4	c. Use the **OSHA Standards in the Workplace Rubric** to assess students.

Standards

Industry Standards: International Technology Education Association (ITEA)—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.
STL6 Students will develop an understanding of the role of society in the development of and use of technology.

ACT College Readiness Standards

E1 Topic Development in Terms of Purpose and Focus
E2 Organization, Unity, and Coherence
M5 Graphical Representations
R5 Meaning of Words
S1 Interpretation of Data
W1 Expressing Judgments
W2 Focusing on the Topic

21st Century Skills Standards

CLS3 Social and Cross-Cultural Skills
CLS4 Productivity and Accountability
CLS5 Leadership and Responsibility

National Educational Technology Standards for Students

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

References

Karsnitz, J., O'Brian, S., & Hutchinson, J. (2009). *Engineering design: An introduction*. New York, NY: Delmar Cengage Learning.

Occupational Safety and Health Administration. (n.d.). Retrieved October 1, 2008, from http://www.osha.gov/

Suggested Rubrics and Checklists

Name: _____

Date: _____

Period: _____

Student Orientation Documents Checklist

- ☐ Acceptable Use Policy
- ☐ Student Responsibility Contract
- ☐ Web Page Policy
- ☐ Classroom Management Policy
- ☐ Technology Student Association (or other Career and Technical Student Organization) Membership Information

Name: _____

Date: _____

Period: _____

Group Participation Rubric

Project Title:

	1 point	2 points	3 points	4 points	Total
Group Discussions	Rarely contributed to discussions of the group	Contributed good effort to discussions of the group	Contributed great effort to discussions of the group	Contributed exceptional effort to discussions of the group	
On-Task Behavior	Exhibited on-task behavior inconsistently	Exhibited on-task behavior some of the time	Exhibited on-task behavior most of the time	Exhibited on-task behavior consistently	
Helping Others	Did not assist other group members	Seldom assisted other group members	Occasionally assisted other group members	Assisted other group members	
Listening	Ignored ideas of group members	Seldom listened to ideas of group members	Occasionally listened to ideas of group members	Always listened to ideas of group members	
				Total Score	

Name: _____

Date: _____

Period: _____

Writing Rubric

Project Title:

Criteria					Points
	1 Point	**2 Points**	**3 Points**	**4 Points**	
Organization	The sequence of information is difficult to follow.	The reader has difficulty following the work because the student jumps around.	The student presents information in a logical sequence that the reader can follow.	Information is in a logical, interesting sequence that the reader can follow.	_____
Format and Sentences	The student did not follow the required format; plagiarism is depicted.	The student did not follow the format; the essay includes sentences that are unclear and incorrect.	The student followed the format; the article is attached; and the article is handwritten.	The student followed the format; the article is attached and typed.	_____
Grammar and Spelling	Demonstrates little concept of proper grammar usage and spelling	The presentation has three misspellings and/or grammatical errors.	The presentation has no more than two misspellings and/or grammatical errors.	The presentation has no misspellings or grammatical errors.	_____
Creativity	Work displays no creativity.	Work displays little creativity.	Work displays some creativity.	Work is very neat and creative.	_____
Due Date	Worked turned in a week late	Worked turned in 3 days late	Work turned in 1 day late	Work turned in on time	_____
				Total Points	

Name: _____

Date: _____

Period: _____

OSHA Standards in the Workplace

CATEGORY	4 Points	3 Points	2 Points	1 Point	Score
Content - Accuracy	At least 7 accurate facts are displayed on the poster.	5 to 6 accurate facts are displayed on the poster.	3 to 4 accurate facts are displayed on the poster.	Less than 3 accurate facts are displayed on the poster.	
Graphics - Clarity	Graphics are all in focus, and the content is easily viewed and identified from 6 ft away.	Most graphics are in focus, and the content is easily viewed and identified from 6 ft away.	Most graphics are in focus, and the content is easily viewed and identified from 4 ft away.	Many graphics are not clear or are too small.	
Required Elements	The poster includes all required elements as well as additional information.	All required elements are included on the poster.	All but one of the required elements are included on the poster.	Several required elements are missing.	
Attractiveness	The poster is exceptionally attractive in terms of design, layout, and neatness.	The poster is attractive in terms of design, layout, and neatness.	The poster is acceptably attractive though it may be a bit messy.	The poster is distractingly messy or very poorly designed. It is not attractive.	
Grammar	There are no grammatical mistakes on the poster.	There is 1 grammatical mistake on the poster.	There are 2 grammatical mistakes on the poster.	There are more than 2 grammatical mistakes on the poster.	
				Total	

Name: _____

Date: _____

Period: _____

Safety Scenarios—What Would You Do?

Scenario 1: Juan comes into class after lunch and sits at his desk. He is exhausted from playing basketball at lunch, so he puts his head down on his desk. He feels something on his face and realizes that it is some broken glass. Someone in the previous class must have broken a test tube. What should the students from the previous class have done differently?

Scenario 2: Veronica is working with a Bunsen burner (open flame). Her hair swings down and lands in the flame. What should she have done before she lit the Bunsen burner?

Scenario 3: Ms. Patterson has given you very specific directions on how to complete a lab experiment. Your lab partner is curious and wants to see what will happen if you add 30 drops of indicator to a solution instead of 2 drops. What should you tell your partner?

Scenario 4: During a lab, Edgar realizes that his pencil needs to be sharpened, so he gets up to sharpen it. His partner gets bored without him, so he gets up to go see how other experiments are going. Someone at another table gets up to get a paper towel because her hands are getting messy. Adriana has Ms. Patterson's permission to get up and get a beaker. As she walks back to her seat, Edgar's pencil breaks again, so he pushes out his chair to go back to the sharpener. This trips Adriana, and she breaks the beaker. How could this have been avoided?

Scenario 5: Today is the first day that the class is working on modules. In the Thermal Unit, there is a certain type of wax that must be used along with gloves and a lighter for safety. While checking the equipment inventory, Stephanie noticed that the lighter was missing. She informed Ms. Patterson of the situation. Ms. Patterson instructed Stephanie to skip that particular experiment. Yet, because Stephanie was so excited about the experiment, she used the hot plate instead to light a piece of paper. She quickly threw the paper in the trash to avoid getting caught by the teacher. What rule did Stephanie break? What other hazards may occur from this incident?

Scenario 6: You are following all the rules and are being very careful, but you accidentally adjusted the pressure to high on the Pneumatic Module. You placed your safety glasses on your forehead instead of putting them on. What are some possible incidents that could occur? How would you handle them? What if you were following all the rules and a tube accidentally loosens? What would you do?

Scenario 7: You are the division head for a large chemical plant that is part of a Fortune 500 company. Because of the nature of your business, there are a number of medical facilities on site to handle medical emergencies and accidents. You learn through the grapevine that a nurse stationed at one of the infirmaries has been diagnosed with the AIDS virus and that some employees are worried. How would you handle this situation?

Unit 2: Engineering History, Ethics, and Careers

Competency 1: Explore the history of engineering, its major achievements, and key figures. DOK 1, STL1, STL2, STL4, STL7

Suggested Enduring Understandings

1. Students will understand the concept of engineering.
2. Students will understand the evolution of engineering.
3. Students will recognize key figures in the history of engineering.

Suggested Essential Questions

1. What is engineering?
2. What do engineers do?
3. Who would you say are some of the key contributors to the evolution of engineering?
4. What are some ways in which the work of engineers throughout history affects your life today?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Identify the characteristics of engineers. (DOK 1)	a. As an introduction, display a graphic picture of an engineer at work. Group the students, and have them make a list of adjectives that describe the attributes of an engineer. Use www.wordle.net to create a graphic using the engineering adjectives. Display the graphics in the room to remind students of the traits of quality engineers. As an extension, have the students create a poem, song, or rap describing the characteristics of an engineer. E4, E5, E6 R5, W1, W2, W3, W4, W5, CS4, CS4, CS5, T1, T2, T3	a. Teacher observation and **Presentation Rubric**
b. Identify the key contributors in the field of engineering. (DOK 1)	b. Using a still digital story (e.g., Microsoft Photo Story), introduce some key contributors in the field of engineering. Have the students select a key contributor and conduct research on that individual. Students should create a one-page report with a visual aid to present their contributor to the class. Have students use the text, Internet, and other resources to create a mural-sized timeline of the evolution of engineering. Group students, and assign them different periods of time to add information, pictures, and details of how things changed and improved. If possible, display the mural on the outer wall of your class for everyone to view. E4, E5, E6, R5, W1, W2, W4, W5, CS3, CS4, CS5, T2, T3	b. **Writing Rubric**, **Presentation Rubric**, and a written test
c. Identify historical engineering designs, and tell what effects it	c. Using a multimedia presentation, discuss the historical engineering designs (bridges, pyramids, building styles) and their creators. Have the	c. Teacher observation

	has on today's society. (DOK 1)	students conduct research on historic and current engineering designs and the inventors of each. Students should identify the physical limitations that existed and then research to see if they think the people in that time period used their resources wisely or if they could have done the job more effectively in a different way. Students should report their findings to the class and suggest at least one improvement the inventors could have made with the resources of the era. E4, E5, E6, R5, W1, W2, W4, W5, CS3, CS4, CS5, T2, T3, T4	

Competency 2: Recognize the importance of ethical teamwork in the field of engineering. DOK 1, STL4, STL6, STL10

Suggested Enduring Understandings

1. Students will understand the importance of team member attributes, team collaboration, and efficiency.
2. Students will understand components that are used to make successful teams.
3. Students will understand ethics associated with the engineering process.
4. Students will understand the relevance of ethics in the classroom and society.

Suggested Essential Questions

1. Why do companies focus on teamwork?
2. What are some elements that hinder the growth of a team?
3. Why is it important for team members to collaborate?
4. Why should team members use good communication skills?
5. How does an individual team member's personal ethic affect the team as a whole?
6. Do all countries design and build new products according to the same standards? Explain. Predict possible solutions to this ongoing problem.

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Identify successful team attributes. (DOK 1)	a. As an introduction to teamwork, have the students analyze segments of a movie that emphasizes teamwork (e.g., *Remember the Titans*). Have the students identify the key elements that lead to the success of a team. Using the text, connect to industry by discussing why companies focus on teams, highlighting the purpose of teams, team attributes, successful team traits, and the growth stages of a team. Create a discussion forum in Blackboard for students to discuss how they believe teams should work together. R5, W1, W2, W4, W5, CS3, CS4, CS5, T2, T3, T4	a. Teacher observation and Blackboard Discussion Grader
b. Practice teamwork collaboration to construct an engineering device. (DOK 1)	b. Use online testing tools (e.g., www.learning-styles-online.com and http://www.kisa.ca/personality) to have students complete a learning styles inventory and a personality test. Group students according to conflicting learning styles and personality traits. Then have students complete the **Tower Building**	b. **Group Participation Rubric**, **Tower Building Team-Building Activity**, and **Judges'**

			Activity Team-Building Activity. Afterwards, the students should complete the **Team-Building Response** to assess their understanding of teamwork. Emphasize to the students that teamwork is important not only in the classroom but also during competition and on the job. E1, R3, W1, W2, W4, W5, CS2, CS3, CS5, T2, T4, T5		**Worksheet for Tower Building Activity**
c.	Define ethics, etiquette, and morality as they are related to the workplace. (DOK 1)	c.	Access the Web site http://www.ais.msstate.edu/AEE/3803/Fall03pdfs/17-Ethics.pdf to help create a multimedia presentation on ethics. Use the data to help explain the difference between ethics, etiquette, and morality. Incorporate the concepts of leadership ethics, business ethics, and public morality as well as political misuse of funds to help students understand how ethical issues arise. Discuss current issues in the media as examples. Have students brainstorm what tragedies could occur if engineers did not use proper engineering ethics. Group students, and have them create a cause–effect chart of what happens when proper and improper ethics are used in the classroom or in the workplace. Display the charts in the classroom. E4, M5, W4, W5, CS1, CS3, CS4, CS5, T1 T2, T3, T4	c.	Teacher observation and **Group Participation Rubric**
d.	Compare and contrast engineering ethics in the United States to engineering ethics in other countries. (DOK 2)	d.	Have the students research engineering ethics in a global realm. Each student should investigate engineering ethics in China, Japan, Germany, Jamaica, or other relevant countries. Have the students use a word processing application to create a comparison table to chart the data collected (e.g., **Ethical Issues in Other Countries—Comparison Chart**). Have students post a blog to the Blackboard site about what they learned during this process. E4, M5, W4, W5, CS1, CS3, CS4, CS5, T1, T2, T3, T4	d.	Check the table for accuracy. Use the **Blog Checklist** to evaluate the students' blog postings.
e.	Examine the effects of discrimination and stereotyping within a team. (DOK 1)	e.	Create a presentation about stereotypes. Include various stereotypes that affect students today. Also include stereotypes that exist in the workforce. Engage in a discussion about how the students would feel if they were stereotyped and if it would affect their performance. Use discussion questions such as the following: Do you think you have been guilty of stereotyping others? What, if anything, is beneficial about stereotyping? Do first impressions and stereotypes coincide? Can stereotypes be true? Then distribute articles about stereotypes and discrimination. Group the students, and instruct them to jigsaw read (divide the article into sections	e.	Teacher observation and **Brochure Rubric**

	and read only your assigned part) the articles with the intentions of identifying stereotypes and offering solutions to potential problems. E1, R3, W3, CS2, CS3, CS5, T2, T4 As an extension, have students use word processing or publishing software to create a brochure that outlines their company's stance on stereotyping in the workplace.	

Competency 3: Investigate careers within the field of engineering. DOK 1, STL3, STL4, STL6

Suggested Enduring Understandings

1. Students will understand the fields of engineering.
2. Students will understand the job requirements and the job outlook for engineers.
3. Students will understand that society, sociology, and economics affect engineering.
4. Students will understand the importance of creating and maintaining professional skills associated with engineering.

Suggested Essential Questions

1. What are the job requirements in the field of engineering?
2. What are some engineering jobs that are established in your geographical location?
3. Why are good communication skills necessary in the field of engineering? (Lead to technical writing)

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Investigate the different fields of engineering and careers within each. (DOK 1)	a. Have the students research different engineering fields, job opportunities, salaries, licensure, degree requirements, and college programs of study. Have the students locate data such as the number of engineering jobs available in the U.S. job market, women and minorities studying engineering, and types of technology engineers use. Have students focus on three fields of engineering and post a blog on Blackboard with all of the required information from those three fields. Invite local industry representatives and military recruitment personnel to explain what types of engineers those companies hire, the job specification, salary, and so forth. E1, E4, R3, M5, W4, W5, CS1, CS3, CS4, CS5, T1, T2, T3, T4	a. **Blog Checklist**
b. Investigate the career you are most interested in, and plan for further study (beginning of electronic portfolio.) (DOK 1)	b. Have students continue researching the careers of their choice by visiting http://www.bls.gov/oco/. After this, they should be able to choose the career they are most interested in. Then have them locate at least three community colleges or universities that will prepare them for this career. Have the students access the Internet site http://futrell-www.tamu.edu/portfolio.htm to view different types of electronic portfolios. Then have them create an electronic portfolio (ongoing—	b. **Portfolio Rubric** (can be used throughout the course)

	students should add all relevant material to the portfolio throughout the year). The first entry should be their career choice and a plan of study that will prepare them for this career. E4, M5, CS3, CS4, CS5, T4	

Standards

Industry Standards: International Technology Education Association (ITEA)—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.
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.
STL10 Students will develop an understanding of the role of troubleshooting, research and development, inventions and innovation, and experimentation in problem solving.

ACT College Readiness Standards

E1 Topic Development in Terms of Purpose and Focus
E4 Sentence Structure and Formation
E5 Conventions of Usage
E6 Conventions of Punctuation
M5 Graphical Representations
R3 Sequential, Comparative, and Cause–Effect Relationships
R5 Meaning of Words
W1 Expressing Judgments
W2 Focusing on the Topic
W3 Developing a Position
W4 Organizing Ideas
W5 Using Language

21st Century Skills Standards

CLS1 Flexibility and Adaptability
CLS2 Initiative and Self-Direction
CLS3 Social and Cross-Cultural Skills
CLS4 Productivity and Accountability
CLS5 Leadership and Responsibility

National Educational Technology Standards for Students

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

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Suggested Rubrics and Checklists

Name: _____

Date: _____

Period: _____

Presentation Rubric

CATEGORY	4 Points	3 Points	2 Points	1 Point	Score
Voice - Consistency	Voice quality is clear and consistently audible throughout the presentation.	Voice quality is clear and consistently audible throughout the majority (85–95%) of the presentation.	Voice quality is clear and consistently audible through some (70–84%) of the presentation.	Voice quality needs more attention.	
Duration of Presentation	Length of presentation is 3 minutes.	Length of presentation is 2 minutes.	Length of presentation is 1 minute.	Presentation is less than 1 minute OR more than 3 minutes.	
Grammar	Grammar and usage are correct (for the dialect chosen) and contribute to clarity, style, and character development.	Grammar and usage are typically correct (for the dialect chosen) and errors do not detract from the story.	Grammar and usage are typically correct, but errors detract from story.	Repeated errors in grammar and usage distract greatly from the story.	
Voice - Pacing	The pace (rhythm and voice punctuation) fits the story line and helps the audience really get into the story.	Presenter occasionally speaks too fast or too slowly for the story line. The pacing (rhythm and voice punctuation) is relatively engaging for the audience.	The presenter tries to use pacing (rhythm and voice punctuation), but it is often noticeable that the pacing does not fit the story line. Audience is not consistently engaged.	There is no attempt to match the pace of the storytelling to the story line or the audience.	
				Total	

Name: _____

Date: _____

Period: _____

Writing Rubric

Project Title:

Criteria					Points
	1 Point	**2 Points**	**3 Points**	**4 Points**	
Organization	The sequence of information is difficult to follow.	The reader has difficulty following the work because the student jumps around.	The student presents information in a logical sequence that the reader can follow.	Information is in a logical, interesting sequence that the reader can follow.	_____
Format and Sentences	The student did not follow the required format; plagiarism is depicted.	The student did not follow the format; the essay includes sentences that are unclear and incorrect.	The student followed the format; the article is attached; and the article is handwritten.	The student followed the format; the article is attached and typed.	_____
Grammar and Spelling	Demonstrates little concept of proper grammar usage and spelling	The presentation has three misspellings and/or grammatical errors.	The presentation has no more than two misspellings and/or grammatical errors.	The presentation has no misspellings or grammatical errors.	_____
Creativity	Work displays no creativity.	Work displays little creativity.	Work displays some creativity.	Work is very neat and creative.	_____
Due Date	Worked turned in a week late	Worked turned in 3 days late	Work turned in 1 day late	Work turned in on time	_____
				Total Points	

Name: _____

Date: _____

Period: _____

Group Participation Rubric

Project Title:

	1 point	2 points	3 points	4 points	Total
Group Discussions	Rarely contributed to discussions of the group	Contributed good effort to discussions of the group	Contributed great effort to discussions of the group	Contributed exceptional effort to discussions of the group	
On-Task Behavior	Exhibited on-task behavior inconsistently	Exhibited on-task behavior some of the time	Exhibited on-task behavior most of the time	Exhibited on-task behavior consistently	
Helping Others	Did not assist other group members	Seldom assisted other group members	Occasionally assisted other group members	Assisted other group members	
Listening	Ignored ideas of group members	Seldom listened to ideas of group members	Occasionally listened to ideas of group members	Always listened to ideas of group members	
				Total Score	

Tower Building Team-Building Activity

Objectives

- To allow for observation of team interaction while exploring collaboration and competition among groups, particularly in reference to use of resources
- To explore aspects of teamwork: Planning, role assignments, and problem solving
- To explore the dynamics of working with ambiguous goals

Materials

Miscellaneous items: Staplers, scissors, rubber bands, string, construction paper, tape, Tinker toys, index cards, marshmallows, spaghetti, and so forth

Judges' Worksheet for Tower Building Activity for each group

Instructions

1. Each group selects one person to be a judge. The judges use the Judges' Role Briefing Sheet to determine the criteria for the winning tower.
2. The groups are to build a tower with the materials they have been provided. There are no rules for the construction process other than each tower is to be free standing.
3. After time has passed, the judges examine the towers, choose a winner, and share the results.

Judges' Worksheet for Tower Building Activity

Judges' Role-Briefing Sheet

1. As a judge you will select a winning tower according to the criteria of height, aesthetic appeal, and sturdiness. You may use other evaluative criteria should you as a group of judges so choose.

2. You, the judges, will decide the relative weight given to each criterion. *For example, height may factor in for 50% of the points out of an overall score of 100 with aesthetic appeal and sturdiness as 25% each.* You MAY NOT announce the criteria and your weighting procedure to the individual groups.

3. You will decide whether your final decision making is public or private.

4. You should be fair in your judgment and not favor your group.

5. During the construction phase, you should act as an observer.

		Group			
Criterion	**Judge**	**1**	**2**	**3**	**4**
Height	1				
	2				
Weight =	3				
_____%	4				
Aesthetic	1				
Appeal	2				
Weight =	3				
_____%	4				
Sturdiness	1				
	2				
Weight =	3				
_____%	4				
Other	1				
_____	2				
Weight =	3				
_____%	4				
Totals					

Name: _____

Date: _____

Period: _____

Team-Building Response

Directions: Reflecting back on the team-building activity, complete the questions listed below using the guidelines below.

- Use complete sentence structure form (proper grammar and punctuation).
- Typed in black, 11-point Calibri font.
- Use 1-in. top and bottom margins and 1.5-in. left and right margins.
- Footer: Name, Program Name, Date, and Class Period/Block

"Only respond to your assigned role in the team-building activity."

Processing Questions

Team Members:

1. Did your group cooperate well?
2. What helped the process?
3. What hindered the process?
4. Were everyone's opinions/ideas heard?
5. How did you decide which idea/plan was the best?
6. Do you think the judging was fair?
7. What did you learn that you can you apply to your organization?

Judges:

1. What did you perceive your roles to be?
2. Did you feel any sense of bias toward your team's tower?
3. From your observation, what did you learn about teamwork?
4. If the groups remained competitive, what was their reaction of being judged?
5. Did the groups ever consider working together on one structure?
6. If groups collaborated, what prompted the collaboration?
7. Did everyone agree with the decision?
8. What did you learn that you can you apply to your organization?

Name: _____

Date: _____

Period: _____

Ethical Issues in Other Countries—Comparison Chart

Ethical Issue	United States' Stance	(Insert Name of Country)'s Stance
1.		
2.		
3.		
4.		
5.		

Name: _____

Date: _____

Period: _____

Brochure Rubric

CATEGORY	4 Points	3 Points	2 Points	1 Point	Score
Attractiveness and Organization	The brochure has exceptionally attractive formatting and well-organized information.	The brochure has attractive formatting and well-organized information.	The brochure has well-organized information.	The brochure's formatting and organization of material are confusing to the reader.	
Content - Accuracy	All facts in the brochure are accurate.	90–99% of the facts in the brochure are accurate.	80–89% of the facts in the brochure are accurate.	Fewer than 80% of the facts in the brochure are accurate.	
Writing - Organization	Each section in the brochure has a clear beginning, middle, and end.	Almost all sections of the brochure have a clear beginning, middle, and end.	Most sections of the brochure have a clear beginning, middle, and end.	Less than half of the sections of the brochure have a clear beginning, middle, and end.	
Graphics/Pictures	Graphics go well with the text, and there is a good mix of text and graphics.	Graphics go well with the text, but there are so many that they detract from the text.	Graphics go well with the text, but there are too few and the brochure seems text heavy.	Graphics do not go with the accompanying text or appear to be randomly chosen.	
				Total	

Name: _____

Date: _____

Period: _____

Blog Checklist

_____/20 points	Student has all required elements in the blog. (20 points)
_____/20 points	Student stayed on topic. (20 points)
_____/20 points	Blog is formatted correctly. (20 points)
_____/20 points	Student used correct grammar, punctuation, and spelling. (20 points)
_____/10 points	Blog is interesting and informative. (10 points)
_____/10 points	Blog is free of slang and inappropriate language. (10 points)

_____/100 possible points

Name: _____

Date: _____

Period: _____

Portfolio Rubric

	4 Points	3 Points	2 Points	1 Point	Points
Contents	Portfolio contains all of the required materials.	Portfolio contains most of the required materials.	Portfolio contains some of the required materials.	Portfolio contains little of the required materials.	
Choice of Documentation	Samples show student progress and knowledge of general educational principles.	Samples show student progress and some knowledge of general educational principles.	Samples show some student progress and some knowledge of general educational principles.	Random selection of sample documents; no knowledge of general educational principles	
Organization	Portfolio is complete and neatly organized. A reader can easily find things.	Portfolio is well organized. A reader has little difficulty finding things.	Portfolio is fairly well organized. A reader may have a little difficulty finding things.	Portfolio shows some attempt at organization. A reader has difficulty finding things.	
Mechanics	There are no errors in spelling, punctuation, or grammar.	There are few errors in spelling, punctuation, or grammar.	Errors in spelling, punctuation, or grammar are evident.	Errors in spelling, punctuation, or grammar are numerous and detract from the portfolio.	
Overall Portfolio Impact	The portfolio effectively demonstrates the student's skills, abilities, and knowledge to potential employers.	The portfolio helps to demonstrate the student's skills, abilities, and knowledge to potential employers.	The portfolio does little to demonstrate the student's skills, abilities, and knowledge to potential employers.	The portfolio does not demonstrate the student's skills, abilities, and knowledge to potential employers.	
				TOTAL	

Unit 3: Writing, Presenting, and Project Management

Competency 1: Create a technical report. DOK 4, STL10, STL11

Suggested Enduring Understandings

1. Students will have an understanding of the format and procedures of technical writing.

Suggested Essential Questions

1. How could you communicate your ideas to others?
2. Why is it important to follow uniform procedures?
3. What is the need for a technical report?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Examine the importance of correct grammar in a technical document. (DOK 1)	a. Construct sentences that address the following grammatical circumstances, and have students evaluate them as correct or incorrect: Sentence (S), fragment (F), or run-on (RO), subject–verb agreement, wrong wording, missing comma, undesired comma, colon error, unclear pronoun reference, possessive error, headings and subheadings, and number usage. E1, E2, E3, E4, E5, E6, W4, W5, CS2, T1, T2	a. Check for accuracy. Quiz on sentence structure
b. Compose an outline and a technical paper on a career in engineering from Unit 2. (DOK 4)	b. Show students examples of technical writing documents. **Teaching Technical Writing** Introduction Formatting Mechanics Editing Structure Language Illustration Have students conduct research on the career field in engineering they selected in Unit 2. The report should include an outline and three to five pages of text. E1, E2, E3, E4, E5, E6, W4, W5, CS2, T1, T2	b. **Technical Writing Rubric** (Include photos, summary of activity, etc. in e-portfolio.)

Competency 2: Know and be able to use the correct forms for presenting reports. DOK 4, STL10, STL11

Suggested Enduring Understandings

1. Students will understand how to effectively present engineering research in a professional manner.

Suggested Essential Questions

1. What are some effective tools used in communicating other than reports?
2. What are several important techniques that make sure communications are understood with meaning to the receiver?

3. Why are good communication skills necessary in conducting an engineering research presentation?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Develop and deliver a presentation based on the research conducted in the chosen engineering field from Unit 2, demonstrating appropriate communication techniques such as voice quality, posture, attire, eye contact, preparation, and confidence. (DOK 4)	a. Demonstrate to students how to effectively present information. **Teaching Technical Presentations** Structure and Speech Visual Aids Delivery Students will set up presentations using the technical report topics they chose. The presentation should be 5–10 minutes in length. E1, E2, E3, E4, E5, E6, W2, W3, CS1, CS2, T1, T2, T3, T4, T6	a. **Technical Presentation Rubric** (Include photos, summary of activity, etc. in e-portfolio.)

Competency 3: Recognize and demonstrate the importance of project planning and documentation. DOK 4, STL10, STL11

Suggested Enduring Understandings

1. Students will have an understanding of the correct procedures in engineering project management.

Suggested Essential Questions

1. Why do you think you need to organize and structure a project?
2. Why is it important to have someone that is in charge of a particular component of a project?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Examine the aspects of teamwork and project management in the workforce. (DOK 1)	a. Remind students of the importance of teamwork in the workplace. Then introduce project management, deciphering the roles that team members assume during a project. Introduce a Gantt chart, and show how it can be useful in an organization that works with many projects simultaneously. (Reference: *Engineering Your Future,* Ch. 13) E1, E2, E3, E4, E5, E6, R1, R2, R3, R5, W1, W2, W3, W4, W5, CS1, CS2, CS3, CS4, CS5, T1, T2, T3, T4, T6	a. Quiz to assess understanding of project management
b. Compose technical directions to construct a useful product from provided materials. (DOK 3)	b. Using kits provided in the classroom or everyday items (rubber bands, straws, tinker toys, etc.), have students design a useful device. They should plan together and write detailed instructions for the device. Students will then exchange instructions and materials with other groups in the class. Have them build the device according to the technical instructions provided by the creators.	b. **Technical Direction Writing Rubric** and **Response to Technical Direction Writing Assignment** (Include photos, summary of activity, etc. in e-portfolio.)

		Have students present the project and then write a response to the project upon completion. E1, E2, E3, E4, E5, E6, W1, W2, W3, W4, W5, CS1, CS2, CS3, CS4, CS5, T1, T2, T4	
c.	Prepare e-portfolio for potential employers. (DOK 4)	c. Students should have all required elements in the portfolio for potential employers to view. E1, E2, E3, E4, E5, E6, W1, W2, W3, W4, W5, CS1, CS2, CS3, CS4, CS5, T1, T2, T4	c. **Portfolio Rubric**

Standards

Industry Standards: International Technology Education Association (ITEA)—Standards for Technological Literacy

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.

ACT College Readiness Standards

E1 Topic Development in Terms of Purpose and Focus
E2 Organization, Unity, and Coherence
E3 Word Choice in Terms of Style, Tone, Clarity, and Economy
E4 Sentence Structure and Formation
E5 Conventions of Usage
E6 Conventions of Punctuation
R1 Main Ideas and Author's Approach
R2 Supporting Details
R3 Sequential, Comparative, and Cause–Effect Relationships
R5 Meaning of Words
W1 Expressing Judgments
W2 Focusing on the Topic
W3 Developing a Position
W4 Organizing Ideas
W5 Using Language

21st Century Skills Standards

CLS1 Flexibility and Adaptability
CLS2 Initiative and Self-Direction
CLS3 Social and Cross-Cultural Skills
CLS4 Productivity and Accountability
CLS5 Leadership and Responsibility

National Educational Technology Standards for Students

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

References

Alley, M. (2008). *Writing guidelines for engineering and science students*. Retrieved from Penn State University Web site: http://www.writing.engr.psu.edu/

Gomez, A., Oakes, W., & Leone, L. (2004). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press, Inc.

Karsnitz, J., O'Brian, S., & Hutchinson, J. (2009). *Engineering design: An introduction*. New York, NY: Delmar, Cengage Learning.

Suggested Rubrics and Checklists

Name: _____

Date: _____

Period: _____

Technical Writing Rubric

	Exemplary 4	Accomplished 3	Developing 2	Beginning 1	Score
Introduction	Presents a concise lead-in to the report	Gives some information—more like a summary	Gives very little information	Does not give any information about what to expect in the report	
Research	Answers most questions and includes many other interesting facts	Answers some questions and includes a few other interesting facts	Answers some questions	Does not answer any questions suggested in the template	
Procedure	Presents easy-to-follow steps that are logical and adequately detailed	Most of the steps are understandable; some lack detail or are confusing.	Some of the steps are understandable; most are confusing and lack detail.	Not sequential; most steps are missing or are confusing.	
Data and Results	Data table and graph neatly completed and totally accurate	Both accurate; some ill-formed characters	Both complete; minor inaccuracies and/or illegible characters	Data table and/or graph missing information and inaccurate	
Conclusion	Presents a logical explanation for findings and addresses most of the questions	Presents a logical explanation for findings and addresses some of the questions	Presents an illogical explanation for findings and addresses few questions	Presents an illogical explanation for findings and does not address any of the questions suggested in the template	
Grammar and Spelling	All grammar and spelling are correct.	Only one or two errors	More than two errors	Very frequent grammar and/or spelling errors	
Attractiveness	Word processed or typed, clean, and neatly bound in a report cover; illustrations provided	Legible writing, well-formed characters, clean, and neatly bound in a report cover; illustrations provided	Legible writing, some ill-formed letters, print too small or too large, and papers stapled together	Illegible writing; loose pages	
Timeliness	Report handed in on time	Up to 2 days late	Up to 1 week late	Report handed in more than 1 week late	

Total	

Name: _____

Date: _____

Period: _____

Technical Presentation Rubric

	Exemplary 4	**Accomplished 3**	**Developing 2**	**Beginning 1**	**Score**
Content	Clear, appropriate, and correct	Mostly clear, appropriate, and correct	Somewhat confusing, incorrect, or flawed	Confusing, incorrect, or flawed	
Clarity	Logical, interesting sequence	Logical sequence	Unclear sequence	No sequence	
Presentation	Clear voice and precise pronunciation	Clear voice and mostly correct pronunciation	Low voice and incorrect pronunciation	Mumbling and incorrect pronunciation	
Visual Aids	Attractive, accurate, and grammatically correct	Adequate, mostly accurate, and few grammatical errors	Poorly planned, somewhat accurate, or some grammatical errors	Weak, inaccurate, or many grammatical errors	
Length	Appropriate length	Slightly too long or short	Moderately too long or short	Extremely too long or short	
Participation	Well-balanced participation by all group members	All group members have significant participation	Most group members participate	One main speaker with little participation from other group members	
Eye Contact	Maintains eye contact, seldom looking at notes	Maintains eye contact most of time but frequently returns to notes	Occasionally uses eye contact but reads most of information	No eye contact because reading information	
				Total	

Name: _____

Date: _____

Period: _____

Response to Technical Direction Writing Assignment

1. Was your team able to create a usable product with the materials provided? ☐Yes ☐No
   Please explain._____
   _____
   _____

2. How did you feel about the quality of your directions before you gave them to the other group?
   _____
   _____
   _____

3. How did you feel about the quality of your directions after you gave them to the other group?
   _____
   _____
   _____

4. What could you have done differently as a team to improve the product you invented?_____
   _____
   _____

5. What could you have done differently as a team to improve the directions you wrote to build your product?_____
   _____
   _____

6. Rate your group according to productivity from 1 (did not work well together) to 5 (worked together seamlessly toward like goals).
   ☐1 ☐2 ☐3 ☐4 ☐5

   Please elaborate on group success and/or failures, including group members' participation in this project._____
   _____
   _____
   _____
   _____
   _____

Name: _____

Date: _____

Period: _____

Technical Direction Writing Rubric

CATEGORY	4 Points	3 Points	2 Points	1 Point	Score
Mechanics	No grammatical, spelling, or punctuation errors	Almost no grammatical, spelling, or punctuation errors	A few grammatical, spelling, or punctuation errors	Many grammatical, spelling, or punctuation errors	
Technical Directions	Directions are recorded and organized in an extremely neat and orderly fashion.	Directions are recorded legibly and are somewhat organized.	Directions are recorded.	Directions are recorded only with peer/teacher assistance and reminders.	
Product	Product is useful and well constructed.	Product is not necessarily useful but is well constructed.	Product is useful but could be constructed better.	Product is neither useful nor well constructed.	
Ease of Following Directions	Group had no trouble following directions and constructed the product with no problems.	Group had a little trouble following directions but was able to construct the product.	Group had considerable trouble following directions and could hardly construct the product.	Group had extreme trouble following directions and could not construct the product.	
				Total	

Name: _____

Date: _____

Period: _____

Portfolio Rubric

	4 Points	3 Points	2 Points	1 Point	Points
Contents	Portfolio contains all of the required materials.	Portfolio contains most of the required materials.	Portfolio contains some of the required materials.	Portfolio contains little of the required materials.	
Choice of Documentation	Samples show student progress and knowledge of general educational principles.	Samples show student progress and some knowledge of general educational principles.	Samples show some student progress and some knowledge of general educational principles.	Random selection of sample documents; no knowledge of general educational principles	
Organization	Portfolio is complete and neatly organized. A reader can easily find things.	Portfolio is well organized. A reader has little difficulty finding things.	Portfolio is fairly well organized. A reader may have a little difficulty finding things.	Portfolio shows some attempt at organization. A reader has difficulty finding things.	
Mechanics	There are no errors in spelling, punctuation, or grammar.	There are few errors in spelling, punctuation, or grammar.	Errors in spelling, punctuation, or grammar are evident.	Errors in spelling, punctuation, or grammar are numerous and distract from the portfolio.	
Overall Portfolio Impact	The portfolio effectively demonstrates the student's skills, abilities, and knowledge to potential employers.	The portfolio helps to demonstrate the student's skills, abilities, and knowledge to potential employers.	The portfolio does little to demonstrate the student's skills, abilities, and knowledge to potential employers.	The portfolio does not demonstrate the student's skills, abilities, and knowledge to potential employers.	
				TOTAL	

**Please review all safety precautions for the lab before you begin this course.*

Unit 4: Introduction to Robotics

Competency 1: Explore concepts associated with physical principles of engineering. STL3, STL4, STL5, STL6, STL7

Suggested Enduring Understandings

1. Students will understand the forces, motions, and stresses related to engineering.
2. Students will understand the effects of kinematics, momentum, and work in engineering.

Suggested Essential Questions

1. What are factors an engineer must consider when designing a bridge?
2. How do environmental characteristics impact engineering?
3. Why are speed limits lower in curvy, winding roads than on straight roads?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Define and illustrate principles of force, motion, and torque. (DOK 2) IE1, IE2, IE3, IE4, IE5, PHY1	a. After an explanation of force, motion, and torque, group students to research common, everyday items that use force, motion, and torque to do work. They will create a poster with 10 examples and explain how the item uses force, motion, or torque to do work. E1, E2, M5, R4, W2, W5, CS1, CS2, CS4, CS5, T1, T2, T3, T5	a. **Group Participation Rubric** and **Presentation Rubric**
b. Describe Newton's laws of motion. (DOK 1) IE1, IE2, IE3, IE4, IE5, PHY1	b. After an explanation of Newton's laws, the students should solve problems for mass, force, velocity, acceleration, and displacement using the appropriate formulas for each. (Reference: *Engineering Your Future,* Ch. 18) E1, E2, E4, E5, E6, M1, M4, M5, S1, S3, CS2, CS4, T2,T4	b. Written assessment
c. Test structures against various environmental factors. (DOK 3) IE1, IE2, IE3, IE4, IE5, PHY1	c. The teacher will ask the students to list and explain outside factors that affect structures (e.g., wind, rain, erosion, etc.) and how structures can be built to combat them. Students will be given one sheet of 8 1/2-in. by 11-in. paper to construct the tallest tower possible that will stand for a minimum of 2 minutes against a randomly chosen environmental factor (e.g., wind, rain, earthquake, etc.). The students can tear or fold the paper any way they choose. The teacher will determine the winner. As a closing, discuss with students what factors caused the towers to stand or fall. What could have been done to improve the structures? Relate to actual structures found in society. M7, S3, W3, W4, W5, CS1, CS2, CS3, CS4, T1, T4	c. Observe students to ensure proper testing against environmental structures. (Include photos, summary of activity, etc. in e-portfolio.)

Competency 2: Explore mechanisms and simple machines to create working robots. DOK 4, STL1, STL2, STL5, STL9, STL13

Suggested Enduring Understandings

1. Students will understand the differences between

Suggested Essential Questions

1. What are the various machines and/or

machines and mechanisms and how they interrelate.
2. Students will understand the different mechanisms and their functions.
3. Students will understand the different machines and their functions.

mechanisms involved in construction?
2. How does the engine of a car turn the wheels to create motion?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Distinguish between machines and mechanisms. (DOK 3) IE3, PHY1, PHY2,	a. Following a lesson on the difference between machines and mechanisms, the students will use the posters created in competency 1a to identify each item on their posters as machines or mechanisms. (Reference: *Engineering Design,* Ch. 12) E1, E2, M5, R4, W2, W5, CS2, CS4, T2, T4	a. Observe that students can distinguish between machines and mechanisms.
b. Define, calculate, and demonstrate gear ratios, AMA (actual mechanical advantage), and IMA (ideal mechanical advantage). (DOK 3) IE1, IE2, IE3, IE4, IE5, PHY1, PHY2	b. Give the students problems to calculate for gear ratio, AMA, and IMA. After they have solved the problems with the appropriate equations, they will confirm their findings by building the gear setups with robot kits (e.g., Tetrix). M1, M4, M7, M8, S1, S2, S3, CS4, T2, T4	b. Evaluate problems. Use teacher observation for accuracy with robot kits. Written assessment
c. Students will design and build a device to use to show force, motion, and/or torque using simple machines (trebuchet, catapults, backhoe, pulley system, etc.). (DOK 4) IIE2, IE3, IE4, PHY1, PHY2	c. The teacher will show a video from the annual Punkin' Chunkin' competition (http://www.youtube.com/watch?v=iG2c9e7UAXY) in which contestants use trebuchets or cannons to throw pumpkins for distance. The class will then discuss the mechanics and mechanisms of a trebuchet. Students will build trebuchets from the provided materials. They will then throw ammunition of common weight for accuracy and for distance. M2, M5, M7, S1, CS1, CS2, CS3, CS4, CS5, T1, T2, T4	c. **Rubric—Trebuchet Model** (Include photos, winning certificates, summary of activity in e-portfolio)
d. Define and construct robots. (DOK 4) IE3, PHY1, PHY2	Use specialized software (i.e. Learnmate®) to investigate, design and construct robots. M6, M7, S3, CS1, CS2, CS3, CS4, CS5, T1, T2, T3, T4	d. **Group Participation Rubric, Simple Machines Checklist, and Assessments provided with specialized software.** (Include photos, summary of activity, etc. in e-portfolio.)

Standards

Industry Standards: International Technology Education Association (ITEA)—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.
STL9 Students will develop an understanding of engineering design.
STL13 Students will develop the abilities to assess the impact of products and systems.

Mississippi Academic Course Competencies and Benchmarks

PHY1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
PHY2 Develop an understanding of concepts related to forces and motion.
IE1 Compute unit conversions, and illustrate graphical interpretations.
IE2 Apply algebraic equations and functions to engineering situations.
IE3 Apply geometric principles to engineering situations.
IE4 Apply fundamental concepts of measurement such as time, distance, area, and volume with principles of engineering in a variety of contexts.
IE5 Interpret charts, graphs, and other data obtained from actual or hypothetical engineering events and situations.

ACT College Readiness Standards

E1 Topic Development in Terms of Purpose and Focus
E2 Organization, Unity, and Coherence
E3 Word Choice in Terms of Style, Tone, Clarity, and Economy
E4 Sentence Structure and Formation
E5 Conventions of Usage
E6 Conventions of Punctuation
M1 Basic Operations and Applications
M4 Expressions, Equations, and Inequalities
M5 Graphical Representations
M6 Properties of Plane Figures
M7 Measurement
M8 Functions
R4 Meaning of Words
S1 Interpretation of Data
S2 Scientific Investigation
S3 Evaluation of Models, Inferences, and Experimental Results
W2 Focusing on the Topic
W3 Developing a Position
W4 Organizing Ideas
W5 Using Language

21st Century Skills Standards

CLS1 Flexibility and Adaptability
CLS2 Initiative and Self-Direction
CLS3 Social and Cross-Cultural Skills
CLS4 Productivity and Accountability
CLS5 Leadership and Responsibility

National Educational Technology Standards for Students

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

References

Karsnitz, J., O'Brian, S., & Hutchinson, J. (2009). *Engineering design: An introduction*. New York, NY: Delmar Cengage Learning.

Gomez, A., Oakes, W., & Leone, L. (2004). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press, Inc.

Mikezk. (2006, September 3). Punkin chunkin part 1 [Video file]. Video posted to http://www.youtube.com/watch?v=iG2c9e7UAXY

Suggested Rubrics and Checklists

Name: _____

Date: _____

Period: _____

Group Participation Rubric

Project Title:

	1 point	2 points	3 points	4 points	Total
Group Discussions	Rarely contributed to discussions of the group	Contributed good effort to discussions of the group	Contributed great effort to discussions of the group	Contributed exceptional effort to discussions of the group	
On-Task Behavior	Exhibited on-task behavior inconsistently	Exhibited on-task behavior some of the time	Exhibited on-task behavior most of the time	Exhibited on-task behavior consistently	
Helping Others	Did not assist other group members	Seldom assisted other group members	Occasionally assisted other group members	Assisted other group members	
Listening	Ignored ideas of group members	Seldom listened to ideas of group members	Occasionally listened to ideas of group members	Always listened to ideas of group members	
				Total Score	

Name: _____

Date: _____

Period: _____

Presentation Rubric

CATEGORY	4 Points	3 Points	2 Points	1 Point	Score
Voice - Consistency	Voice quality is clear and consistently audible throughout the presentation.	Voice quality is clear and consistently audible throughout the majority (85–95%) of the presentation.	Voice quality is clear and consistently audible through some (70–84%) of the presentation.	Voice quality needs more attention.	
Duration of Presentation	Length of presentation is 3 minutes.	Length of presentation is 2 minutes.	Length of presentation is 1 minute.	Presentation is less than 1 minute OR more than 3 minutes.	
Grammar	Grammar and usage are correct (for the dialect chosen) and contribute to clarity, style, and character development.	Grammar and usage are typically correct (for the dialect chosen) and errors do not detract from the story.	Grammar and usage are typically correct, but errors detract from story.	Repeated errors in grammar and usage distract greatly from the story.	
Voice - Pacing	The pace (rhythm and voice punctuation) fits the story line and helps the audience really get into the story.	Presenter occasionally speaks too fast or too slowly for the story line. The pacing (rhythm and voice punctuation) is relatively engaging for the audience.	The presenter tries to use pacing (rhythm and voice punctuation), but it is often noticeable that the pacing does not fit the story line. Audience is not consistently engaged.	There is no attempt to match the pace of the storytelling to the story line or the audience.	
				Total	

Name: _____

Date: _____

Period: _____

Simple Machines Checklist

_____ points	Machine using a lever. (10 points)
_____ points	Machine using a wheel and axle. (10 points)
_____ points	Machine using a pulley. (10 points)
_____ points	Machine using an inclined plane. (10 points)
_____ points	Machine using a wedge. (10 points)
_____ points	Machine using a screw. (10 points)
_____ points	Machine using all six simple machines. (40 points)

_____/100 possible points

Name: _____

Date: _____

Period: _____

Rubric—Trebuchet Model

Please note the following:

1. This rubric only applies to trebuchets. If you build a catapult, the maximum score you can achieve is 25 points.
2. Trebuchets that do not meet the material requirements will not be tested and will receive a maximum score of 25 points.
3. Due to safety considerations, designs that exceed the mass or volume requirement will not be fired. They will only be scored on design. (Maximum of 50 points)

Design 75 points

Meets measurement requirements

Has either stakes or wheels depending on design chosen

Remote firing (25 points if it works)

Arm meets length requirements.

Constructed primarily of wood—no PVC or metal

Performance 125 points

Fires (15 points)

Remains functional after firing (15 points)

Fires consistently in the right direction (25 points)

Achieves the 7.5 m to 15 m range (70 points)

Bonus Points (creativity—up to 15 additional points)

Total points for model

_____/200

Engineering Design

Unit 5: Engineering Design Process

Competency 1: Recognize the need for a design process. DOK 1, STL8, STL9, STL10, STL11

Suggested Enduring Understandings

1. The design process is necessary for the development of new products.
2. All products in society have been developed through the engineering design process.

Suggested Essential Questions

1. What is your idea of a design process?
2. How does engineering design impact your society?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Define the design process. (DOK 1) PHY1	a. Using a multimedia presentation, define all components of the 10-step design process. (Reference: *Engineering Your Future,* Ch. 15) Please be aware that there are conflicting views as to how many steps a design process has, but this is the one that will be used in this course. E2, CS1, CS4, T2, T3, T4 • Identify the problem/product innovation. • Define the working criteria/goals. • Research and gather data. • Brainstorm/generate creative ideas. • Analyze potential solutions. • Develop and test models. • Make the decision. • Communicate and specify. • Implement and commercialize. • Perform post-implementation review and assessment.	a. **Group Participation Rubric** and **Presentation Rubric**
b. Identify items designed by engineers and those not designed by engineers. (DOK 1) PHY1	b. Using pictures, a multimedia presentation, or a still digital story (e.g., Microsoft PhotoStory), have students work in groups to identify items designed by engineers (bridges, architectural structures, highways, computers, etc.) and those not developed by engineers (natural items, art, etc). Have groups discuss how these items differ and report to the class. (Students should be able to conclude that most everyday items have been developed by engineers.)	b. Written assessment

Competency 2: Examine how the design process is used to create and modify products and inventions, then apply it to your own invention. DOK 4, STL8, STL9, STL10, STL11

Suggested Enduring Understandings

1. The design process leads to new products and inventions or the improvement of products.

Suggested Essential Questions

1. Why do products and inventions change or need to improve?

2. Why is using the design process beneficial to someone developing products or inventions?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Follow the design process to modify a product or invention. (DOK 1) PHY1	a. Using the Internet and other sources, have students trace the history and/or evolution of an invention or product of their choice and evaluate its effects on society. Students should evaluate the effectiveness of using a systematic approach of design for that product or invention. The students should then follow the design process to determine whether or not this invention needs any improvements. They should then write an analysis report based on their findings using the **Analysis Report Guidelines**. R1, R2, R4, R5, W1, W2, CS3, CS4, T2, T3, T4	a. **Writing Rubric** (Include report, summary of activity, etc. in e-portfolio.)
b. Apply concepts of planning, design, building, testing, quality assurance, and customer needs.(DOK 4) PHY1, IE3, IE4	b. Hook students by showing videos of inventions designed to improve the quality of life for disabled individuals. Examples follow: *Physically challenged van* http://www.youtube.com/watch?v=ZGjzA6rqTMM&feature=related *Physically challenged car* http://www.youtube.com/watch?v=gpC52u4F6IU *Speech recognition software demonstration* http://www.youtube.com/watch?v=Adm634Y9KUY *Pool ramp* http://www.youtube.com/watch?v=pm_YsdqL984&feature=related *Pool lift* http://www.youtube.com/watch?v=9EhzqYVfy9o&feature=related Group students, and have them apply the design process to complete the **Design Process Application Activity**. M4, M6, R1, R2, R4, R5, W1, W2, W3, W4, W5, CS1, CS2, CS3, CS4, CS5, T1, T2, T3, T4, T6	b. **Invention for Physically Challenged** (Include photos, summary of activity, etc. in e-portfolio.)

Standards

Industry Standards: International Technology Education Association (ITEA)—Standards for Technological Literacy

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.

Mississippi Academic Course Competencies and Benchmarks

PHY1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
IE3 Apply geometric principles to engineering situations
IE4 Apply fundamental concepts of measurement such as time, distance, area, and volume with principles of engineering in a variety of contexts.

ACT College Readiness Standards

R1 Main Ideas and Author's Approach
R4 Meaning of Words
R5 Generalizations and Conclusions
W1 Expressing Judgments
W2 Focusing on the Topic
W3 Developing a Position
W4 Organizing Ideas
W5 Using Language

21st Century Skills Standards

CLS1 Flexibility and Adaptability
CLS2 Initiative and Self-Direction
CLS3 Social and Cross-Cultural Skills
CLS4 Productivity and Accountability
CLS5 Leadership and Responsibility

National Educational Technology Standards for Students

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

References

65aquaman. (2008, February 29). Pro pool lift [Video file]. Video posted to http://www.youtube.com/watch?v=9EhzqYVfy9o&feature=related

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

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Masscmw. (2008, May 3). Car for physically challenged [Video file]. Video posted to http://www.youtube.com/watch?v=gpC52u4F6IU

Mathtalk. (2007, May 27). Physically challenged math = Algebra + speech recognition [Video file]. Video posted to http://www.youtube.com/watch?v=Adm634Y9KUY

Wheelchairvan. (2008, April 22). Vangator lifts for wheelchair accessible vehicles [Video file]. Video posted to http://www.youtube.com/watch?v=ZGjzA6rqTMM&feature=related.

Suggested Rubrics and Checklists

Name: _____

Date: _____

Period: _____

Group Participation Rubric

Project Title:

	1 point	2 points	3 points	4 points	Total
Group Discussions	Rarely contributed to discussions of the group	Contributed good effort to discussions of the group	Contributed great effort to discussions of the group	Contributed exceptional effort to discussions of the group	
On-Task Behavior	Exhibited on-task behavior inconsistently	Exhibited on-task behavior some of the time	Exhibited on-task behavior most of the time	Exhibited on-task behavior consistently	
Helping Others	Did not assist other group members	Seldom assisted other group members	Occasionally assisted other group members	Assisted other group members	
Listening	Ignored ideas of group members	Seldom listened to ideas of group members	Occasionally listened to ideas of group members	Always listened to ideas of group members	
				Total Score	

Name: _____

Date: _____

Period: _____

Presentation Rubric

CATEGORY	4 Points	3 Points	2 Points	1 Point	Score
Voice - Consistency	Voice quality is clear and consistently audible throughout the presentation.	Voice quality is clear and consistently audible throughout the majority (85–95%) of the presentation.	Voice quality is clear and consistently audible through some (70–84%) of the presentation.	Voice quality needs more attention.	
Duration of Presentation	Length of presentation is 3 minutes.	Length of presentation is 2 minutes.	Length of presentation is 1 minute.	Presentation is less than 1 minute OR more than 3 minutes.	
Grammar	Grammar and usage are correct (for the dialect chosen) and contribute to clarity, style, and character development.	Grammar and usage are typically correct (for the dialect chosen) and errors do not detract from the story.	Grammar and usage are typically correct, but errors detract from story.	Repeated errors in grammar and usage distract greatly from the story.	
Voice - Pacing	The pace (rhythm and voice punctuation) fits the story line and helps the audience really get into the story.	Presenter occasionally speaks too fast or too slowly for the story line. The pacing (rhythm and voice punctuation) is relatively engaging for the audience.	The presenter tries to use pacing (rhythm and voice punctuation), but it is often noticeable that the pacing does not fit the story line. Audience is not consistently engaged.	There is no attempt to match the pace of the storytelling to the story line or the audience.	
				Total	

Name: _____

Date: _____

Period: _____

Writing Rubric

Project Title:

Criteria					Points
	1 Point	**2 Points**	**3 Points**	**4 Points**	
Organization	The sequence of information is difficult to follow.	The reader has difficulty following the work because the student jumps around.	The student presents information in a logical sequence that the reader can follow.	Information is in a logical, interesting sequence that the reader can follow.	_____
Format and Sentences	The student did not follow the required format; plagiarism is depicted.	The student did not follow the format; the essay includes sentences that are unclear and incorrect.	The student followed the format; the article is attached; and the article is handwritten.	The student followed the format; the article is attached and typed.	_____
Grammar and Spelling	Demonstrates little concept of proper grammar usage and spelling	The presentation has three misspellings and/or grammatical errors.	The presentation has no more than two misspellings and/or grammatical errors.	The presentation has no misspellings or grammatical errors.	_____
Creativity	Work displays no creativity.	Work displays little creativity.	Work displays some creativity.	Work is very neat and creative.	_____
Due Date	Worked turned in a week late	Worked turned in 3 days late	Work turned in 1 day late	Work turned in on time	_____
				Total Points	

Analysis Report Guidelines

Directions: Follow the 10-step design process to evaluate the need for modifications or improvements of a product or invention.

Your report should include the following:

- **Title Page**
- **Product or invention in question:**
- **Invented by:**
- **Date invented:**
- **Modifications since date of invention:**
- **Description of how design process was followed:** (Describe the steps you took to determine what modifications should be made.)
- **Suggested modifications:** (Describe what could be changed about this product that would improve it.)

Include a footer with your name at the left margin and the date at the right margin.

Design Process Application Activity

Directions: Research the Americans with Disability Act and how it has affected the local, state, and national economies. Compile a list of famous or non-famous people with physical challenges and what technology they used to overcome their disabilities to be successful in their careers. How has technology evolved over the last 50 years to assist the physically challenged? Include in your research the most common physical disability prevalent in today's society and what technology was created to assist afflicted individuals.

Armed with this research, apply the 10-step design process to develop a product that will benefit a physically challenged individual. You should do this assignment based on the following scenario:

A local company is working to assist the physically challenged in designing models for assisting them with their quality of life. If a product is deemed extraordinary and useful by a panel of experts, the product will be manufactured for their use. Your challenge is to design a product that improves the quality of life for a physically challenged individual.

Include a one-page description of your product and a rough sketch of your invention.

Name: _____

Date: _____

Period: _____

Invention for Physically Challenged

CATEGORY	4 Points	3 Points	2 Points	1 Point	Points
Quality of Information	Information clearly relates to the main topic. It includes several supporting details and/or examples.	Information clearly relates to the main topic. It provides 1 to 2 supporting details and/or examples.	Information clearly relates to the main topic. No details and/or examples are given.	Information has little or nothing to do with the main topic.	
Internet Use	Successfully uses suggested Internet links to find information and navigates within these sites easily without assistance	Usually able to use suggested Internet links to find information and navigates within these sites easily without assistance	Occasionally able to use suggested Internet links to find information and navigates within these sites easily without assistance	Needs assistance or supervision to use suggested Internet links and/or to navigate within these sites	
Mechanics	No grammatical, spelling, or punctuation errors	Almost no grammatical, spelling, or punctuation errors	A few grammatical, spelling, or punctuation errors	Many grammatical, spelling, or punctuation errors	
Paragraph Construction	All paragraphs include introductory sentence, explanations or details, and concluding sentence.	Most paragraphs include introductory sentence, explanations or details, and concluding sentence.	Paragraphs included relate information but are typically not constructed well.	Paragraphing structure is not clear, and sentences are not typically related within the paragraphs.	
Diagrams and Illustrations	Diagrams and illustrations are neat and accurate and add to the reader's understanding of the topic.	Diagrams and illustrations are accurate and add to the reader's understanding of the topic.	Diagrams and illustrations are neat and accurate and sometimes add to the reader's understanding of the topic.	Diagrams and illustrations are not accurate OR do not add to the reader's understanding of the topic.	
				Total	

Unit 6: Sketching and Modeling

Competency 1: Create 2-D and 3-D models with CAD software. DOK 4, STL1, STL3, STL6, STL10, STL12, STL13

Suggested Enduring Understandings

1. The students will understand the commands and concepts necessary for producing drawings with computer-aided drafting.
2. The students will understand basic concepts of computer-aided drafting and design technology.
3. The students will understand and be able to demonstrate applications of 2-D and 3-D computer-aided drafting and design.

Suggested Essential Questions

1. What is used to get started with the drafting process?
2. What are the basic elements of computer-aided drafting?
3. How is computer-aided drafting used in the workplace?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Trace the history of drafting and design. (DOK 1) PHY1	a. Using a multimedia presentation, trace the history of drafting and design in engineering. E1, CS1, CS4, CS5, T3	a. Use the Blackboard assessment system to give students a quiz on history, applications, and terms in drafting and design.
b. Identify drafting and design applications in business and industry. (DOK 1) IE3	b. Have students use technology research tools and communication tools, such as the Blackboard discussion board, to research and discuss the applications of computer-aided drafting and design technology in engineering fields. R1, R2, R3, R5, CS1, CS2, CS4, T1, T2, T3	b. Blackboard Discussion Board Grader Check for completion.
c. Identify terms and concepts related to drafting and design. (DOK 1) IE3	c. Have students define and illustrate terms related to computer-aided drafting and design technology. R1, R2, R3, R5, CS1, CS2, CS4, T1, T2, T3	c. Teacher-created vocabulary quiz
d. Demonstrate the proper use of scales, including engineering and metric scales. (DOK 2) IE4, IE5	d. Demonstrate to students the differences in the types of scales. Demonstrate how to use each scale: Civil engineer, mechanical engineer, and metric. As an activity, have reproductions of different scales with predetermined measurements and have the students determine the readings. Give the students a reproduction of a mechanical drawing, and have them use the civil or mechanical engineer's 1:1 (10) scale to determine the dimensions at various locations on the part. Give the students a floor plan drawn 1/4" = 1'-0" scale, and have them determine the dimensions at various locations. Distribute comic strips to each student, and	d. Observe students to ensure proper use of scales. Check for accuracy. (Include photos, summary of activity, etc. in e-portfolio.)

	assign the students equally-spaced grids such as 10x10, 15x15, 20x20, and so forth. Have them draw the grid on paper and on the comic strips. They will then transfer the cartoon onto the paper so the comic will be drawn to the desired scale. Display and have a third party judge the drawings for accuracy. M1, M2, M3, M4, M7, CS1, CS2, CS4, T1, T2, T4, T6	
e. Distinguish between the types of drawing views: Orthographic, isometric, and perspective. (DOK 2) IE3, IE4, IE5	e. Compare the various types of views, and discuss the use of each. Views are orthographic, isometric, and perspective. Using multimedia technology to demonstrate the proper setup for an orthographic drawing. Create an assignment for students to sketch an orthographic drawing with the top, front and right side views properly aligned. Provide images of perspective and isometric drawings, and have students sketch the orthographic drawings. M1, M2, M3, M4, M5, M6, M7, CS1, CS2, CS4, T1, T2, T3, T4, T6	e. **Rubric for 2-D and 3-D Models** (Include drawings, summary of activity, etc. in e-portfolio.)
f. Identify and design 2-D and 3-D engineering drawings. (DOK 2) IE3, IE4, IE5	f. Introduce CAD software (e.g., SolidWorks). Have students produce single-view drawings using the following basic CAD commands: Line, erase, move, circle, arc, copy, trim, fillet, dimension, and text. Students should also learn to make use of zoom commands, snap, and grid. A suggested advanced activity would have students make use of inserting blocks, creating layers, using different line types, creating construction lines, and creating hatch patterns. Have students produce an engineering type drawing (mechanical drawing) creating the orthographic views of top, front, and right side (properly aligned). Have students make proper use of hidden lines and centerlines. Have students properly dimension the drawing part. Have students create a border and a title block and plot or print the drawing. M1, M2, M3, M4, M5, M6, M7, CS1, CS2, CS4, T1, T2, T3, T4, T6 http://www.skynet.ie/~hermes/ptutorials/tutorials.html	f. **Rubric for 2-D and 3-D Models** (Include drawings, summary of activity, etc. in e-portfolio.)

g. Construct and print a 3-D engineering assembly drawing. (DOK 4) IE3, IE4, IE5	g. Have students create a 3-D model of the invention designed in Unit 4 in CAD software (e.g., Solid Works) to assist the physically challenged. Their drawings should include dimensions and labels so a layperson could easily understand the inventions. After receiving instructor approval of their 3-D models, students should print them out on the 3-D printer as a prototype. Each group will orally present to the class their research findings and justify why they chose to create their new product. Visual aids will be presented along with their oral presentation through computer animation software. The presentation might include how the product works or how it improved an existing product. Each group should create a unique company name, logo, and brochure for the product using publishing software. M1, M2, M3, M4, M5, M6, M7, CS1, CS2, CS4, CS5, T1, T2, T3, T4, T6	g. **Rubric for 2-D and 3-D Models** and **Presentation Rubric** (Include photos, summary of activity, etc. in e-portfolio.)
h. Animate a 3-D engineering drawing. (DOK 2) IE3, IE4, IE5	h. Students will animate the 3-D drawing they created in the previous performance indicator using CAD software (e.g., SolidWorks). M3, M4, M5, M6, M7, CS2, CS3, CS5, T1, T2, T3, T4, T6	h. **Animation Rubric**

Standards

Industry Standards: International Technology Education Association (ITEA)—Standards for Technological Literacy

STL1 Students will develop an understanding of the characteristics and scope of technology.
STL3 Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
STL6 Students will develop an understanding of the role of society in the development of and use of technology.
STL10 Students will develop an understanding of the role of troubleshooting, research and development, inventions and innovation, and experimentation in problem solving.
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.

Mississippi Academic Course Competencies and Benchmarks

PHY1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
IE3 Apply geometric principles to engineering situations.
IE4 Apply fundamental concepts of measurement such as time, distance, area, and volume with principles of engineering in a variety of contexts.
IE5 Interpret charts, graphs, and other data obtained from actual or hypothetical engineering events and situations.

ACT College Readiness Standards

E1 Topic Development in Terms of Purpose and Focus
M1 Basic Operations and Applications
M2 Probability, Statistics, and Data Analysis
M3 Numbers: Concepts and Properties
M4 Expressions, Equations, and Inequalities
M5 Graphical Representations
M6 Properties of Plane Figures
M7 Measurement
R1 Main Ideas and Author's Approach
R2 Supporting Details
R3 Sequential, Comparative, and Cause–Effect Relationships
R5 Generalizations and Conclusions

21st Century Skills Standards

CLS1 Flexibility and Adaptability
CLS2 Initiative and Self-Direction
CLS3 Social and Cross-Cultural Skills
CLS4 Productivity and Accountability
CLS5 Leadership and Responsibility

National Educational Technology Standards for Students

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

References

Feeney, R. (2007). *Parametric modelling with SolidWorks*. Retrieved October 1, 2008, from http://www.skynet.ie/~hermes/ptutorials/tutorials.html

Gomez, A., Oakes, W., & Leone, L. (2004). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press, Inc.

Karsnitz, J., O'Brian, S., & Hutchinson, J. (2009). *Engineering design: An introduction*. New York, NY: Delmar Cengage Learning.

Suggested Rubrics and Checklists

Name: _____

Date: _____

Period: _____

Rubric for 2-D and 3-D Models

	4 Points	3 Points	2 Points	1 Point	Score
CAD Technique	Successfully completes drawing using proper drafting techniques and details	Successfully completes most of the drawing using proper drafting techniques and details	Successfully completes part of the drawing using proper drafting techniques and details	Fails to complete drawing or poorly presents drawing	
2-D Model	Parametric model contains the orthographic views of top, front, and right side (properly aligned).	Parametric model mostly contains the orthographic views of top, front, and right side.	Parametric model partially contains the orthographic views of top, front, and right side (properly aligned).	Student failed to show the orthographic views.	
CAD Components	Student successfully produces single-view drawings using the following basic CAD commands: Line, erase, move, circle, arc, copy, trim, fillet, dimension, and text.	Student almost fully produces single-view drawings using the following basic CAD commands: Line, erase, move, circle, arc, copy, trim, fillet, dimension, and text.	Student partially produces single-view drawings using the following basic CAD commands: Line, erase, move, circle, arc, copy, trim, fillet, dimension, and text.	Student fails to produce single-view drawings using the following basic CAD commands: Line, erase, move, circle, arc, copy, trim, fillet, dimension, and text.	
3-D Model Labeling and Dimensioning	3-D model is fully labeled and dimensioned. All parts are easily identified.	3-D model is adequately labeled and dimensioned. Most parts are easily identified.	3-D model is partially labeled and dimensioned. Some parts are easily identified.	3-D model is not labeled and dimensioned. No parts are easily identified.	
				Total	

Name: _____

Date: _____

Period: _____

Presentation Rubric

CATEGORY	4 Points	3 Points	2 Points	1 Point	Score
Voice - Consistency	Voice quality is clear and consistently audible throughout the presentation.	Voice quality is clear and consistently audible throughout the majority (85–95%) of the presentation.	Voice quality is clear and consistently audible through some (70–84%) of the presentation.	Voice quality needs more attention.	
Duration of Presentation	Length of presentation is 3 minutes.	Length of presentation is 2 minutes.	Length of presentation is 1 minute.	Presentation is less than 1 minute OR more than 3 minutes.	
Grammar	Grammar and usage are correct (for the dialect chosen) and contribute to clarity, style, and character development.	Grammar and usage are typically correct (for the dialect chosen) and errors do not detract from the story.	Grammar and usage are typically correct, but errors detract from story.	Repeated errors in grammar and usage distract greatly from the story.	
Voice - Pacing	The pace (rhythm and voice punctuation) fits the story line and helps the audience really get into the story.	Presenter occasionally speaks too fast or too slowly for the story line. The pacing (rhythm and voice punctuation) is relatively engaging for the audience.	The presenter tries to use pacing (rhythm and voice punctuation), but it is often noticeable that the pacing does not fit the story line. Audience is not consistently engaged.	There is no attempt to match the pace of the storytelling to the story line or the audience.	
				Total	

Name: _____

Date: _____

Period: _____

Animation Rubric

Animation Indicator	Points Possible	Score
Animation is planned and executed perfectly. Details of all aspects of animation are evident.	15–20 points	
Animation is planned and executed reasonably well. Details of all aspects of animation are evident.	10–15 points	
Animation is planned and executed adequately. Most details of animation are evident.	5–10 points	
Animation is not planned or executed. Details of the animation are not evident.	0–5 points	
Total		

Unit 7: Production, Quality Control, and Engineering Failure

Competency 1: Explore the processes of manufacturing and production. DOK 1, STL1, STL3, STL10, STL13, STL19

Suggested Enduring Understandings

1. Students will understand the steps of manufacturing and production.

Suggested Essential Questions

1. How is a product created from an idea to a final item?
2. Why would a company build a prototype?
3. How does marketing impact production?
4. How are failure and improvement related?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Define terms associated with manufacturing. (DOK1) PHY1	a. The teacher will show a video (e.g., *How It's Made*) that shows the inception, production, quality control, and marketing of a product. The students will create a still digital story (e.g., Microsoft PhotoStory) of the definitions that shows the terms chronologically through the manufacturing process. E2, E4, R4, CS1, CS2, CS4, T1, T2, T5, T6	a. **Presentation Rubric**
b. Identify the major commands and components of CAD/CAM software. (DOK 1) PHY1, IE4	b. The class will discuss the commands and terms associated with CAD/CAM. M4, M6, M7, CS1, CS2, CS4, T1, T4, T5, T6	b. Written test
c. Design a part to be produced on a milling machine. (DOK 4) PHY1, IE1, IE3, IE4	c. The students will use CAD/CAM software to create a design with art and text to be milled on the milling machine. M4, M6, M7, CS1, CS2, CS4, T1, T4, T5, T6	c. **CAD/CAM Rubric** (Include photos, summary of activity, etc. in e-portfolio.)

Competency 2: Explore the methods of quality control. DOK 1, STL8, STL10, STL11, STL19

Suggested Enduring Understandings

1. Students will understand the reasons for checking quality throughout production.
2. Students will understand the methods of quality control.

Suggested Essential Questions

1. Why would a factory inspect parts during assembly rather than only inspecting the final product?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Describe basic concepts of quality control	a. Using a multimedia presentation, introduce students to the terms,	a. Written test

technology. (DOK 1) IE4, IE5	concepts, and applications related to quality control technology in Engineering (digital vernier caliper, digital micrometer, electromagnetic frequency meters, illuminator, digital decibel meter, etc.). E1, E2, M1, M2, M3, M4, R5, S1, S3, W2, W4, CS1, CS2, CS4, T1, T4, T5, T6	
b. Perform applications of quality control technology. (DOK 4) PHY1, IE1, IE2, IE3, IE5	b. Perform quality control hands-on activities, including statistical process control, material testing, and precision measurement using the tools of quality control (digital vernier caliper, digital micrometer, electromagnetic frequency meters, illuminator, digital decibel meter, etc.). M2, M3, M4, M5, M6, M7, S1, S3, CS1, CS2, CS4, T1, T4, T5, T6	**b. Marble Statistical Process Control Chart** **Statistical Process Control—Illumination Levels** **Bolt Statitstical Process Control Chart** (Include photos, summary of activity, etc. in e-portfolio.)

Competency 3: Explore the causes and effects of engineering failure. DOK 1, STL1, STL 5, STL8, STL9

Suggested Enduring Understandings

1. Students will understand the forces that cause roads, structures, and so forth to fail.
2. Students will understand how engineers plan to avoid failure.

Suggested Essential Questions

1. How can the environment lead to the failure of exposed structures?
2. How do engineers predict failure and build to avoid it?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Examine the effects of engineering failures on structures. (DOK 1) PHY1, PHY2, IE3, IE4	a. Have the students randomly pick a bridge design (K-Truss, Brown, Howe, etc.) to research and build. The students, in pairs, will build balsa bridges according to current TSA competition regulations to test for strength. Upon completion, students will test the bridges using the bridge breaker. Prizes could be awarded to the teams with the strongest bridges. M2, M5, S1, S3, CS1, CS2, CS4, CS5, T1, T2, T3, T4	a. **Group Participation Rubric** and **Bridge Regulations** (Include photos, summary of activity, etc. in e-portfolio.)

Standards

Industry Standards: International Technology Education Association (ITEA)—Standards for Technological Literacy

STL1 Students will develop an understanding of the characteristics and scope of technology.
STL3 Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
STL5 Students will develop an understanding of the effects of technology on the environment.
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.
STL13 Students will develop the abilities to assess the impact of products and systems.
STL19 Students will develop an understanding of and be able to select and use manufacturing technologies.

Mississippi Academic Course Competencies and Benchmarks

PHY1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
PHY2 Develop an understanding of concepts related to forces and motion.
IE1 Compute unit conversions, and illustrate graphical interpretations.
IE2 Apply algebraic equations and functions to engineering situations.
IE3 Apply geometric principles to engineering situations
IE4 Apply fundamental concepts of measurement such as time, distance, area, and volume with principles of engineering in a variety of contexts.
IE5 Interpret charts, graphs, and other data obtained from actual or hypothetical engineering events and situations.

ACT College Readiness Standards

E1 Topic Development in Terms of Purpose and Focus
E2 Organization, Unity, and Coherence
M1 Basic Operations and Applications
M2 Probability, Statistics, and Data Analysis
M3 Numbers: Concepts and Properties
M4 Expressions, Equations, and Inequalities
M5 Graphical Representations
M6 Properties of Plane Figures
M7 Measurement
R5 Generalizations and Conclusions
S1 Interpretation of Data
S3 Evaluation of Models, Inferences, and Experimental Results
W2 Focusing on the Topic
W4 Organizing Ideas

21st Century Skills Standards

CLS1 Flexibility and Adaptability
CLS2 Initiative and Self-Direction
CLS4 Productivity and Accountability
CLS5 Leadership and Responsibility

National Educational Technology Standards for Students

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

References

Gomez, A., Oakes, W., & Leone, L. (2004). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press, Inc.

Karsnitz, J., O'Brian, S., & Hutchinson, J. (2009). *Engineering design: An introduction*. New York, NY: Delmar Cengage Learning.

Suggested Rubrics and Checklists

Name: _____

Date: _____

Period: _____

Presentation Rubric

CATEGORY	4 Points	3 Points	2 Points	1 Point	Score
Voice - Consistency	Voice quality is clear and consistently audible throughout the presentation.	Voice quality is clear and consistently audible throughout the majority (85–95%) of the presentation.	Voice quality is clear and consistently audible through some (70–84%) of the presentation.	Voice quality needs more attention.	
Duration of Presentation	Length of presentation is 3 minutes.	Length of presentation is 2 minutes.	Length of presentation is 1 minute.	Presentation is less than 1 minute OR more than 3 minutes.	
Grammar	Grammar and usage are correct (for the dialect chosen) and contribute to clarity, style, and character development.	Grammar and usage are typically correct (for the dialect chosen) and errors do not detract from the story.	Grammar and usage are typically correct, but errors detract from story.	Repeated errors in grammar and usage distract greatly from the story.	
Voice - Pacing	The pace (rhythm and voice punctuation) fits the story line and helps the audience really get into the story.	Presenter occasionally speaks too fast or too slowly for the story line. The pacing (rhythm and voice punctuation) is relatively engaging for the audience.	The presenter tries to use pacing (rhythm and voice punctuation), but it is often noticeable that the pacing does not fit the story line. Audience is not consistently engaged.	There is no attempt to match the pace of the storytelling to the story line or the audience.	
				Total	

Name: _____

Date: _____

Period: _____

CAD/CAM Rubric

Wood Piece 1	Comments	Points
Design		/10
Fabrication		/10
	Total	/20

Wood Piece 2	Comments	Points
Design		/10
Fabrication		/10
	Total	/20

Wood Piece 3	Comments	Points
Design		/10
Fabrication		/10
	Total	/20

Black Plastic	Comments	Points
Design		/10
Fabrication		/10
	Total	/20

Clear Plastic	Comments	Points
Design		/10
Fabrication		/10
	Total	/20

Design: Use of text and graphics
Fabrication: Appropriate cut depth
Clearly cut design

Name: _____

Date: _____

Period: _____

Marble Statistical Process Control Chart

PART NAME		**MACHINE**	
OPERATION		**OPERATOR**	
UNITS		**GAGE**	

SUBGROUP →	1	2	3	4	5	6	GRAND
TIME							
SAMPLE 1							
SAMPLE 2							
SAMPLE 3							
SAMPLE 4							
SAMPLE 5							
SUM							
AVERAGE X							
RANGE R							

AVERAGE – X PLOT

AVERAGE – R PLOT

Name: _____

Date: _____

Period: _____

Statistical Process Control—Illumination Levels

Instructions: Complete the chart below with your light intensity measurements. Choose 10 places in our classroom in addition to the locations at the bottom of the table.

SOURCE	Source Name	Eye Level (ft candles)	2 ft away (ft candles)
#1			
#2			
#3			
#4			
#5			
#6			
#7			
#8			
#9			
#10			
Hallway			
Door			
Another Hallway			
Office			
Gym			
Library			
Cafeteria			

Name: _____

Date: _____

Period: _____

Bolt Statitstical Process Control Chart

PART NAME		**MACHINE**	
OPERATION		**OPERATOR**	
UNITS		**GAGE**	

SUBGROUP →	1	2	3	4	5	6	GRAND
TIME							
SAMPLE 1							
SAMPLE 2							
SAMPLE 3							
SAMPLE 4							
SAMPLE 5							
SUM							
AVERAGE X							
RANGE R							

AVERAGE – X PLOT

AVERAGE – R PLOT

Name: _____

Date: _____

Period: _____

Group Participation Rubric

Project Title:

	1 point	2 points	3 points	4 points	Total
Group Discussions	Rarely contributed to discussions of the group	Contributed good effort to discussions of the group	Contributed great effort to discussions of the group	Contributed exceptional effort to discussions of the group	
On-Task Behavior	Exhibited on-task behavior inconsistently	Exhibited on-task behavior some of the time	Exhibited on-task behavior most of the time	Exhibited on-task behavior consistently	
Helping Others	Did not assist other group members	Seldom assisted other group members	Occasionally assisted other group members	Assisted other group members	
Listening	Ignored ideas of group members	Seldom listened to ideas of group members	Occasionally listened to ideas of group members	Always listened to ideas of group members	
				Total Score	

Bridge Regulations

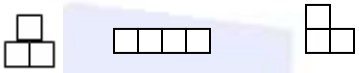
Materials: 20 ft of basswood strips
One 3-in. by 5-in. note card
Bridge glue

A sketch of the bridge must be submitted prior to construction.

Lamination: Only two strips of wood can be glued together with the grain of the wood running parallel.

CORRECT

INCORRECT



Gusset: Note cards may be cut and used as gussets to strengthen the joints. They can be no larger than a quarter. The gussets may not touch or overlap, nor can they be sandwiched between two laminated strips of wood.

The structure must reach 1 in. beyond the abutment (plus or minus 1/8 in.). Therefore, the structure must be 2 in. longer than the span (plus or minus 1/4 in.).

The height of the structure must be 2 in. above the abutment. The length will be randomly picked from a list of measurements from 10 in. to 16 in. in 1-in. increments.

The load platform (3 in. by 3 in.) must be glued on the top and center of the structure.

Upon completion, the structures will be weighed and the weight recorded on the load platform. The structure will then have load applied. The amount of load at failure will be recorded.

The structure efficiency will be determined by the failure weight * 4.54, divided by the structure weight. The result will be rounded to three decimal places.

The structure with the highest efficiency rating will receive 100 points, 2nd place – 97 points, 3rd place – 94 points, 4th place – 91 points, 5th place – 88 points, and 6th place – 85 points.

Rules violations: There will be a deduction of 10% of the failure weight for each violation. If a team's structure violates three or more regulations, that structure will not be judged and will receive 0 points.

Requirements	**Yes**	**No**
Length (+/- 1/4 in.)		
Height		
Gussets		
Lamination		

Scoring	
Bridge Weight	
Failure Weight	
Deductions (up to 20%)	
Bridge Efficiency	

**Please review all safety precautions for the lab before you begin this course.*

Systems in Engineering

Unit 8: The Four Systems

Competency 1: Examine electrical systems in engineering. DOK 1, STL1, STL2, STL3, STL7, STL8, STL9, STL10, STL19, STL20

Suggested Enduring Understandings

1. Students will understand how force affects electrical systems.
2. Students will understand how rate affects electrical systems.
3. Students will understand how resistance affects electrical systems.
4. Students will understand how power affects electrical systems.

Suggested Essential Questions

1. What would happen if a car battery were installed incorrectly?
2. Why do certain electronic devices (i.e., cell phones) use specific wall adapters for charging?
3. How does wire size relate to the amount of energy at the power supply?
4. How is your electric bill affected by the devices and appliances you use in your home?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Identify and define terms associated with energy. (DOK 1) PHY1, IE1, IE4	a. Discuss with students concepts related to energy. (Reference: *Engineering Design*, Ch. 12; *Engineering Your Future,* Ch. 18) E1, E2, M1, M2, M3, M4, M5, R4, W1, W2, W3, W4, W5, CS1, CS2, CS3, T1, T2, T3, T4, T5, T6	a. Vocabulary quiz
b. Calculate total energy usage for the student's own house. (DOK 2) PHY1, IE1, IE4	b. The students will list the appliances and electronic devices in their homes along with the amount of time each is used per day. They will research the amount of energy each appliance and device uses. They will calculate how much electricity their houses use per day, week, month, and year. They will form a report for their parents explaining how they can reduce their electricity use to live more efficiently. They will present their findings to the class. (References: *Engineering Your Future,* Ch. 18; http://www.ehow.com/how_2172446_calculate-electric-costs-energy.html?ref=fuel&utm_source=yahoo&utm_medium=ssp&utm_campaign=yssp_art) E1, E2, M1, M2, M3, M4, M5, R4, W1, W2, W3, W4, W5, CS1, CS2, CS3, T1, T2, T3, T4, T5, T6	b. Check calculations for accuracy. **Presentation Rubric**

Competency 2: Examine fluid systems in engineering. DOK 1, STL1, STL2, STL3, STL7, STL8, STL9, STL10, STL19, STL20

Suggested Enduring Understandings

1. Students will understand how force affects fluid systems.
2. Students will understand how rate affects fluid systems.
3. Students will understand how resistance affects fluid systems.

Suggested Essential Questions

1. Why does a shower lose pressure when the toilet is flushed?
2. Why do firefighters use large hoses instead of regular water hoses?
3. Why would you want to use higher weight oil in your car during the summer?

4. Students will understand how power affects fluid systems.	4. Why do tractor trailers hiss when they stop?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Identify and define terms associated with fluid systems in engineering. (DOK 1) PHY1, PHY2	a. Discuss with students concepts related to fluid systems (e.g., Pascal's law, pressure, Newton's third law, hydraulic, viscosity, pneumatic, etc.). (Reference: *Engineering Design*, Ch. 14) E1, E2, M1, M2, M7, R4,S1, S2, S3, W1, W2, W3, W4, W5, CS1, CS2, CS4, T1, T2, T4	a. Vocabulary quiz
b. Construct a small hovercraft. (DOK 4) PHY1, PHY2	b. After completing the fluid systems, have a class discussion about how pneumatic power is used in hovercrafts. The students will use the materials provided to build a hovercraft to maneuver in the room or in a flat place outside. Potential hovercraft instructions (includes a leaf blower): http://amasci.com/amateur/hovercft.html M1, M2, M7, R4,S1, S2, S3, W1, W2, W3, W4, W5, CS1, CS2, CS4, T1, T2, T4	b. **Hovercraft Rubric**

Competency 3: Examine mechanical systems in engineering. DOK 1, STL1, STL2, STL3, STL7, STL8, STL9, STL10, STL19, STL20

Suggested Enduring Understandings	Suggested Essential Questions
1. Students will understand how force affects mechanical systems.	1. Why do some bicycles have multiple sets of gears at the pedals and at the rear wheel?
2. Students will understand how rate affects mechanical systems.	2. Why do runners continue running beyond the finish line instead of stopping at the finish line?
3. Students will understand how resistance affects mechanical systems.	3. Why is salt or hot rock added to bridges in the winter?
4. Students will understand how power affects mechanical systems.	4. Why did the ADA specify the maximum wheelchair ramp slope to be 1:12?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Identify and define terms associated with mechanical systems in engineering. (DOK 1) PHY1, PHY2, IE1, IE2, IE3, IE4, IE5	a. Discuss with students concepts related to mechanical systems (e.g., kinematics, velocity, acceleration, force, vector, torque, gear ratio, etc.). E1, E2, M1, M2, M5, M7, R4, W1, W2, W3, W4, W5, CS1, CS4, T1, T4	a. Vocabulary quiz
b. Assemble mousetrap-powered cars. (DOK 2) PHY1, PHY2, IE1, IE2, IE3, IE4, IE5	b. The students will discuss how cars use power from the motor to turn the wheels. They will use the supplied kit to build a mousetrap-powered car. Some students will be given mousetraps, and the other half will use rattraps. They will race the cars over a specified distance to measure speed. They will also race the cars to measure for the longest distance travelled. The class will graph and compare the results of the different power	b. **Mousetrap Car Rubric**

plants. M1, M2, M5, M7, W1, W2, W3, W4, W5, CS1, CS4, T1, T4

Competency 4: Examine thermal systems in engineering. DOK1, STL1, STL2, STL3, STL7, STL8, STL9, STL10, STL19, STL20

Suggested Enduring Understandings

1. Students will understand how force affects thermal systems.
2. Students will understand how rate affects thermal systems.
3. Students will understand how resistance affects thermal systems.
4. Students will understand how power affects thermal systems.

Suggested Essential Questions

1. Why does the curtain suck in at the bottom when you take a shower?
2. Why do cooks add salt to water to boil noodles?
3. Why do incandescent lightbulbs get hot?
4. How do solar panels make electricity?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Identify and define terms associated with thermal systems in engineering. (DOK 1) PHY1, IE4	a. Discuss with students concepts related to thermal systems (e.g., heat, electromagnetic, thermodynamics, solar, etc.). Play Science Vocabulary Hangman at http://education.jlab.org/vocabhangman/index.html. E2, M1, M2, M5, M7, R4, W1, W2, W3, W4, W5, CS1, CS2, CS4, T1, T2, T4	a. Vocabulary quiz
b. Construct a model house that uses solar power. (DOK 4) PHY1, IE4	b. In pairs, the students will build solar houses with the supplied kits. They will measure the amount of electricity the solar panel is producing and the amount of electricity each device in the house is using. E2, M1, M2, M5, M7, CS1, CS2, CS4, T1, T2, T4	b. Check construction of the solar house. **Group Participation Rubric**

Standards

Industry Standards: International Technology Education Association (ITEA)—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.
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.
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.

Mississippi Academic Course Competencies and Benchmarks

PHY1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
PHY2 Develop an understanding of concepts related to forces and motion.
IE1 Compute unit conversions, and illustrate graphical interpretations.
IE2 Apply algebraic equations and functions to engineering situations.
IE3 Apply geometric principles to engineering situations
IE4 Apply fundamental concepts of measurement such as time, distance, area, and volume with principles of engineering in a variety of contexts.
IE5 Interpret charts, graphs, and other data obtained from actual or hypothetical engineering events and situations.

ACT College Readiness Standards

E1 Topic Development in Terms of Purpose and Focus
E2 Organization, Unity, and Coherence
M1 Basic Operations and Applications
M2 Probability, Statistics, and Data Analysis
M3 Numbers: Concepts and Properties
M4 Expressions, Equations, and Inequalities
M5 Graphical Representations
M7 Measurement
R4 Meaning of Words
S1 Interpretation of Data
S2 Scientific Investigation
S3 Evaluation of Models, Inferences, and Experimental Results
W1 Expressing Judgments
W2 Focusing on the Topic
W3 Developing a Position
W4 Organizing Ideas
W5 Using Language

21st Century Skills Standards

CLS1 Flexibility and Adaptability
CLS2 Initiative and Self-Direction
CLS3 Social and Cross-Cultural Skills
CLS4 Productivity and Accountability

National Educational Technology Standards for Students

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

References

Beaty, B. (n.d.). *Science fair project: Vacuum cleaner powered, large simple hovercraft*. Retrieved October 1, 2008, from http://amasci.com/amateur/hovercft.html

Ehow.com. (n.d.). How to calculate energy costs—Energy 101. In *How to*. Retrieved October 1, 2008, from http://www.ehow.com/how_2172446_calculate-electric-costs-energy.html?ref=fuel&utm_source=yahoo&utm_medium=ssp&utm_campaign=yssp_art

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Gomez, A., Oakes, W., & Leone, L. (2004). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press, Inc.

Karsnitz, J., O'Brian, S., & Hutchinson, J. (2009). *Engineering design: An introduction*. New York, NY: Delmar Cengage Learning.

Suggested Rubrics and Checklists

Name: _____

Date: _____

Period: _____

Presentation Rubric

CATEGORY	4 Points	3 Points	2 Points	1 Point	Score
Voice - Consistency	Voice quality is clear and consistently audible throughout the presentation.	Voice quality is clear and consistently audible throughout the majority (85–95%) of the presentation.	Voice quality is clear and consistently audible through some (70–84%) of the presentation.	Voice quality needs more attention.	
Duration of Presentation	Length of presentation is 3 minutes.	Length of presentation is 2 minutes.	Length of presentation is 1 minute.	Presentation is less than 1 minute OR more than 3 minutes.	
Grammar	Grammar and usage are correct (for the dialect chosen) and contribute to clarity, style, and character development.	Grammar and usage are typically correct (for the dialect chosen) and errors do not detract from the story.	Grammar and usage are typically correct, but errors detract from story.	Repeated errors in grammar and usage distract greatly from the story.	
Voice - Pacing	The pace (rhythm and voice punctuation) fits the story line and helps the audience really get into the story.	Presenter occasionally speaks too fast or too slowly for the story line. The pacing (rhythm and voice punctuation) is relatively engaging for the audience.	The presenter tries to use pacing (rhythm and voice punctuation), but it is often noticeable that the pacing does not fit the story line. Audience is not consistently engaged.	There is no attempt to match the pace of the storytelling to the story line or the audience.	
				Total	

Name: _____

Date: _____

Period: _____

Hovercraft Rubric

CATEGORY	4	3	2	1	Score
Plan	Plan is neat with clear measurements and labeling for all components.	Plan is neat with clear measurements and labeling for most components.	Plan provides clear measurements and labeling for most components.	Plan does not show measurements clearly or is otherwise inadequately labeled.	
Construction - Materials	Appropriate materials were selected and creatively modified in ways that made them even better.	Appropriate materials were selected and there was an attempt at creative modification to make them even better.	Appropriate materials were selected.	Inappropriate materials were selected and contributed to a product that performed poorly.	
Modification/Testing	Clear evidence of troubleshooting, testing, and refinements based on data or scientific principles.	Clear evidence of troubleshooting, testing and refinements.	Some evidence of troubleshooting, testing and refinements.	Little evidence of troubleshooting, testing or refinement.	
Function	Structure functions extraordinarily well, holding up under atypical stresses.	Structure functions well, holding up under typical stresses.	Structure functions pretty well, but deteriorates under typical stresses.	Fatal flaws in function with complete failure under typical stresses.	
Total					

Name: _____

Date: _____

Period: _____

Mousetrap Car Rubric

Cars must be completed by the specified day and time. Cars not finished then will be docked 5 points for every day they are late.

Time will be measured for the car to travel a specified distance. The fastest time will receive a 100, second place will receive a 97, third place will receive a 94, and so forth.

Distance will be measured from the front of the car in its starting position to the front of the car when it stops or hits an obstacle (wall), whichever occurs first. The longest distance will receive a 100, second place will receive a 97, third place will receive a 94, and so forth.

		Class Rank
Complete Car		
Time		
Speed		
Distance		

Name: _____

Date: _____

Period: _____

Group Participation Rubric

Project Title:

	1 point	2 points	3 points	4 points	Total
Group Discussions	Rarely contributed to discussions of the group	Contributed good effort to discussions of the group	Contributed great effort to discussions of the group	Contributed exceptional effort to discussions of the group	
On-Task Behavior	Exhibited on-task behavior inconsistently	Exhibited on-task behavior some of the time	Exhibited on-task behavior most of the time	Exhibited on-task behavior consistently	
Helping Others	Did not assist other group members	Seldom assisted other group members	Occasionally assisted other group members	Assisted other group members	
Listening	Ignored ideas of group members	Seldom listened to ideas of group members	Occasionally listened to ideas of group members	Always listened to ideas of group members	
				Total Score	

Unit 9: CIM—Computer Integrated Manufacturing

Competency 1: Design and write a program for controlling a robot. DOK 4, STL9, STL10, STL12, STL19

Suggested Enduring Understandings

1. Students will understand the factors for implementing robots in modern factories.
2. Students will understand the safety issues of working with robots in manufacturing.
3. Students will understand how robots are programmed for specific functions.

Suggested Essential Questions

1. How and why are manufacturers using robots in their factories?
2. Why do factories clearly mark a robot's work envelope?
3. What roles do people play in using robots, and how do they carry out these tasks?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Identify the terms associated with CIM and the components of a work envelope and a robot. (DOK 1) PHY1, PHY2, IE3, IE4	a. The class will discuss the parts and components of the robot as well as vocabulary associated with computer-integrated manufacturing. (Reference: *Engineering Design*, Ch. 9) E2, R4, CS1, CS2, T6	a. Matching quiz to identify robot components and CIM vocabulary.
b. Manually control a robot. (DOK 2) PHY1, PHY2, IE3, IE4	b. Have students identify the controls for a robot. The students will manually control the robot to move a block from a designated place on the work surface to another designated location. M1, M6, S3, CS2, CS4, T3, T4, T6	b. Observe students for accuracy in manually controlling a robot.
c. Compose and execute a simple program to control the robot. (DOK 4) PHY1, PHY2, IE3, IE4	c. Have students record positions and create a program to move a block from a designated place on the work surface to another designated location. M1, M6, S3, CS2, CS4, T1, T4, T6	c. Observe student work to see that the program is executed properly.
d. Compose and execute a complex program to control the robot. (DOK 4) PHY1, PHY2, IE3, IE4	d. Have the students create a program with loops and subroutines. The students will create a program so that the robot will respond to inputs to move an object from the input sensor to another location and will repeat as long as there is input from the sensor or will wait until input returns. M1, M6, S3, CS1, CS2, CS4, T1, T4, T6	d. **CIM Robot Checklist**

Competency 2: Design and create an object using NC code. DOK 4, STL9, STL10, STL11, STL12, STL19

Suggested Enduring Understandings

1. Students will understand the safety issues of programming and controlling a CNC machine.
2. Students will understand the components of the CNC machine and their uses.
3. Students will understand how CNC machines are programmed.

Suggested Essential Questions

1. Why are shields, guards, and other safety devices necessary on CNC machines?
2. How and why do CNC machines use different cutting tools?
3. How are NC codes and coordinate locations used by CNC machines?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Ass0essment Strategies
a. Label a diagram of the CNC machine to show its components and safety features. (DOK 1) PHY2, IE1, IE2, IE3, IE4, IE5	a. Show a still digital story (e.g., Microsoft PhotoStory) of the CNC machine to explain its parts. Then provide the students with a diagram of the CNC machine and allow them to label the document. E2, R4, CS2, CS4, T3, T6	a. Check the diagram for accuracy.
b. Create and execute an NC program to create a design specified by the teacher. (DOK 3) PHY2, IE1, IE2, IE3, IE4, IE5	b. Provide the student with a design to recreate using NC code and the CNC machine. M1, M5, M6, M7, S3, CS2, CS4, T4, T6	b. Observe student work to see that the program is created correctly.
c. Create and execute an original NC program to create a three-dimensional object. (DOK 4) PHY2, IE1, IE2, IE3, IE4, IE5	c. Provide the students with an object with one component missing in order for the students to create the missing part using NC code and the CNC machine. M1, M5, M6, M7, S3, CS2, CS4, T4, T6	c. Test students to see that they can execute an original NC program to create a three-dimensional object.

Competency 3: Set up the CIM cell using the robot and CNC machine. DOK 4, STL9, STL10, STL11, STL12, STL19

Suggested Enduring Understandings

1. Students will understand the hazards of CIM cell operations.
2. Students will understand how the CNC machine and robot work together.

Suggested Essential Questions

1. What makes CIM cell operations dangerous?
2. How do manufacturers use CIM?
3. Why do manufacturers monitor CIM operating times, speed, movements, and so forth?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Create and post warning signs for the CIM cell, and mark the work envelope with tape on the work surface. (DOK 2) PHY2, IE4	a. Show examples of safety signs and markings that show safe zones and unsafe zones around machines and tools. M1, M7, R4, CS1, CS2, CS3, CS4, CS5, T1, T2, T3, T4, T5, T6	a. Observe student work to see that zones are marked appropriately.
b. Write and synchronize an NC program and a robot program. (DOK 4) PHY2, IE4	b. The teacher will give the students a scenario in which to create a CIM operation. (i.e., a part of 1-in. by 2.5-in. by 2-in. maximum dimension is to be milled in 60 seconds; stock is to be moved from its feeding tray to the CNC machine in three steps that takes less than 30 seconds; milled stock is to be moved from the CNC machine to storage in two steps and less than 20 seconds). The CIM will wait until stock is available and repeat as long as	b. Test students on the NC program and robot synchronization.

stock is available. M1, M5, M6, M7, M8, R4, CS1, CS2, CS3, CS4, CS5, T1, T2, T3, T4, T5, T6

Standards

Industry Standards: International Technology Education Association (ITEA)—Standards for Technological Literacy

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.
STL19 Students will develop an understanding of and be able to select and use manufacturing technologies.

Mississippi Academic Course Competencies and Benchmarks

PHY1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
PHY2 Develop an understanding of concepts related to forces and motion.
IE1 Compute unit conversions, and illustrate graphical interpretations.
IE2 Apply algebraic equations and functions to engineering situations.
IE3 Apply geometric principles to engineering situations.
IE4 Apply fundamental concepts of measurement such as time, distance, area, and volume with principles of engineering in a variety of contexts.
IE5 Interpret charts, graphs, and other data obtained from actual or hypothetical engineering events and situations.

ACT College Readiness Standards

E2 Organization, Unity, and Coherence
M1 Basic Operations and Applications
M5 Graphical Representations
M6 Properties of Plane Figures
M7 Measurement
M8 Functions
R4 Meaning of Words
S3 Evaluation of Models, Inferences, and Experimental Results
W1 Expressing Judgments
W2 Focusing on the Topic
W3 Developing a Position
W4 Organizing Ideas
W5 Using Language

21st Century Skills Standards

CLS1 Flexibility and Adaptability
CLS2 Initiative and Self-Direction
CLS3 Social and Cross-Cultural Skills
CLS4 Productivity and Accountability
CLS5 Leadership and Responsibility

National Educational Technology Standards for Students

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

References

Gomez, A., Oakes, W., & Leone, L. (2004). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press, Inc.

Karsnitz, J., O'Brian, S., & Hutchinson, J. (2009). *Engineering design: An introduction*. New York, NY: Delmar Cengage Learning.

Suggested Rubrics and Checklists

Name: _____

Date: _____

Period: _____

CIM Robot Checklist

_____Program is written correctly with loops and subroutines. (20 points)

_____Program runs efficiently. (20 points)

_____Program repeats as long as there is input from the sensor. (20 points)

_____Work is completed on time. (20 points)

_____Work displays understanding of CIM robot control. (20 points)

_____/100 points

**Please review all safety precautions for the lab before you begin this course.*

Applying Engineering Concepts

Unit 10: Advanced Robotics

Competency 1: Design, construct, program, and reprogram robotic equipment to work properly. DOK 4, STL3, STL4, STL5, STL6, STL7

Suggested Enduring Understandings

1. The students will understand advanced concepts associated with robotic equipment.

Suggested Essential Questions

1. How do robots know what the programmers want them to do?
2. What has to happen in order for a robot to work properly?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Design a functional robot using provided software and hardware. (DOK 4) IE3, PHY1, PHY2	a. Conduct daily lessons on the programming language used with your hardware. Students should use the provided specialized software (i.e. Learnmate®) to design a robot. M6, M7, S3, CS1, CS2, CS3, CS4, CS5, T1, T2, T3, T4	a. Assessments provided with specialized software.
b. Construct a functional robot using provided software and hardware. (DOK 4) IE3, PHY1, PHY2	b. Use the provided specialized software (i.e. Learnmate®) to construct a robot. M6, M7, S3, CS1, CS2, CS3, CS4, CS5, T1, T2, T3, T4	b. Assessments provided with specialized software.
c. Program a functional robot using provided software and hardware. (DOK 2) IE3, PHY1, PHY2	c. Use the provided specialized software (i.e. Learnmate®) to program a robot. M6, M7, S3, CS1, CS2, CS3, CS4, CS5, T1, T2, T3, T4	c. Assessments provided with specialized software.
d. Reprogram a functional robot using provided software and hardware. (DOK 3) IE3, PHY1, PHY2	d. Use the provided specialized software (i.e. Learnmate®) to reprogram a robot. M6, M7, S3, CS1, CS2, CS3, CS4, CS5, T1, T2, T3, T4	d. Assessments provided with specialized software.
e. Create a blog outlining the successes and failures associated with designing the robot. (DOK 4) IE3, PHY1, PHY2	e. Use the Blackboard® software to share with classmates about the successes and failures you experienced while designing your robot. M6, M7, S3, CS1, CS2, CS3, CS4, CS5, T1, T2, T3, T4	e. Blog Checklist (Include photos, summary of activity, etc. in e-portfolio.)

Standards

Industry Standards: International Technology Education Association (ITEA)—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.
STL9 Students will develop an understanding of engineering design.
STL13 Students will develop the abilities to assess the impact of products and systems.

Mississippi Academic Course Competencies and Benchmarks

PHY1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
PHY2 Develop an understanding of concepts related to forces and motion.
IE1 Compute unit conversions, and illustrate graphical interpretations.
IE2 Apply algebraic equations and functions to engineering situations.
IE3 Apply geometric principles to engineering situations.
IE4 Apply fundamental concepts of measurement such as time, distance, area, and volume with principles of engineering in a variety of contexts.
IE5 Interpret charts, graphs, and other data obtained from actual or hypothetical engineering events and situations.

ACT College Readiness Standards

E1 Topic Development in Terms of Purpose and Focus
E2 Organization, Unity, and Coherence
E3 Word Choice in Terms of Style, Tone, Clarity, and Economy
E4 Sentence Structure and Formation
E5 Conventions of Usage
E6 Conventions of Punctuation
M1 Basic Operations and Applications
M4 Expressions, Equations, and Inequalities
M5 Graphical Representations
M6 Properties of Plane Figures
M7 Measurement
M8 Functions
R4 Meaning of Words
S1 Interpretation of Data
S2 Scientific Investigation
S3 Evaluation of Models, Inferences, and Experimental Results
W2 Focusing on the Topic
W3 Developing a Position
W4 Organizing Ideas
W5 Using Language

21st Century Skills Standards

CLS1 Flexibility and Adaptability
CLS2 Initiative and Self-Direction
CLS3 Social and Cross-Cultural Skills
CLS4 Productivity and Accountability
CLS5 Leadership and Responsibility

National Educational Technology Standards for Students

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

References

Karsnitz, J., O'Brian, S., & Hutchinson, J. (2009). *Engineering design: An introduction*. New York, NY: Delmar Cengage Learning.

Gomez, A., Oakes, W., & Leone, L. (2004). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press, Inc.

Mikezk. (2006, September 3). Punkin chunkin part 1 [Video file]. Video posted to http://www.youtube.com/watch?v=iG2c9e7UAXY

Suggested Rubrics and Checklists

Name: _____

Date: _____

Period: _____

Blog Checklist

_____/20 points	Student has all required elements in the blog. (20 points)
_____/20 points	Student stayed on topic. (20 points)
_____/20 points	Blog is formatted correctly. (20 points)
_____/20 points	Student used correct grammar, punctuation, and spelling. (20 points)
_____/10 points	Blog is interesting and informative. (10 points)
_____/10 points	Blog is free of slang and inappropriate language. (10 points)

_____/100 possible points

Unit 11: Digital Electronic Control System Technology

Competency 1: Describe applications of electronic control systems technology. STL1, STL2, STL5, STL9, STL10, STL17

Suggested Enduring Understandings

1. Students will understand the functions of electronic components as they relate to engineering.
2. Students will understand the evolution of electronics and what they are typically composed of.
3. Students will understand electronic systems terminology.

Suggested Essential Questions

1. What are electronic systems?
2. How do electronic systems function?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Use electronics vocabulary to lead and conduct group discussions. PHY1, IE1, IE2, IE5	a. Use a multimedia presentation to introduce electronic terms such as alarm, analog electronics, digital electronics, input, logic gate, NAND gate, NOR gate, NOT gate, open switch, OR gate, output, process, relay, signal, and truth table. Instruct students to define and illustrate these vocabulary words. E1, R4, CS1, CS2, CS4, T3	a. Written vocabulary test
b. Compare past and modern electronics as well as the notable electrical engineers who created them. PHY1	b. Have students research the evolution of electronics including past and present innovations, inventors, and contributions. Students should narrow their research to three electronic innovations and inventors and present their research using a voice-dictated still digital story (e.g., Microsoft PhotoStory). E1, M5, R5, S1, CS4, T3, T6	b. **Digital Story Presentation Rubric**
c. Identify and use the tools used in designing a digital device. PHY1, IE1, IE2, IE5	c. Using a multimedia presentation or the original device, identify the tools and components that are needed to design and test a digital device. Conduct a demonstration of how each tool should be used. Using transparencies, a multimedia presentation, Internet videos (e.g., YouTube), and/or guided practices, demonstrate the proper procedures for soldering electrical devices. E4, E5, E6, R5, W1, W2, W3, W4, W5, CS3, CS4, CS5, T1, T2, T3	c. Observe students to ensure proper use of soldering devices during guided practice. Written test on soldering and identifying electrical components

Competency 2: Apply concepts of electronic control systems technology. DOK 2, STL1, STL2, STL5, STL9, STL10, STL17

Suggested Enduring Understandings

1. Students will understand how truth tables relate to electronic functions.
2. Students will be able to construct electronic diagrams.

Suggested Essential Questions

1. What common products use the various types of electronic gates?
2. What components are needed to construct an electronic system?
3. What are truth tables?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Conduct practical exercise to identify components of electronic control system technology. (DOK 2) PHY4	a. Create a multimedia presentation to introduce electronic control systems. Have students compose a blog entry on Blackboard about new knowledge they have gained pertaining to electronic systems. E1, M1, R4, S1, CS5, T2, T3, T6	a. **Blog Checklist**
b. Construct truth tables associated with the AND, NAND, NOT, NOR, and OR gates. (DOK 3) PHY4	b. Have students draw truth tables that are plausible for electronic tools. E1, M1, M5, R4, S1, CS5, T2, T3, T6	b. Written test that requires matching of truth tables and gates
c. Engage in a practical exercise to construct and demonstrate projects that will utilize breadboards, wires, sensors, infrared sensors, touch sensors, speed controls and relays. (DOK 3) PHY4	c. Have students use their knowledge of soldering to solder small resistors and wire. Students should create or follow simple diagrams to create electronic output devices. Have students construct alarms, sensors, controls, and relays using bread boards, wires, and resistors. Test the final product. Have students create a wiring diagram to exchange with fellow students to create electronic devices. E1, M1, M5, R4, S1, CS5, T2, T3, T6	c. Written test on wiring and soldering Observe students to ensure accuracy in soldering.

Standards

Industry Standards: International Technology Education Association (ITEA)—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.
STL5 Students will develop an understanding of the effects of technology on the environment.
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.
STL17 Students will develop an understanding of and be able to select and use information and communication technologies.

Mississippi Academic Course Competencies and Benchmarks

PHY1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
PHY4 Discuss the characteristics and properties of light and sound.
IE1 Compute unit conversions, and illustrate graphical interpretations.
IE2 Apply algebraic equations and functions to engineering situations.
IE5 Interpret charts, graphs, and other data obtained from actual or hypothetical engineering events and situations.

ACT College Readiness Standards

E1 Topic Development in Terms of Purpose and Focus
E5 Conventions of Usage
E6 Conventions of Punctuation
M1 Basic Operations and Applications
M5 Graphical Representations
R4 Meaning of Words
R5 Generalizations and Conclusions
S1 Interpretation of Data
W1 Expressing Judgments
W2 Focusing on the Topic
W3 Developing a Position
W4 Organizing Ideas
W5 Using Language

21st Century Skills Standards

CLS1 Flexibility and Adaptability
CLS2 Initiative and Self-Direction
CLS3 Social and Cross-Cultural Skills
CLS4 Productivity and Accountability
CLS5 Leadership and Responsibility

National Educational Technology Standards for Students

T1 Creativity and Innovation
T2 Communication and Collaboration
T3 Research and Information Fluency
T6 Technology Operations and Concepts

References

Gomez, A., Oakes, W., & Leone, L. (2004). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press, Inc.

Karsnitz, J., O'Brian, S., & Hutchinson, J. (2009). *Engineering design: An introduction*. New York, NY: Delmar Cengage Learning.

Suggested Rubrics and Checklists

Name: _____

Date: _____

Period: _____

Digital Story Presentation Rubric

CATEGORY	4 Points	3 Points	2 Points	1 Point	Score
Voice - Consistency	Voice quality is clear and consistently audible throughout the presentation.	Voice quality is clear and consistently audible throughout the majority (85–95%) of the presentation.	Voice quality is clear and consistently audible through some (70–84%) of the presentation.	Voice quality needs more attention.	
Point of View - Purpose	Establishes a purpose early on and maintains a clear focus throughout	Establishes a purpose early on and maintains focus for most of the presentation	There are a few lapses in focus, but the purpose is fairly clear.	It is difficult to figure out the purpose of the presentation.	
Grammar	Grammar and usage are correct (for the dialect chosen) and contribute to clarity, style, and character development.	Grammar and usage are typically correct (for the dialect chosen), and errors do not detract from the story.	Grammar and usage are typically correct, but errors detract from story.	Repeated errors in grammar and usage detract greatly from the story.	
Images	Images create a distinct atmosphere or tone that matches different parts of the story. The images may communicate symbolism and/or metaphors.	Images create an atmosphere or tone that matches some parts of the story. The images may communicate symbolism and/or metaphors.	An attempt is made to use images to create an atmosphere/tone, but it needs more work. Image choice is logical.	Little or no attempt to use images to create an appropriate atmosphere/tone	
Detail Quality	The story is told with exactly the right amount of detail throughout. It does not seem too short, nor does it seem too long.	The story composition is typically good, though it seems to drag somewhat OR need slightly more detail in one or two sections.	The story seems to need more editing. It is noticeably too long or too short in more than one section.	The story needs extensive editing. It is too long or too short to be interesting.	
				Total	

Name: _____

Date: _____

Period: _____

Blog Checklist

_____/20 points	Student has all required elements in the blog. (20 points)
_____/20 points	Student stayed on topic. (20 points)
_____/20 points	Blog is formatted correctly. (20 points)
_____/20 points	Student used correct grammar, punctuation, and spelling. (20 points)
_____/10 points	Blog is interesting and informative. (10 points)
_____/10 points	Blog is free of slang and inappropriate language. (10 points)

_____/100 possible points

Unit 12: Workforce Readiness

Competency 1: Develop employability skills that will prepare students for the world of work. DOK 4, STL3, STL4, STL6

Suggested Enduring Understandings

1. Students will have an understanding of workforce readiness skills.
2. Students will understand why it is important to have a portfolio and resume.

Suggested Essential Questions

1. Why do you need a personal resume when job hunting?
2. How does a portfolio help you in your job interview/search?
3. What are the proper procedures, behaviors, and so forth during a job interview?
4. What is diversity in the workplace?
5. Why is it important to make career decisions in your life?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Examine examples of correctly formatted job applications, resumes, and job interviews, then create your own. (DOK 4)	a. Show students examples of correctly formatted career-planning materials. Have students complete a job application and a resume and participate in a mock interview for the job. Video the interview. E1, E2, E3, E4, E5, E6, W4, W5, CS2, T1, T2	a. Check documents for accuracy. Have students self-evaluate the interview video with the **Interview Video Checklist**. (Include the resume and video in e-portfolio.)
b. Recognize diversity in the workplace. (DOK 1)	b. Using the Internet or other sources, show students videos pertaining to diversity in the workplace (e.g., http://www.youtube.com/watch?v=EsNBu-BvgbM). Engage in a discussion about what diversity in the workplace means. Extend this activity to a discussion board forum in Blackboard where students will offer suggestions on how to best handle diversity issues in the workplace. E1, E2, E3, E4, E5, E6, W4, W5, CS2, T1, T2	b. Blackboard Discussion Board Grader

Standards

Industry Standards: International Technology Education Association (ITEA)—Standards for Technological Literacy

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.

STL6 Students will develop an understanding of the role of society in the development of and use of technology.

ACT College Readiness Standards

E1 Topic Development in Terms of Purpose and Focus

E2 Organization, Unity, and Coherence

E3 Word Choice in Terms of Style, Tone, Clarity, and Economy

E4 Sentence Structure and Formation

E5 Conventions of Usage

E6 Conventions of Punctuation

W4 Organizing Ideas

W5 Using Language

21st Century Skills Standards

CLS2 Initiative and Self-Direction

National Educational Technology Standards for Students

T1 Creativity and Innovation

T2 Communication and Collaboration

References

Gomez, A., Oakes, W., & Leone, L. (2004). *Engineering your future: A project-based introduction to engineering*. Wildwood, MO: Great Lakes Press, Inc.

Karsnitz, J., O'Brian, S., & Hutchinson, J. (2009). *Engineering design: An introduction*. New York, NY: Delmar Cengage Learning.

Safety Skills. (2008, October 2). Diversity in the workplace [Video file]. Video posted to http://www.youtube.com/watch?v=EsNBu-BvgbM

Suggested Rubrics and Checklists

Name: _____

Date: _____

Period: _____

Interview Video Checklist

Rate yourself from 1 to 5, with 1 being the lowest and 5 being the highest, using the following indicators.

_____Makes eye contact with interviewer(s)

_____Answers questions with full sentences

_____Answers questions succinctly without getting off topic

_____Presents self professionally (body posture, clothing, etc.)

_____Refers to resume or portfolio when answering questions

_____Brings extra copies of resume and portfolio to interview

_____Successfully outlines strengths without appearing boastful

---

_____/35

Key

30–35: You've got the job!

25–29: You're one of the top candidates.

20–24: You looked pretty good. Maybe if no one else applies, you will get the job.

15–19: You are not in consideration for the job.

7–14: You must improve your interviewing skills if you want a job.

Student Competency Profile (Course 1)

Student's 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 and Safety

_____ 1. Identify course expectations, school policies, and program policies related to this course.

_____ 2. Demonstrate proper use and care for laboratory equipment.

Unit 2 : Engineering History, Ethics, and Careers

_____ 1. Explore the history of engineering, its major achievements, and key figures.

_____ 2. Recognize the importance of ethical teamwork in the field of engineering.

_____ 3. Investigate careers within the field of engineering.

Unit 3: Writing, Presenting, and Project Management

_____ 1. Create a technical report.

_____ 2. Know and be able to use the correct forms for presenting reports.

_____ 3. Recognize the importance of project planning and documentation.

Unit 4: **Introduction to Robotics**

_____ 1. Explore concepts associated with physical principles of engineering.

_____ 2. Explore mechanisms and simple machines.

Student Competency Profile (Course 2)

Student's 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 5 : Engineering Design Process

_____ 1. Recognize the need for a design process.

_____ 2. Examine how the design process is used to create and modify products and inventions.

Unit 6 : Sketching and Modeling

_____ 1. Create 2-D and 3-D models with CAD software.

Unit 7: Production, Quality Control, and Engineering Failure

_____ 1. Explore the processes of manufacturing and production.

_____ 2. Explore the methods of quality control.

_____ 3. Explore the causes and effects of engineering failure.

Student Competency Profile (Course 3)

Student's 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 8: The Four Systems

_____ 1. Examine electrical systems in engineering.

_____ 2. Examine fluid systems in engineering.

_____ 3. Examine mechanical systems in engineering.

_____ 4. Examine thermal systems in engineering.

Unit 9: CIM—Computer Integrated Manufacturing

_____ 1. Design and write a program for controlling a robot.

_____ 2. Design and create an object using NC code.

_____ 3. Set up the CIM cell using the robot and CNC machine.

Student Competency Profile (Course 4)

Student's 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 10: Advanced Robotics

_____ 1. Design, construct, program, and reprogram robotic equipment to work properly.

Unit 11: Digital Electronic Control System Technology

_____ 1. Describe applications of electronic control systems technology.

_____ 2. Apply concepts of electronic control systems technology.

Unit 12: Workforce Readiness

_____ 1. Develop employability skills that will prepare students for the world of work.

Appendix A: 21st Century Skills Standards

CLS1 Flexibility and Adaptability
CLS2 Initiative and Self-Direction
CLS3 Social and Cross-Cultural Skills
CLS4 Productivity and Accountability
CLS5 Leadership and Responsibility

Today's life and work environments require far more than thinking skills and content knowledge. The ability to navigate the complex life and work environments in the globally competitive information age requires students to pay rigorous attention to developing adequate life and career skills.

CS 1 Flexibility and Adaptability

- Adapting to varied roles and responsibilities
- Working effectively in a climate of ambiguity and changing priorities

CS 2 Initiative and Self-Direction

- Monitoring one's own understanding and learning needs
- Going beyond basic mastery of skills and/or curriculum to explore and expand one's own learning and opportunities to gain expertise
- Demonstrating initiative to advance skill levels toward a professional level
- Defining, prioritizing, and completing tasks without direct oversight
- Utilizing time efficiently and managing workload
- Demonstrating commitment to learning as a lifelong process

CS 3 Social and Cross-Cultural Skills

- Working appropriately and productively with others
- Leveraging the collective intelligence of groups when appropriate
- Bridging cultural differences and using differing perspectives to increase innovation and the quality of work

CS 4 Productivity and Accountability

- Setting and meeting high standards and goals for delivering quality work on time
- Demonstrating diligence and a positive work ethic (e.g., being punctual and reliable)

CS 5 Leadership and Responsibility

- Using interpersonal and problem-solving skills to influence and guide others toward a goal
- Leveraging strengths of others to accomplish a common goal
- Demonstrating integrity and ethical behavior
- Acting responsibly with the interests of the larger community in mind

Appendix B: Mississippi Academic Standards

INTRODUCTION TO ENGINEERING

IE1 Compute unit conversions, and illustrate graphical interpretations.
IE2 Apply algebraic equations and functions to engineering situations.
IE3 Apply geometric principles to engineering situations
IE4 Apply fundamental concepts of measurement such as time, distance, area, and volume with principles of engineering in a variety of contexts.
IE5 Interpret charts, graphs, and other data obtained from actual or hypothetical engineering events and situations.

PHYSICS

PHY1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
PHY2 Develop an understanding of concepts related to forces and motion.
PHY3 Develop an understanding of concepts related to work and energy.
PHY4 Discuss the characteristics and properties of light and sound.
PHY5 Apply an understanding of magnetism, electric fields, and electricity.
PHY6 Analyze and explain concepts of nuclear physics.

Appendix C: ACT College Readiness Standards

English

E1 Topic Development in Terms of Purpose and Focus

- Identify the basic purpose or role of a specified phrase or sentence.
- Delete a clause or sentence because it is obviously irrelevant to the essay.
- Identify the central idea or main topic of a straightforward piece of writing.
- Determine relevancy when presented with a variety of sentence-level details.
- Identify the focus of a simple essay, applying that knowledge to add a sentence that sharpens that focus or to determine if an essay has met a specified goal.
- Delete material primarily because it disturbs the flow and development of the paragraph.
- Add a sentence to accomplish a fairly straightforward purpose such as illustrating a given statement.
- Apply an awareness of the focus and purpose of a fairly involved essay to determine the rhetorical effect and suitability of an existing phrase or sentence or to determine the need to delete plausible but irrelevant material.
- Add a sentence to accomplish a subtle rhetorical purpose such as to emphasize, to add supporting detail, or to express meaning through connotation.
- Determine whether a complex essay has accomplished a specific purpose.
- Add a phrase or sentence to accomplish a complex purpose, often expressed in terms of the main focus of the essay.

E2 Organization, Unity, and Coherence

- Use conjunctive adverbs or phrases to show time relationship in simple narrative essays (e.g., *then, this time*, etc).
- Select the most logical place to add a sentence in a paragraph.
- Use conjunctive adverbs or phrases to express straightforward logical relationships (e.g., *first, afterward, in response*).
- Decide the most logical place to add a sentence in an essay.
- Add a sentence that introduces a simple paragraph.
- Determine the need for conjunctive adverbs or phrases to create subtle logical connections between sentences (e.g., *therefore, however, in addition*).
- Rearrange the sentences in a fairly uncomplicated paragraph for the sake of logic.
- Add a sentence to introduce or conclude the essay or to provide a transition between paragraphs when the essay is fairly straightforward.
- Make sophisticated distinctions concerning the logical use of conjunctive adverbs or phrases, particularly when signaling a shift between paragraphs.
- Rearrange sentences to improve the logic and coherence of a complex paragraph.
- Add a sentence to introduce or conclude a fairly complex paragraph.
- Consider the need for introductory sentences or transitions, basing decisions on a thorough understanding of both the logic and rhetorical effect of the paragraph and essay.

E3 Word Choice in Terms of Style, Tone, Clarity, and Economy

- Revise sentences to correct awkward and confusing arrangements of sentence elements.
- Revise vague nouns and pronouns that create obvious logic problems.
- Delete obviously synonymous and wordy material in a sentence.
- Revise expressions that deviate from the style of an essay.

- Delete redundant material when information is repeated in different parts of speech (e.g., *alarmingly startled*).
- Use the word or phrase most consistent with the style and tone of a fairly straightforward essay.
- Determine the clearest and most logical conjunction to link clauses.
- Revise a phrase that is redundant in terms of the meaning and logic of the entire sentence.
- Identify and correct ambiguous pronoun references.
- Use the word or phrase most appropriate in terms of the content of the sentence and tone of the essay.
- Correct redundant material that involves sophisticated vocabulary and sounds acceptable as conversational English (e.g., *an aesthetic viewpoint* versus *the outlook of an aesthetic viewpoint*).
- Correct vague and wordy or clumsy and confusing writing containing sophisticated language.
- Delete redundant material that involves subtle concepts or that is redundant in terms of the paragraph as a whole.

E4 Sentence Structure and Formation

- Use conjunctions or punctuation to join simple clauses.
- Revise shifts in verb tense between simple clauses in a sentence or between simple adjoining sentences.
- Determine the need for punctuation and conjunctions to avoid awkward-sounding sentence fragments and fused sentences.
- Decide the appropriate verb tense and voice by considering the meaning of the entire sentence.
- Recognize and correct marked disturbances of sentence flow and structure (e.g., participial phrase fragments, missing or incorrect relative pronouns, dangling or misplaced modifiers).
- Revise to avoid faulty placement of phrases and faulty coordination and subordination of clauses in sentences with subtle structural problems.
- Maintain consistent verb tense and pronoun person on the basis of the preceding clause or sentence.
- Use sentence-combining techniques, effectively avoiding problematic comma splices, run-on sentences, and sentence fragments, especially in sentences containing compound subjects or verbs.
- Maintain a consistent and logical use of verb tense and pronoun person on the basis of information in the paragraph or essay as a whole.
- Work comfortably with long sentences and complex clausal relationships within sentences, avoiding weak conjunctions between independent clauses and maintaining parallel structure between clauses.

E5 Conventions of Usage

- Solve such basic grammatical problems as how to form the past and past participle of irregular but commonly used verbs and how to form comparative and superlative adjectives.
- Solve such grammatical problems as whether to use an adverb or adjective form, how to ensure straightforward subject–verb and pronoun–antecedent agreement, and which preposition to use in simple contexts.
- Recognize and use the appropriate word in frequently confused pairs such as *there* and *their*, *past* and *passed*, and *led* and *lead*.
- Use idiomatically appropriate prepositions, especially in combination with verbs (e.g., *long for, appeal to*).
- Ensure that a verb agrees with its subject when there is some text between the two.
- Ensure that a pronoun agrees with its antecedent when the two occur in separate clauses or sentences.
- Identify the correct past and past participle forms of irregular and infrequently used verbs and form present–perfect verbs by using *have* rather than *of*.
- Correctly use reflexive pronouns, the possessive pronouns *its* and *your*, and the relative pronouns *who* and *whom*.
- Ensure that a verb agrees with its subject in unusual situations (e.g., when the subject–verb order is inverted or when the subject is an indefinite pronoun).
- Provide idiomatically and contextually appropriate prepositions following verbs in situations involving sophisticated language or ideas.

- Ensure that a verb agrees with its subject when a phrase or clause between the two suggests a different number for the verb.

E6 Conventions of Punctuation

- Delete commas that create basic sense problems (e.g., between verb and direct object).
- Provide appropriate punctuation in straightforward situations (e.g., items in a series).
- Delete commas that disturb the sentence flow (e.g., between modifier and modified element).
- Use commas to set off simple parenthetical phrases.
- Delete unnecessary commas when an incorrect reading of the sentence suggests a pause that should be punctuated (e.g., between verb and direct object clause).
- Use punctuation to set off complex parenthetical phrases.
- Recognize and delete unnecessary commas based on a careful reading of a complicated sentence (e.g., between the elements of a compound subject or compound verb joined by *and*).
- Use apostrophes to indicate simple possessive nouns.
- Recognize inappropriate uses of colons and semicolons.
- Use commas to set off a nonessential/nonrestrictive appositive or clause.
- Deal with multiple punctuation problems (e.g., compound sentences containing unnecessary commas and phrases that may or may not be parenthetical).
- Use an apostrophe to show possession, especially with irregular plural nouns.
- Use a semicolon to indicate a relationship between closely related independent clauses.
- Use a colon to introduce an example or an elaboration.

Math

M1 Basic Operations and Applications

- Perform one-operation computation with whole numbers and decimals.
- Solve problems in one or two steps using whole numbers.
- Perform common conversions (e.g., inches to feet or hours to minutes).
- Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent.
- Solve some routine two-step arithmetic problems.
- Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average.
- Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour).
- Solve word problems containing several rates, proportions, or percentages.
- Solve complex arithmetic problems involving percent of increase or decrease and problems requiring integration of several concepts from pre-algebra and/or pre-geometry (e.g., comparing percentages or averages, using several ratios, and finding ratios in geometry settings).

M2 Probability, Statistics, and Data Analysis

- Calculate the average of a list of positive whole numbers.
- Perform a single computation using information from a table or chart.
- Calculate the average of a list of numbers.
- Calculate the average, given the number of data values and the sum of the data values.
- Read tables and graphs.
- Perform computations on data from tables and graphs.
- Use the relationship between the probability of an event and the probability of its complement.
- Calculate the missing data value, given the average and all data values but one.
- Translate from one representation of data to another (e.g., a bar graph to a circle graph).
- Determine the probability of a simple event.

- Exhibit knowledge of simple counting techniques.*
- Calculate the average, given the frequency counts of all the data values.
- Manipulate data from tables and graphs.
- Compute straightforward probabilities for common situations.
- Use Venn diagrams in counting.*
- Calculate or use a weighted average.
- Interpret and use information from figures, tables, and graphs.
- Apply counting techniques.
- Compute a probability when the event and/or sample space is not given or obvious.
- Distinguish between mean, median, and mode for a list of numbers.
- Analyze and draw conclusions based on information from figures, tables, and graphs.
- Exhibit knowledge of conditional and joint probability.

M3 Numbers: Concepts and Properties

- Recognize equivalent fractions and fractions in lowest terms.
- Recognize one-digit factors of a number.
- Identify a digit's place value.
- Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor.
- Find and use the least common multiple.
- Order fractions.
- Work with numerical factors.
- Work with scientific notation.
- Work with squares and square roots of numbers.
- Work problems involving positive integer exponents.*
- Work with cubes and cube roots of numbers.*
- Determine when an expression is undefined.*
- Exhibit some knowledge of the complex numbers.†
- Apply number properties involving prime factorization.
- Apply number properties involving even and odd numbers and factors and multiples.
- Apply number properties involving positive and negative numbers.
- Apply rules of exponents.
- Multiply two complex numbers.†
- Draw conclusions based on number concepts, algebraic properties, and/or relationships between expressions and numbers .
- Exhibit knowledge of logarithms and geometric sequences.
- Apply properties of complex numbers.

M4 Expressions, Equations, and Inequalities

- Exhibit knowledge of basic expressions (e.g., identify an expression for a total as b + g).
- Solve equations in the form x + a = b, where a and b are whole numbers or decimals.
- Substitute whole numbers for unknown quantities to evaluate expressions.
- Solve one-step equations having integer or decimal answers.
- Combine like terms (e.g., 2x + 5x).
- Evaluate algebraic expressions by substituting integers for unknown quantities.
- Add and subtract simple algebraic expressions.
- Solve routine first-degree equations.
- Perform straightforward word-to-symbol translations.
- Multiply two binomials.*
- Solve real-world problems using first-degree equations.

- Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions).
- Identify solutions to simple quadratic equations.
- Add, subtract, and multiply polynomials.*
- Factor simple quadratics (e.g., the difference of squares and perfect square trinomials).*
- Solve first-degree inequalities that do not require reversing the inequality sign.*
- Manipulate expressions and equations.
- Write expressions, equations, and inequalities for common algebra settings.
- Solve linear inequalities that require reversing the inequality sign.
- Solve absolute value equations.
- Solve quadratic equations.
- Find solutions to systems of linear equations.
- Write expressions that require planning and/or manipulating to accurately model a situation.
- Write equations and inequalities that require planning, manipulating, and/or solving.
- Solve simple absolute value inequalities.

M5 Graphical Representations

- Identify the location of a point with a positive coordinate on the number line.
- Locate points on the number line and in the first quadrant.
- Locate points in the coordinate plane.
- Comprehend the concept of length on the number line.*
- Exhibit knowledge of slope.*
- Identify the graph of a linear inequality on the number line.*
- Determine the slope of a line from points or equations.*
- Match linear graphs with their equations.*
- Find the midpoint of a line segment.*
- Interpret and use information from graphs in the coordinate plane.
- Match number line graphs with solution sets of linear inequalities.
- Use the distance formula.
- Use properties of parallel and perpendicular lines to determine an equation of a line or coordinates of a point.
- Recognize special characteristics of parabolas and circles (e.g., the vertex of a parabola and the center or radius of a circle).†
- Match number line graphs with solution sets of simple quadratic inequalities.
- Identify characteristics of graphs based on a set of conditions or on a general equation such as $y = ax2 + c$.
- Solve problems integrating multiple algebraic and/or geometric concepts.
- Analyze and draw conclusions based on information from graphs in the coordinate plane.

M6 Properties of Plane Figures

- Exhibit some knowledge of the angles associated with parallel lines.
- Find the measure of an angle using properties of parallel lines.
- Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90°, 180°, and 360°).
- Use several angle properties to find an unknown angle measure.
- Recognize Pythagorean triples.*
- Use properties of isosceles triangles.*
- Apply properties of 30°-60°-90°, 45°-45°-90°, similar, and congruent triangles.
- Use the Pythagorean theorem.
- Draw conclusions based on a set of conditions.
- Solve multistep geometry problems that involve integrating concepts, planning, visualization, and/or making connections with other content areas.
- Use relationships among angles, arcs, and distances in a circle.

M7 Measurement

- Estimate or calculate the length of a line segment based on other lengths given on a geometric figure.
- Compute the perimeter of polygons when all side lengths are given.
- Compute the area of rectangles when whole number dimensions are given.
- Compute the area and perimeter of triangles and rectangles in simple problems.
- Use geometric formulas when all necessary information is given.
- Compute the area of triangles and rectangles when one or more additional simple steps are required.
- Compute the area and circumference of circles after identifying necessary information.
- Compute the perimeter of simple composite geometric figures with unknown side lengths.*
- Use relationships involving area, perimeter, and volume of geometric figures to compute another measure.
- Use scale factors to determine the magnitude of a size change.
- Compute the area of composite geometric figures when planning or visualization is required.

M8 Functions

- Evaluate quadratic functions, expressed in function notation, at integer values.
- Evaluate polynomial functions, expressed in function notation, at integer values.†
- Express the sine, cosine, and tangent of an angle in a right triangle as a ratio of given side lengths.†
- Evaluate composite functions at integer values.†
- Apply basic trigonometric ratios to solve right-triangle problems.†
- Write an expression for the composite of two simple functions.†
- Use trigonometric concepts and basic identities to solve problems.†
- Exhibit knowledge of unit circle trigonometry.†
- Match graphs of basic trigonometric functions with their equations.

Notes

- Students who score in the 1–12 range are most likely beginning to develop the knowledge and skills assessed in the other ranges.
- Standards followed by an asterisk (*) apply to the PLAN and ACT Mathematics Tests only.
- Standards followed by a dagger (†) apply to the ACT Mathematics Test only.

Reading

R1 Main Ideas and Author's Approach

- Recognize a clear intent of an author or narrator in uncomplicated literary narratives.
- Identify a clear main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Infer the main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in uncomplicated passages.
- Identify a clear main idea or purpose of any paragraph or paragraphs in uncomplicated passages.
- Infer the main idea or purpose of straightforward paragraphs in more challenging passages.
- Summarize basic events and ideas in more challenging passages.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in more challenging passages.
- Infer the main idea or purpose of more challenging passages or their paragraphs.
- Summarize events and ideas in virtually any passage.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in virtually any passage.
- Identify clear main ideas or purposes of complex passages or their paragraphs.

R2 Supporting Details

- Locate basic facts (e.g., names, dates, events) clearly stated in a passage.
- Locate simple details at the sentence and paragraph level in uncomplicated passages.
- Recognize a clear function of a part of an uncomplicated passage.
- Locate important details in uncomplicated passages.
- Make simple inferences about how details are used in passages.
- Locate important details in more challenging passages.
- Locate and interpret minor or subtly stated details in uncomplicated passages.
- Discern which details, though they may appear in different sections throughout a passage, support important points in more challenging passages.
- Locate and interpret minor or subtly stated details in more challenging passages.
- Use details from different sections of some complex informational passages to support a specific point or argument.
- Locate and interpret details in complex passages.
- Understand the function of a part of a passage when the function is subtle or complex.

R3 Sequential, Comparative, and Cause–Effect Relationships

- Determine when (e.g., first, last, before, after) or if an event occurred in uncomplicated passages.
- Recognize clear cause–effect relationships described within a single sentence in a passage.
- Identify relationships between main characters in uncomplicated literary narratives.
- Recognize clear cause–effect relationships within a single paragraph in uncomplicated literary narratives.
- Order simple sequences of events in uncomplicated literary narratives.
- Identify clear relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear cause–effect relationships in uncomplicated passages.
- Order sequences of events in uncomplicated passages.
- Understand relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear relationships between characters, ideas, and so forth in more challenging literary narratives.
- Understand implied or subtly stated cause–effect relationships in uncomplicated passages.
- Identify clear cause–effect relationships in more challenging passages.
- Order sequences of events in more challenging passages.
- Understand the dynamics between people, ideas, and so forth in more challenging passages.
- Understand implied or subtly stated cause–effect relationships in more challenging passages.
- Order sequences of events in complex passages.
- Understand the subtleties in relationships between people, ideas, and so forth in virtually any passage.
- Understand implied, subtle, or complex cause–effect relationships in virtually any passage.

R4 Meaning of Words

- Understand the implication of a familiar word or phrase and of simple descriptive language.
- Use context to understand basic figurative language.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in uncomplicated passages.
- Use context to determine the appropriate meaning of virtually any word, phrase, or statement in uncomplicated passages.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in more challenging passages.
- Determine the appropriate meaning of words, phrases, or statements from figurative or somewhat technical contexts.
- Determine, even when the language is richly figurative and the vocabulary is difficult, the appropriate meaning of context-dependent words, phrases, or statements in virtually any passage.

R5 Generalizations and Conclusions

- Draw simple generalizations and conclusions about the main characters in uncomplicated literary narratives.
- Draw simple generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw simple generalizations and conclusions using details that support the main points of more challenging passages.
- Draw subtle generalizations and conclusions about characters, ideas, and so forth in uncomplicated literary narratives.
- Draw generalizations and conclusions about people, ideas, and so forth in more challenging passages.
- Use information from one or more sections of a more challenging passage to draw generalizations and conclusions about people, ideas, and so forth.
- Draw complex or subtle generalizations and conclusions about people, ideas, and so forth, often by synthesizing information from different portions of the passage.
- Understand and generalize about portions of a complex literary narrative.

Science

S1 Interpretation of Data

- Select a single piece of data (numerical or nonnumerical) from a simple data presentation (e.g., a table or graph with two or three variables, a food web diagram).
- Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels).
- Select two or more pieces of data from a simple data presentation.
- Understand basic scientific terminology.
- Find basic information in a brief body of text.
- Determine how the value of one variable changes as the value of another variable changes in a simple data presentation.
- Select data from a complex data presentation (e.g., a table or graph with more than three variables, a phase diagram).
- Compare or combine data from a simple data presentation (e.g., order or sum data from a table).
- Translate information into a table, graph, or diagram.
- Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table).
- Compare or combine data from a complex data presentation.
- Interpolate between data points in a table or graph.
- Determine how the value of one variable changes as the value of another variable changes in a complex data presentation.
- Identify and/or use a simple (e.g., linear) mathematical relationship between data.
- Analyze given information when presented with new, simple information.
- Compare or combine data from a simple data presentation with data from a complex data presentation.
- Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data.
- Extrapolate from data points in a table or graph.
- Compare or combine data from two or more complex data presentations.
- Analyze given information when presented with new, complex information.

S2 Scientific Investigation

- Understand the methods and tools used in a simple experiment.
- Understand the methods and tools used in a moderately complex experiment
- Understand a simple experimental design.
- Identify a control in an experiment.
- Identify similarities and differences between experiments.

- Understand the methods and tools used in a complex experiment.
- Understand a complex experimental design.
- Predict the results of an additional trial or measurement in an experiment.
- Determine the experimental conditions that would produce specified results.
- Determine the hypothesis for an experiment.
- Identify an alternate method for testing a hypothesis.
- Understand precision and accuracy issues.
- Predict how modifying the design or methods of an experiment will affect results.
- Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results.

S3 Evaluation of Models, Inferences, and Experimental Results

- Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model.
- Identify key issues or assumptions in a model.
- Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a simple hypothesis or conclusion and why.
- Identify strengths and weaknesses in one or more models.
- Identify similarities and differences between models.
- Determine which model(s) is/are supported or weakened by new information.
- Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion.
- Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model.
- Determine whether new information supports or weakens a model and why.
- Use new information to make a prediction based on a model.
- Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a complex hypothesis or conclusion and why.

Writing

W1 Expressing Judgments

- Show a little understanding of the persuasive purpose of the task but neglect to take or to maintain a position on the issue in the prompt.
- Show limited recognition of the complexity of the issue in the prompt.
- Show a basic understanding of the persuasive purpose of the task by taking a position on the issue in the prompt but may not maintain that position.
- Show a little recognition of the complexity of the issue in the prompt by acknowledging, but only briefly describing, a counterargument to the writer's position.
- Show understanding of the persuasive purpose of the task by taking a position on the issue in the prompt.
- Show some recognition of the complexity of the issue in the prompt by doing the following:
    - Acknowledging counterarguments to the writer's position
    - Providing some response to counterarguments to the writer's position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a broad context for discussion.
- Show recognition of the complexity of the issue in the prompt by doing the following:
    - Partially evaluating implications and/or complications of the issue, and/or
    - Posing and partially responding to counterarguments to the writer's position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a critical context for discussion.
- Show understanding of the complexity of the issue in the prompt by doing the following:

- Examining different perspectives, and/or
- Evaluating implications or complications of the issue, and/or
- Posing and fully discussing counterarguments to the writer's position

W2 Focusing on the Topic

- Maintain a focus on the general topic in the prompt through most of the essay.
- Maintain a focus on the general topic in the prompt throughout the essay.
- Maintain a focus on the general topic in the prompt throughout the essay, and attempt a focus on the specific issue in the prompt.
- Present a thesis that establishes focus on the topic.
- Maintain a focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a thesis that establishes a focus on the writer's position on the issue.
- Maintain a clear focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a critical thesis that clearly establishes the focus on the writer's position on the issue.

W3 Developing a Position

- Offer a little development, with one or two ideas; if examples are given, they are general and may not be clearly relevant; resort often to merely repeating ideas.
- Show little or no movement between general and specific ideas and examples.
- Offer limited development of ideas using a few general examples; resort sometimes to merely repeating ideas.
- Show little movement between general and specific ideas and examples.
- Develop ideas by using some specific reasons, details, and examples.
- Show some movement between general and specific ideas and examples.
- Develop most ideas fully, using some specific and relevant reasons, details, and examples.
- Show clear movement between general and specific ideas and examples.
- Develop several ideas fully, using specific and relevant reasons, details, and examples.
- Show effective movement between general and specific ideas and examples.

W4 Organizing Ideas

- Provide a discernible organization with some logical grouping of ideas in parts of the essay.
- Use a few simple and obvious transitions.
- Present a discernible, though minimally developed, introduction and conclusion.
- Provide a simple organization with logical grouping of ideas in parts of the essay.
- Use some simple and obvious transitional words, though they may at times be inappropriate or misleading.
- Present a discernible, though underdeveloped, introduction and conclusion.
- Provide an adequate but simple organization with logical grouping of ideas in parts of the essay but with little evidence of logical progression of ideas.
- Use some simple and obvious, but appropriate, transitional words and phrases.
- Present a discernible introduction and conclusion with a little development.
- Provide unity and coherence throughout the essay, sometimes with a logical progression of ideas.
- Use relevant, though at times simple and obvious, transitional words and phrases to convey logical relationships between ideas.
- Present a somewhat developed introduction and conclusion.
- Provide unity and coherence throughout the essay, often with a logical progression of ideas.
- Use relevant transitional words, phrases, and sentences to convey logical relationships between ideas.
- Present a well-developed introduction and conclusion.

W5 Using Language

- Show limited control of language by doing the following:

- Correctly employing some of the conventions of standard English grammar, usage, and mechanics, but with distracting errors that sometimes significantly impede understanding
- Using simple vocabulary
- Using simple sentence structure
- Correctly employing some of the conventions of standard English grammar, usage, and mechanics, but with distracting errors that sometimes impede understanding
- Using simple but appropriate vocabulary
- Using a little sentence variety, though most sentences are simple in structure
- Correctly employing many of the conventions of standard English grammar, usage, and mechanics, but with some distracting errors that may occasionally impede understanding
- Using appropriate vocabulary
- Using some varied kinds of sentence structures to vary pace
- Correctly employing most conventions of standard English grammar, usage, and mechanics with a few distracting errors but none that impede understanding
- Using some precise and varied vocabulary
- Using several kinds of sentence structures to vary pace and to support meaning
- Correctly employing most conventions of standard English grammar, usage, and mechanics with just a few, if any, errors
- Using precise and varied vocabulary
- Using a variety of kinds of sentence structures to vary pace and to support meaning

Appendix D: National Industry Standards

International Technology Education Association (ITEA)—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 E:
National Educational Technology Standards for Students

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:
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:
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:
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:
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:
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:

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.