Courses of Study
For
Project Lead The Way
Introduction To Design (IED)
Principles of Engineering (POE)
Digital Electronics (DE)
Engineering Design and Development (EDD)

Subject Code 17.1087

CTPD 023

WEST SHORE CAREER AND TECHNICAL EDUCATION DISTRICT
LAKEWOOD, OHIO

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Acknowledgements
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Sincere appreciation goes to the following individuals for their assistance and cooperation in preparing this Project Lead The Way program's course of study.

Lakewood Board of Education, Lakewood City Schools
Dr. David Estrop, Superintendent, Lakewood City Schools
Dr. William Wagner, Lakewood High School Principal
Mrs. Linda Thayer, Director, West shore Career and Technical
Mrs. Jan McAndrew, Instructor, Introduction to Engineering
Mr. Robert Sedlak, Instructor, Principles of Engineering
Mr. Edward Holmok, Instructor, Digital Electronics

And the Project Lead The Way Advisory Committee:

Mr. Phil Weber, Weld Systems Integrators, Sales Engineer
Mr. Nick Stipanovich, Turbo Machine Inc., Manager
Mr. James Drake, CWRU. Instructor Engineering Technology
Mr. Eric Mondok, Avco Fire Protection
Mrs. Joanne Ritschel, High School Mathematics Instructor
Mr. Kevin Meehan, High School Mathematics Instructor

For their helpful suggestions and encouragement: Donna Richmond, Professor Kent State University

Recommendation of Advisory Committee
Project Lead The Way
West Shore Career & Technical District

The Career & Technical Advisory Committee of the Project Lead The Way Program, West Shore Career & Technical District, has reviewed this course of study and recommends it for use as the foundation for instruction in classroom, laboratory, and cooperative occupational experiences.

The developers of the course of study have considered local labor market needs and the school district's ability to offer specialized programs. The competencies found on the manufacturing content standards for this program have been reviewed and accepted as being congruent with our school district's philosophy and student outcome measures.

We believe that this course of study adequately and correctly focuses upon the development of technical competencies, attitudes, values, and appreciation's critical to successful employment in the business realm.

After reviewing this document, we recommend that the Project Lead The Way Course of Study be approved and adopted on _____.
(date)

_____	_____
Mr. Phil Weber Weld Systems Integrators, Sales Engineer Teacher	Mr. Nick Stipanovich Turbo Machine Inc. Manager
_____	_____
Mr. James Drake CWRU – Instructor Engineering Technology	Mr. Eric Mondok Avco Fire Protection
_____	_____
Mrs. Joanne Ritschel High School Mathematics Instructor	Mr. Kevin Meehan High School Mathematics Instructor

Resolution
Project Lead The Way
West Shore Career & Technical District

WHEREAS, the Project Lead The Way advisory Committee of the Lakewood City Schools has reviewed the *Project Lead The Way* Course of Study, and WHEREAS, the course of study is based upon the Career Content Standards Competencies for *Introduction to Design, Principles of Engineering, and Digital Electronics,* and

WHEREAS, the Project Lead The Way Advisory Committee has reviewed these competencies and has edited competencies to address local labor market needs, and to acknowledge the school district's ability to offer specialized programs,

NOW, THEREFORE, BE IT RESOLVED, in accordance with the superintendent's recommendation, that the *Lakewood City Schools* adopt the *Project Lead The Way* Course of Study.

Approval date: _____

_____ _____

Superintendent Board President

MISSION / VISION STATEMENT
PROJECT LEAD THE WAY
WEST SHORE CAREER AND TECHNICAL EDUCATION DISTRICT

Mission of Lakewood City Schools

In partnership with our families and community, Lakewood City Schools will develop responsible citizens, who are critical and creative thinkers, committed to life-long learning, invested in a diverse society, and prepared for technological and global opportunities.

Lakewood City Schools Vision Statement

In recognition of the need of the community for Life Long Learning, the Lakewood City School District will become the primary provider of academic services for all learners ranging in age from Pre-Kindergarten Children through Adults. In addition, the school district will enhance academic services through improved coordination of social and medical services in partnership with our community and other educational institutions.

CAREER AND TECHNICAL EDUCATION GOALS
PROJECT LEAD THE WAY
WEST SHORE CAREER AND TECHNICAL EDUCATION DISTRICT

- To continue to infuse technology into the curriculum and meet industry standards
- Continue to upgrade and modernize career and technical labs and offer a variety of career training opportunities
- To continue to partner with post-secondary education institutions to create pathways to foster life-long learning
- To develop and maintain active advisory committee membership which offer overall direction and specific occupational knowledge of competencies required in business and industry
- To continue to develop ties with parents and community to meet community education needs.

PROGRAM DESIGN
Project Lead The Way
WEST SHORE CAREER AND TECHNICAL EDUCATION DISTRICT

PROGRAM PHILOSOPHY:

We believe the Project Lead The Way program should provide all interested students with appropriate skills to make a smooth transition through the variety of educational environments into entry-level engineering fields of study whether in business or in further academic studies areas.

We believe the curriculum should have a firm basis in providing the students with the necessary communications, mathematics, science, and reasoning skills for success on the job.

We believe that the Project Lead The Way program should offer leadership and academic training necessary for further studies in the engineering field, employability opportunities, citizenship, and cooperative activities so that students may gain experience in making decisions and accepting responsibility for their actions.

We believe the program offers life-long learning skills needed to:

- survive in a technical society
- engage in entrepreneurial endeavors and maximize their potential as productive citizens

PROGRAM GOALS:

Program goals for students attending the West shore Career and Technical school include:

- Students will develop the skills, knowledge, attitudes, and values sufficient to secure employment and/or pursue post secondary education in the field of their choice.
- Students will develop, expand, and refine math, science, and communication skills through application appropriate to the world of work and necessary for everyday success.
- Student will demonstrate occupational competencies at a level of proficiency acceptable to the employment market and to demonstrate the ability to adapt, retrain, and advance in an ever changing work environment.
- Students will demonstrate an understanding of positive work ethics, attitude, self-concept, and preserve mental and physical health as it relates to the processes of managing work, family, and use of leisure time.
- Students will participate in career and technical student organization activities to the extent of improved skills, knowledge, and self-concept needed for success

- Students will demonstrate communication and basic computer operations skills to solve problems that will be encountered on a day to day basis
- Students will receive exposure to "high tech" procedures needed to meet the demands of business and industry.
- Students will value the free enterprise system and know they are able to work as entrepreneurs as well as employers.
- Students who are educationally, economically, and/or physically disadvantaged are mainstream unless the disability prevents the student from benefiting from the program or creates a significant safety hazard to self or other students

Overview of Program

The Project Lead The Way program at Lakewood High School is currently a three-year program designed for 9th, 10th and11th grade students who are interested in pursuing post-secondary education upon graduation. The program curriculum is based on the North coast Ohio Tech Prep Consortiums Technical Competency Profiles for Engineering Technologies. This curriculum is the result of a comprehensive review of the PLTW Advisors and refinement of the State's TCP Engineering Technologies document by a panel of representatives from secondary, post-secondary and business leaders.

Students are encouraged to take the proper classes so that they are prepared for their next step in their educational careers. The following pathway chart is a recommended sequence for students interested in this career field of Pre-Engineering.

9th Grade	10th Grade	11th Grade	12th Grade
English 1	English 2	English 3	English 4
Algebra 1 or Geometry	Geometry or Algebra II	Algebra II or Pre-Calculus	Pre-Calculus or Calculus
Biology or Earth Science	Chemistry or Biology	Chemistry or Physics	Physics
Social Studies	Social Studies	Social Studies	Elective
Foreign Language	Foreign Language	Digital Electronics	To Be Determined
Introduction to Design	Principles of Engineering		
Music/ Art/ PE	Music/Art /PE		

In the 9th, 10th and 11th grade components of the Tech Prep program, all students are part of a seamless curriculum, which allows student to transition into post-secondary programs. Each competency and competency builder in the required curriculum is designated to be introduced, reinforced, or mastered at various levels.

The basic instructional philosophy for the Tech Prep programs encourages project-based learning. To this end, a senior project (to be introduced in 2009) will be completed by each student as a culmination of their high school exit from tech prep. An advisory committee comprised of representatives from business and industry, program graduates and academic representatives from school meets twice each year to provide input and guidance in this program.

Throughout the school year, students participate in a variety of work-based learning projects as developed by PLTW, in order to learn more about the engineering industry as a whole. Early placement/ internships/ mentoring assignments/ job shadowing and ultimately post high school college and university study are all goals of the program.

Students enrolled in Project Lead The Way are also members of North Coast Tech Prep consortia. Students are also encouraged to participate in the Tech Prep Regional Showcase.

Population Served

PLTW Tech Prep programs are open to all grades 9 though 12. It is strongly suggested that entering freshman are taking geometry concurrent with the first PLTW class of IDE (Introduction to Design), and must complete a calculus course by the time they graduate from high school. To receive college credit students must maintain a 3.0 GPA in their Tech Prep programs and an overall GPA of 2.0 and maintain a 95% attendance rate.

Housing of the Program

- Classroom and laboratory
- Fieldtrips to provide learning experiences outside the classroom
- Partnership with business to provide an additional hands-on training
- Early placement also provides learning experiences outside the classroom

Supervisor of the Program

The teacher of the Project Lead The Way programs report directly to the West Shore Career and Technical Director

Occupations Addressed

- Engineering Technician
- All types of Engineering Fields
- Computer Technician
- Engineering Design
- Entrepreneur

Basic Program Operation

Provide classroom instruction and laboratory experience. Develop fundamental knowledge, skills, abilities, values, and attitudes in entrepreneurship, leadership, and employability skills. Related class is forty minutes a day for a total of 3.3 hours per week. The Lab experience is for forty minutes a day for a total of 3.3 hour per week

Articulation Agreements

Articulation agreements have been developed between West Shore Career and Technical District and Cuyahoga Community College. There is on-going dialogue following the established process and procedures between our school and each participating post-secondary institution to develop and maintain articulation agreements. The procedure can include post-secondary options, waiver of classes or other formats providing time-shortened or advanced skill associate degree paths.

Technology

Technology is an integral part of the Project Lead The Way program. Computer hardware and software are maintained as state-of-the-art Instructional delivery of curriculum through technology is the norm for this class.

Integrated Academics
Academics are taught outside the CTE program by a licensed teacher, however, is integrated as part of this program in order to raise standards. Math, Science, English and Communications skills are essential and integral parts of the program competencies.

Student Leadership
It is anticipated that students will:
-develop study habits commensurate with the workload
-maintain workbooks and sketch books throughout each year
-understand course requirements occasionally demand that students work in groups, and that the success of the group equates to the lowest common denominator

Critical Thinking and Decision Making

Develops the use of critical thinking skills in making wise decisions as an integral part of classroom instruction and laboratory learning activities
Teaches decision-making techniques through problem solving, case studies, and real life experiences

Statement of Modifications

Significant academic accommodations and/or modifications of competency to the Project Lead The Way curriculum may limit or prevent successful training and/or future employment options in this area. Also accommodations and/or modification necessary for physical limitations and/or social work behaviors may also limit or prevent successful training and/or future employment options in this area

Disclaimer Statement

This Course of Study conforms to all federal, state and local laws and regulations including Title IX and non discrimination against any student because of race, color, creed, sex, religion, citizenship, economic status, married status, pregnancy, handicap, other physical characteristics, age or national origin. This policy of nondiscrimination shall also apply to otherwise qualified handicapped individuals.

INTRODUCTION TO ENGINEERING

INTRODUCTION TO ENGINEERING DESIGN

Unit 1: Introduction

EDU:	12	AD
	P	R

Competency C.S. 1.1: Discuss the history of engineering and engineering technology design

TPO: Given access to printed and electronic media, research, discuss and write a report about the engineering technology timeline and events.

Clear Learning Target: I can
Descriptors:

1.1.1 Describe how the history of art has influenced innovations in the field of engineering and engineering technology, and explain the impact of artistic expression as it relates to consumer products

1.1.2 Discuss how artistic period and style have influenced product and architectural design

1.1.3 Describe the design concept of form and function and explain its use in product design

1.1.4 Describe the evolution of technology and be able to identify engineering and engineering technology achievements through history

1.1.5 Describe the chronological development and accelerating rate of change that innovations in tools and materials have brought about over time as it relates to a given consumer product

1.1.6 Review the history of measurement tools and identify innovations that have led to improved functionality of that tool

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades 9-12, all students should develop

- **Systems, order, and organization**

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop

- **Abilities of technological design**

Principles and Standards for School Mathematics

Representation: Instructional programs from pre-kindergarten through grade 12 should enable all students to use representations to model and interpret physical, social, and mathematical phenomena.

Standards for English Language Arts

Standard 3: Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts. They draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and other texts, their word identification strategies, and their understanding of textual features (e.g. sound-letter correspondence, sentence structure, context, graphics).

Standard 4: Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.

Standard 5: Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences and for a variety of purposes.

Standard 7: Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and nonprint texts, artifacts, and people) to communicate their discoveries in ways that suit their purpose and audience.

EDU:	**12**	**AD**
	P	R

Competency C.S. 1.2: Explore career pathways in engineering and engineering technology related to design

TPO: Given instruction, real world scenarios and access to printed and electronic media, investigate careers in engineering and technology to instructors standards with 85% accuracy.

Clear Learning Target: I can

Descriptors:

1.2.1 Identify career opportunities in design engineering and engineering technology and explain their job functions

1.2.2 Explore career opportunities in a given engineering and engineering technology field and list the educational requirements for each profession

1.2.3 Explore a given professional organization and summarize the range of services provided by the organization

Standards for English Language Arts

Standard 4: Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.

Standard 5: Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences and for a variety of purposes.

Standard 12: Students use spoken, written and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).

Unit 2: Introduction to Design

EDU:	12	AD
	P	R

Competency C.S. 2.1: Apply the steps of the design process to solve a variety of design problems

TPO: Given instruction, visual aids and printed media, describe in writing and verbal presentation the design process for a current day product.

Clear Learning Targets: I can

Descriptors:

2.1.1 List the seven steps of the design process and explain the activities that occur during each phase

2.1.2 Describe the value of working as a team and discuss the benefits of collaboration

2.1.3 Recognize the importance of focusing on detail when executing the design process

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades 9-12, all students should develop

- **Evidence, models, and explanation**

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop

- **Abilities of technological design**

EDU:	12	AD
	P	R

Competency C.S. 2.2: Describe the application of the principles and elements of design utilized in products, print media, and art forms

TPO: Given access to printed and electronic media, create a visual presentation that describes current products and their use of principles and elements of design.

Clear Learning Target: I can

Descriptors:

2.2.1 Investigate the principles and elements of design and demonstrate their use in the design process
2.2.2 Identify the use of the principles and elements of design in various products, print media, and art forms
2.2.3 Incorporate the principles and elements of design by incorporating them in design solutions

Standards for Technological Literacy

BM B:	Expressing ideas to others verbally and through sketches and models is an important part of the design process.
BM D:	When designing an object, it is important to be creative and consider all ideas.
BM J:	Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.
Standard 11	Students will develop the abilities to apply the design process.
BM H:	Apply a design process to solve problems in and beyond the laboratory-classroom.

Unit 3: Student Portfolio Development

EDU:	12	AD
	P	R

Competency C.S. 3.1: Develop a portfolio to organize and display evidence of work

TPO: Given a list of portfolio materials; create the cover and heading pages with descriptions of documents placed in specific areas. Checked quarterly to 100% accuracy.

Clear Learning Targets: I can

Descriptors:

3.1.1 Identify the proper elements of a fully developed portfolio
3.1.2 Identify and discuss the ethical issues surrounding portfolio artifacts
3.1.3 Compare and contrast defined elements of a good portfolio specified in the PowerPoint presentation to the sample provided in the PLTW® Design Resource Guide

Standards for Technological Literacy

BM I:	Corporations can often create demand for a product by bringing it onto the market and advertising it.
STL 8:	Students will develop an understanding of the attributes of design.
BM J:	Make two-dimensional and three-dimensional representations of the designed solution.

BM R:	Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models.
BM P:	There are many ways to communicate information, such as graphic and electronic means.
BM Q:	Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli.

Standards for English Language Arts

Standard 4:	Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
Standard 5:	Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences and for a variety of purposes.
Standard 6:	Students apply knowledge of language structure, language conventions (e.g., spelling and punctuation), media techniques, figurative language, and genre to create, critique, and discuss print and non-print texts.

EDU:	**12**	**AD**
	P	R

Competency C.S 3.2 Use the portfolio to make a presentation that defends current proficiency

TPO: Demonstrate appropriate documentation and oral presentation skills with portfolio to for mock interview with audience assessment rubric.

Clear Learning Target: I can

Descriptors:

3.2.1 Prepare the presentation

3.2.2 Deliver the presentation, receive and process the feedback

Standards for Technological Literacy

BM L:	The process of engineering design takes into account a number of factors.
STL 10:	Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
BM R:	Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models.
BM L:	Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques.

Unit 4: Sketching and Visualization

EDU:	12	AD
	P	R

Competency C.S. 4.1: Utilize sketching and visualization techniques

TPO: Using examples presented in class, sketch geometric objects using drafting tools and paper to 85% accuracy.

Clear Learning Target: I can

Descriptors:

4.1.1 Integrate proper sketching techniques and styles in the creation of sketches

4.1.2 Demonstrate the ability to produce two-dimensional geometric figures

Standards for Technological Literacy

BM B: Expressing ideas to others verbally and through sketches and models is an important part of the design process.

BM C: People use symbols when they communicate by technology.

BM G: Letters, characters, icons, and signs are symbols that represent ideas, quantities, elements, and operations.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades 9-12, all students should develop

- **Evidence, models, and explanation**

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop

- **Abilities of technological design**

Principles and Standards for School Mathematics

Geometry: Instructional programs from pre-kindergarten through grade 12 should enable all students to analyze characteristics and properties of two- and three-dimensional geometric shapes; specify locations and describe spatial relationships using coordinate geometry and other representational systems; apply transformations and use symmetry to analyze mathematical situations; and use visualization, spatial reasoning, and geometric modeling to solve problems.

Measurement: Instructional programs from pre-kindergarten through grade 12 should enable all students to understand measurable attributes of objects and the units, systems, and processes of measurement; and apply appropriate techniques, tools, and formulas to determine measurements.

EDU:	12	AD
	P	R

Competency C.S. 4.2: Select and produce the appropriate pictorial style to best communicate solutions in the design process

TPO: Using examples presented in class, construct pictorial drawings using isometric angles on the drafting board and CAD.

Clear Learning Target: I can

Descriptors:

4.2.1 Formulate pictorial sketches to develop ideas, solve problems, and understand relationships during the design process

4.2.2 Create sketches utilizing both the additive and subtractive methods to assess underlying geometric and perceptual principles

4.2.3 Select a sketching method that is efficient in its use of color, form, and symbols representing abstract data

4.2.4 Augment pictorial sketches with shading to improve communication

Standards for Technological Literacy

Standard 9: Students will develop an understanding of engineering design.

BM B: Expressing ideas to others verbally and through sketches and models is an important part of the design process.

EDU:	12	AD
	P	R

Competency C.S. 4.3: Evaluate and select the necessary view to graphically communicate design solutions

TPO: Using examples presented in class, draw detailed sketches with notes, leaders, callouts, dimensions, parts lists on drawing board and CAD.

Clear Learning Target: I can

Descriptors:

4.3.1 Interpret annotated sketches in the design analysis process

4.3.2 Integrate annotated sketches in presentations, portfolio, and documentation process

4.3.3 Develop properly annotated sketches to accurately convey data in a design solution

Standards for Technological Literacy

Standard 11: Students will develop the abilities to apply the design process.

BM E: The process of designing involves presenting some possible solutions in visual form and then selecting the best solution(s) from many.

Unit 5: Geometric Relationships

EDU:	12	AD
	P	R

Competency C.S. 5.1: Construct various geometric forms and shapes

TPO: Using examples presented in class, construct development drawings using drawing board and CAD.

Clear Learning Target: I can

Descriptors:

5.1.1 Define and contrast points, lines, and line segments

5.1.2 Identify major geometric shapes (isosceles triangle, right triangle, scalene triangle, rectangles, squares, rhombus, trapezoid, pentagon, hexagon, and octagon)

5.1.3 Construct various geometric shapes using a compass, ruler, and triangle

5.1.4 Define the elements and types of angles

5.1.5 Construct and bisect various types of angles using a compass, ruler, and triangle

5.1.6 Define terminology associated with arcs and circles

5.1.7 Construct arcs, circles, and ellipses using a compass, ruler, and triangle

Principles and Standards for School Mathematics

Geometry: Instructional programs from pre-kindergarten through grade 12 should enable all students to analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships;
specify locations and describe spatial relationships using coordinate geometry and other representational systems; apply transformations and use symmetry to analyze mathematical situations; use visualization, spatial reasoning, and geometric modeling to solve problems.

Communication: Instructional programs from pre-kindergarten through grade 12 should enable all students to organize and consolidate their mathematical thinking through communication.

EDU:	12	AD
	P	R

Competency C.S. 5.2: Describe geometric constraints

TPO: Using examples presented in class, create geometric constraints using 3D modeling software and print out to 85% accuracy.

Clear Learning Target: I can

Descriptors:

5.2.1 Distinguish and define geometric constraints

5.2.2 Identify the following geometric constraints in given three-dimensional models: horizontal, vertical, parallel, perpendicular, tangent, concentric, collinear, coincident, and equal

Principles and Standards for School Mathematics

Measurement: Instructional programs from pre-kindergarten through grade 12 should enable all students to understand measurable attributes of objects and the units, systems, and processes of measurement; apply appropriate techniques, tools, and formulas to determine measurements.

Communication: Instructional programs from pre-kindergarten through grade 12 should enable all students to organize and consolidate their mathematical thinking through communication.

Connections: Instructional programs from pre-kindergarten through grade 12 should enable all students to understand how mathematical ideas interconnect and build on one another to produce a coherent whole; recognize and apply mathematics in contexts outside of mathematics.

EDU:	12	AD
	P	R

Competency C.S. 5.3: Demonstrate the Cartesian Coordinated System

TPO: Using examples presented in class and handouts, complete worksheets, CAD drawings and assessment to 85% accuracy.

Clear Learning Targets: I can

Descriptors:

5.3.1 Apply the right hand rule to identify the X, Y, and Z axes of the Cartesian Coordinate System

5.3.2 Apply a combination of absolute, relative, and polar coordinates to construct a three-dimensional model

5.3.3 Define the origin planes in the Cartesian Coordinate System

5.3.4 Identify the origin and planar orientations of each side of a three-dimensional model

Principles and Standards for School Mathematics

Number Operations: Instructional programs from pre-kindergarten through grade 12 should enable all students to understand numbers, ways of representing numbers, relationships among numbers, and number systems; understand meanings of operations and how they relate to one another; and computer fluently and make reasonable estimates

Unit 6: Modeling

EDU:	12	AD
	P	R

Competency C.S. 6.1: Communicate conceptual ideas through written and verbal formats

TPO: Using examples presented in class, complete worksheets and assessments to identify vertical and lateral thinking to 85% accuracy.

Clear Learning Target: I can

Descriptors:

6.1.1 Experience the creative thinking process

6.1.2 Recognize the difference between vertical and lateral thinking

6.1.3 Categorize and select a solution to a problem

Science as Inquiry Standard A: As a result of activities in grades 9-12, all students should develop—

- **Abilities necessary to do scientific inquiry**
- **Understandings about scientific inquiry**

Standards for English Language Arts

Standard 4: Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.

Standard 5: Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences and for a variety of purposes.

EDU:	12	AD
	P	R

Competency C.S. 6.2: Analyze and develop graphical representation of given data

TPO: Using examples presented in class and handouts, collect data, create graphic chart and analyze data to 85% accuracy.

Clear Learning Target: I can

Descriptors:

6.2.1 Identify the different graphical methods of data representation

6.2.2 Illustrate the appropriate graphical format to a problem

National Science Education Standards

Science as Inquiry Standard A: As a result of activities in grades 9-12, all students should develop understanding of—

- **Abilities necessary to do scientific inquiry**
- **Understandings about scientific inquiry**

EDU:	12	AD
	P	R

Competency C.S.6.3: Select the appropriate modeling materials to complete a three-dimensional prototype/mockup

TPO: Using examples presented in class create a model for a product per a rubric to 85% accuracy.

Clear Learning Target: I can

Descriptors:

6.3.1 Identify and select the different physical modeling materials

6.3.2 Build and present a model with its correct proportions

National Science Education Standards

Science in Personal and Social Perspectives Standard F: As a result of activities in grades 9-12, all students should develop understanding of—

- Natural resources
- Environmental quality
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

Standards for English Language Arts

Standard 7: Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, and people) to communicate their discoveries in ways that suit their purpose and audience.

EDU:	12	AD
	P	R

Competency C.S. 6.4: Critique design solution using mathematical applications (e.g., volume of a bottle, etc.)

TPO: Given examples and worksheets presented in class, complete worksheet problems and analyze per data in CAD drawing 'properties'.

Clear Learning Target: I can

Descriptors:

6.4.1 Evaluate a problem using mathematical formulae

6.4.2 Analyze a solution to a problem using the correct format of analysis

Standards for English Language Arts

Standard 3: Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts. They draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and other texts, their word identification strategies, and their understanding of textual features (e.g. sound-letter correspondence, sentence structure, context, graphics).

Standard 4:	Students adjust their use of spoken, written, and visual language (e.g. conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
Standard 12:	Students use spoken, written and visual language to accomplish their own purposes (e.g. for learning, enjoyment, persuasion, and the exchange of information).

Principles and Standards for School Mathematics

Number Operations Standard:	Instructional programs from pre-kindergarten through grade 12 should enable all students to compute fluently and make reasonable estimates.
Data Analysis and Probability Standard:	Instructional programs from pre-kindergarten through grade 12 should enable all students to formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.

EDU:	12	AD
	P	R

Competency C.S. 6.5: Evaluate a sketch and generate a model utilizing CAD software

TPO: Given samples and handouts presented in class, draw an object on 3D CAD using dimensions and notes to 85% accuracy.

Clear Learning Target: I can

Descriptors:

6.5.1 Explain the difference between parametric and adaptive designs and be able to specify their uses

6.5.2 Draw a two-dimensional sketch using a CAD package

6.5.3 Apply geometrical and dimensional constraints to a sketch

6.5.4 Demonstrate the ability to generate a three-dimensional model

6.5.5 Demonstrate the use of work features and how they are applied while constructing a solid model

6.5.6 Recognize the use and need of work planes, axes, and points in the development of a computer model

6.5.7 Demonstrate the ability to modify a sketch or feature of a model

Standards for Technological Literacy

Standard 9:	Students will develop an understanding of engineering design.
BM B:	Expressing ideas to others verbally and through sketches and models is an important part of the design process.
BM H:	Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.
Standard 11:	Students will develop abilities to apply the design process.
BM J:	Make two-dimensional and three-dimensional representations of the designed solution.

Standard 12:	Students will develop the abilities to use and maintain technological products and systems.
BM D:	Follow step-by-step directions to assemble a product.
Standard 17:	Students will develop an understanding of and be able to select and use information and communication technologies.
BM K:	The use of symbols, measurements, and drawings promotes clear communication by providing a common language to express ideas.
BM Q:	Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes—

- **Systems, order, and organization**
- **Evidence, models, and explanation**
- **Change, constancy, and measurement**
- **Form and function**

Unit 7: Assembly Modeling

EDU:	12	AD
	P	R

Competency C.S. 7.1: Explore and demonstrate assembly modeling skills to solve a variety of design problems

TPO: Using samples and presentation create assembly 3D drawing using software commands and print to 85% accuracy.

Clear Learning Target: I can

Descriptors:

7.1.1 Apply the base component effectively in the assembly environment
7.1.2 Place and create components in the assembly modeling environment
7.1.3 Construct circular and rectangular patterns of components within an assembly model
7.1.4 Replace components with modified external parts
7.1.5 Perform part manipulation during the creation of an assembly model

Standards for Technological Literacy

Standard 9:	Students will develop an understanding of engineering design.
BM B:	Expressing ideas to others verbally and through sketches and models is an important part of the design process.
BM H:	Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.
Standard 11:	Students will develop abilities to apply the design process.
BM J:	Make two-dimensional and three-dimensional representations of the designed solution.
Standard 12:	Students will develop the abilities to use and maintain technological products and systems.
BM D:	Follow step-by-step directions to assemble a product.
Standard 17:	Students will develop an understanding of and be able to select and use information and communication technologies.
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National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes—

- **Systems, order, and organization**
- **Evidence, models, and explanation**
- **Change, constancy, and measurement**
- **Form and function**

EDU:	12	AD
	P	R

Competency C.S. 7.2: Explore and demonstrate assembly constraints, part libraries, sub-assemblies, driving constraints, and adaptive design

TPO: Using samples and presentation create 3D drawing assembly, part list, orthographic views and presentation views to 85% accuracy.

Clear Learning Target: I can

Descriptors:

7.2.1 Perform part manipulation during the creation of an assembly model
7.2.2 Apply assembly constraints to successfully construct a multi-part object
7.2.3 Utilize part libraries effectively during the assembly modeling process
7.2.4 Employ sub-assemblies during the production of assemblies
7.2.5 Apply drive constraints to simulate the motion of parts in assemblies
7.2.6 Explore and apply adaptive design concepts during the development of sketches, features, parts, and assemblies

Standards for Technological Literacy

Standard 11: Students will develop abilities to apply the design process.
BM J: Make two-dimensional and three-dimensional representations of the designed solution.
Standard 12: Students will develop the abilities to use and maintain technological products and systems.
BM D: Follow step-by-step directions to assemble a product.
Standard 17: Students will develop an understanding of and be able to select and use information and communication technologies.
BM K: The use of symbols, measurements, and drawings promotes clear communication by providing a common language to express ideas.
BM Q: Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes—

- **Systems, order, and organization**
- **Evidence, models, and explanation**
- **Change, constancy, and measurement**
- **Form and function**

Unit 8: Model Analysis and Verification

EDU:	12	AD
	I	P

Competency C.S. 8.1: Evaluate the accuracy of mass properties calculations
TPO: Using examples, worksheets and 3D drawing samples, use the Properties command to manipulate mass properties data to 85% accuracy.
Clear Learning Target: I can
Descriptors:

8.1.1 Demonstrate how to extract mass properties data from their solid models
8.1.2 Describe how analysis of data can be used to update parametric models
8.1.3 List and explain the various mass property calculations, such as, volume, density, mass, surface area, centroid, moment of inertia, products of inertia, radii of gyration, principal axes, and principal moments, and how they are used to evaluate a parametric model

Principles and Standards for School Mathematics

Algebra: Instructional programs from pre-kindergarten through grade 12 should enable all students to understand patterns, relations, and functions; represent and analyze mathematical situations and structures using algebraic symbols; use mathematical models to represent and understand quantitative relationships; analyze change in various contexts.

Geometry: Instructional programs from pre-kindergarten through grade 12 should enable all students to analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships;
specify locations and describe spatial relationships using coordinate geometry and other representational systems; apply transformations and use symmetry to analyze mathematical situations; use visualization, spatial reasoning, and geometric modeling to solve problems.

Measurement: Instructional programs from pre-kindergarten through grade 12 should enable all students to understand measurable attributes of objects and the units, systems, and processes of measurement; apply appropriate techniques, tools, and formulas to determine measurements.

Standards for English Language Arts

Standard 8: Students use a variety of technological and informational resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

EDU:	12	AD
	I	P

Competency C. S. 8.2: Interpret and use correct tolerancing techniques when dimensioning solid models

TPO: after review of instructor presentation and additional resources, apply tolerances to orthographic drawing per worksheet instructions.

Clear Learning Target: I can

Descriptors:

8.2.1 Solve tolerance problems, including limits and fits

8.2.2 Compare and contrast the differences between clearance fit, interference fit, and allowance

Standards for Technological Literacy

Standard 11: Students will develop abilities to apply the design process.

BM R: Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models.

National Science Education Standards

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop—

- **Abilities of technological design**
- **Understandings about science and technology**

Principles and Standards for School Mathematics

Number Operations: Instructional programs from pre-kindergarten through grade 12 should enable all students to understand numbers, ways of representing numbers, relationships among numbers, and number systems; understand meanings of operations and how they relate to one another; and compute fluently and make reasonable estimates.

Measurement: Instructional programs from pre-kindergarten through grade 12 should enable all students to understand measurable attributes of objects and the units, systems, and processes of measurement; apply appropriate techniques, tools, and formulas to determine measurements.

Unit 9: Model Documentation

EDU:	12	AD
	P	R

Competency C.S. 9.1: Translate a three-dimensional drawing or model into corresponding orthographic drawing views

TPO: after review of instructor presentation and additional resources, determine and draw on paper, 2D CAD and 3D software the proper Orthographic views, callouts, dimension, notes, size paper for an Isometric object to 85% accuracy.

Clear Learning Target: I can

Descriptors:

9.1.1 Identify the appropriate sheet size and title block for creating a drawing layout

9.1.2 Describe the purpose, and/or application, of the following drawing views: isometric view, section view, auxiliary view, and detail view

9.1.3 Generate an isometric view from orthographic drawing views

9.1.4 Determine the correct application for the various section views required to illustrate an object's internal detail

9.1.5 Describe the purpose and application of hatch lines and a cutting plane line, as used in a section view

9.1.6 Create the appropriate section view for a specified application

9.1.7 Create a detail view that corresponds to the appropriate orthographic drawing view

9.1.8 Create an auxiliary view to show the detail on an inclined surface of a drawing object

Standards for Technological Literacy

Standard 9:	Students will develop an understanding of engineering design.
BM B:	Expressing ideas to others verbally and through sketches and models is an important part of the design process.
Standard 11:	Students will develop the abilities to apply the design process.
BM E:	The process of designing involves presenting some possible solutions in visual form and then selecting the best solution(s) from many.
Standard 17:	Students will develop an understanding of and be able to select and use information and communication technologies.
BM C:	People use symbols when they communicate by technology.
BM G:	Letters, characters, icons, and signs are symbols that represent ideas, quantities, elements, and operations.
BM K:	The use of symbols, measurements, and drawings promotes clear communication by providing a common language to express ideas.
BM P	There are many ways to communicate information, such as graphic and electronic means.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades 9-12, all students should develop

- **Evidence, models, and explanation**

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop

- **Abilities of technological design**

Principles and Standards for School Mathematics

Geometry: Instructional programs from pre-kindergarten through grade 12 should enable all students to analyze characteristics and properties of two- and three-dimensional geometric shapes; specify locations and describe spatial relationships using coordinate geometry and other representational systems; apply transformations and use symmetry to analyze mathematical situations; and use visualization, spatial reasoning, and geometric modeling to solve problems.

Measurement: Instructional programs from pre-kindergarten through grade 12 should enable all students to understand measurable attributes of objects and the units, systems, and processes of measurement; and apply appropriate techniques, tools, and formulas to determine measurements.

Connections: Instructional programs from pre-kindergarten through grade 12 should enable all students to recognize and apply mathematics in contexts outside of mathematics.

Representation: Instructional programs from pre-kindergarten through grade 12 should enable all students to create and use representations to organize, record, and communicate mathematical ideas; select, apply, and translate among mathematical representations to solve problems; and use representations to model and interpret physical, social, and mathematical phenomena

EDU:	12	AD
	P	R

Competency C.S. 9.2: Demonstrate appropriate dimensioning rules and practices

TPO: Given sample presentations, demonstrate basic dimensioning skills on drawings per ANSI Drafting Standards per 85% accuracy.

Clear Learning Targets: I can

Descriptors:

9.2.1 List the common dimensioning standards

9.2.2 Identify and demonstrate the use of common dimensioning systems

9.2.3 Describe the characteristics and demonstrate the use of unidirectional and aligned dimensions

9.2.4 Differentiate the use of and demonstrate an understanding of size and location dimensions by applying these types of dimensions to annotated sketches and drawings

9.2.5 Set up and integrate the use of a customized common dimensioning standard

9.2.6 Identify and demonstrate the use of dimensioning practices on section, auxiliary, and assembly models

9.2.7 Define tolerancing and solve tolerance problems

Standards for Technological Literacy

Standard 11:	Students will develop abilities to apply the design process.
BM R:	Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models.
Standard 12:	Students will develop the abilities to use and maintain technological products and systems.
BM G:	Use common symbols, such as numbers and words, to communicate key ideas.
BM L:	Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques.

National Science Education Standards

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop—

- **Abilities of technological design**
- **Understandings about science and technology**

Principles and Standards for School Mathematics

Number Operations:	Instructional programs from pre-kindergarten through grade 12 should enable all students to understand numbers, ways of representing numbers, relationships among numbers, and number systems; understand meanings of operations and how they relate to one another; and compute fluently and make reasonable estimates.
Measurement:	Instructional programs from pre-kindergarten through grade 12 should enable all students to understand measurable attributes of objects and the units, systems, and processes of measurement; apply appropriate techniques, tools, and formulas to determine measurements.
Connections:	Instructional programs from pre-kindergarten through grade 12 should enable all students to recognize and use connections among mathematical ideas; recognize and apply mathematics in contexts outside of mathematics

EDU:	12	AD
	P	R

Competency C.S. 9.3: Apply appropriate annotations on sketches and drawings

TPO: Given instruction, complete worksheets and add notes to drawings on CAD with 85% accuracy.

Clear Learning Target: I can

Descriptors:

9.3.1 Identify annotations on sketches and drawings

9.3.2 Formulate general and proprietary specifications to further communicate information relating to product design

Standards for Technological Literacy

BM A:	Products are made to meet individual needs and wants.
Standard 8:	Students will develop an understanding of the attributes of design.
BM H:	The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processes and results.
Standard 17	Students will develop an understanding of and be able to select and use information and communication technologies.
BM Q:	Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades 9-12, all students should develop—

- **Change, constancy, and measurement**
- **Form and function**

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop—

- **Abilities of technological design**

Principles and Standards for School Mathematics

Problem Solving	Instructional programs from pre-kindergarten through grade 12 should enable all students to solve problems that arise in mathematics and in other contexts; apply and adapt a variety of

appropriate strategies to solve problems.

Communication: Instructional programs from pre-kindergarten through grade 12 should enable all students to organize and consolidate their mathematical thinking through communication; and communicate their mathematical thinking coherently and clearly to peers, teachers, and others.

Standards for English Language Arts

Standard 4: Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.

Standard 5: Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences and for a variety of purposes.

Unit 10: Presentation

EDU:	12	AD
	P	R

Competency C.S. 10.1: Practice effective oral communication techniques

TPO: after watching video and worksheet practice, practice oral presentation on a technical topic with peer rubric assessment.

Clear Learning Target: I can

Descriptors:

10.1.1 Discuss the impact of voice variation, eye contact, posture, and attire when delivering an oral presentation

10.1.2 Demonstrate the following communication techniques: voice variation, eye contact, posture, attire, practice and preparation, and projecting confidence

Standards for Technological Literacy

Standard 17: Students will develop an understanding of and be able to select and use information and communication technologies.

BM B: Technology enables people to communicate by sending and receiving information over a distance.

BM C: People use symbols when they communicate by technology.

BM D: The processing of information through the use of technology can be used to help humans make decisions and solve problems.

BM E: Information can be acquired and sent through a variety of technological sources, including print and electronic media.

BM F: Communication technology is the transfer of messages among people and/or machines over distances through the use of technology.

BM H: Information and communication systems allow information to be transferred from human to human, human to machine, and machine to human.

BM J: The design of a message is influenced by such factors as the intended audience, medium, purpose, and nature of the message.

BM K: The use of symbols, measurements, and drawings promotes clear communication by providing a common language to express ideas.

BM P: There are many ways to communicate information, such as graphic and electronic means.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes—

- Systems, order, and organization

- Evidence, models, and explanation
- Change, constancy, and measurement
- Form and Function

Science As Inquiry Standard A: As a result of activities in grades 9-12, all students should develop understanding of—

- Abilities necessary to do scientific inquiry

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop—

- Abilities of technological design
- Understandings about science and technology

Principles and Standards for School Mathematics

Communication Standard:	Instructional programs from pre-kindergarten through grade 12 should enable all students to organize and consolidate their mathematical thinking through communication; communicate their mathematical thinking coherently and clearly to peers, teachers, and others; analyze and evaluate the mathematical thinking and strategies of others.
Connections Standard:	Instructional programs from pre-kindergarten through grade 12 should enable all students to recognize and apply mathematics in contexts outside of mathematics.
Representation Standard:	Instructional programs from pre-kindergarten through grade 12 should enable all students to create and use representations to organize, record, and communicate mathematical ideas.

Standards for English Language Arts

Standard 1:	Students read a wide range of print and nonprint texts to build an understanding of texts of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classical and contemporary works.
Standard 4:	Students adjust their use of spoken, written, and visual language (e.g. conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
Standard 12:	Students use spoken, written and visual language to accomplish their own purposes (e.g. for learning, enjoyment, persuasion, and the exchange of information).

EDU:	12	AD
	P	R

Competency C.S. 10.2: Utilize the most appropriate presentation aids in oral and written presentations

TPO: Given examples by the instructor, create a Power Point presentation on Visual Presentation to the class.

Clear Learning Target: I can

Descriptors:

10.2.1 Describe various forms of visual aids and identify when to use them in a presentation

10.2.2 Identify the most appropriate type of visual aid for a presentation considering the audience and level of formality

10.2.3 Describe the most appropriate type of written documentation for a presentation considering the audience and level of formality

10.2.4 Identify the elements of the various forms of written documentation

Standards for Technological Literacy

Standard 17: Students will develop an understanding of and be able to select and use information and communication technologies.

BM B: Technology enables people to communicate by sending and receiving information over a distance.

BM C: People use symbols when they communicate by technology.

BM D: The processing of information through the use of technology can be used to help humans make decisions and solve problems.

BM E: Information can be acquired and sent through a variety of technological sources, including print and electronic media.

BM F: Communication technology is the transfer of messages among people and/or machines over distances through the use of technology.

BM H: Information and communication systems allow information to be transferred from human to human, human to machine, and machine to human.

BM J: The design of a message is influenced by such factors as the intended audience, medium, purpose, and nature of the message.

BM K: The use of symbols, measurements, and drawings promotes clear communication by providing a common language to express ideas.

BM P: There are many ways to communicate information, such as graphic and electronic means.

Principles and Standards for School Mathematics

Communication Standard:	Instructional programs from pre-kindergarten through grade 12 should enable all students to organize and consolidate their mathematical thinking through communication; communicate their mathematical thinking coherently and clearly to peers, teachers, and others; analyze and evaluate the mathematical thinking and strategies of others.
Representation Standard:	Instructional programs from pre-kindergarten through grade 12 should enable all students to create and use representations to organize, record, and communicate mathematical ideas.

Standards for English Language Arts

Standard 4:	Students adjust their use of spoken, written, and visual language (e.g. conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
Standard 12:	Students use spoken, written and visual language to accomplish their own purposes (e.g. for learning, enjoyment, persuasion, and the exchange of information).

Unit 11: Production

EDU:	12	AD
	I	P

Competency C.S. 11.1: Evaluate material characteristics for manufacturing a specific product and identify the correct manufacturing process needed to produce that product

TPO: After watching a manufacturing process video and handouts from lecture, demonstrate an awareness of various manufacturing processes by completing a worksheet to 100% accuracy.

Clear Learning Target: I can

Descriptors:

11.1.1 Identify all of the manufacturing team members in the decision making process of designing a product

11.1.2 Categorize manufacturing specifications and constraints needed to produce a product

Standards for Technological Literacy

Standard 8: Students will develop an understanding of the attributes of design.

BM J: The design needs to be continually checked and critiqued, and the ideas of the design must be redefined and improved.

BM K: Requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other.

Standard 9: Students will develop an understanding of engineering design.

BM H: Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes—

- **Systems, order, and organization**
- **Evidence, models, and explanation**
- **Change, constancy, and measurement**
- **Evolution and equilibrium**
- **Form and function**

Science as Inquiry Standard A: As a result of activities in grades 9-12, all students should develop—

- **Abilities necessary to do scientific inquiry**
- **Understandings about scientific inquiry**

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop—

- **Abilities of technological design**
- **Understandings about science and technology**

Principles and Standards for School Mathematics

Measurement: Instructional programs from pre-kindergarten through grade 12 should enable all students to—

- understand measurable attributes of objects and the units, systems, and processes of measurement;
- apply appropriate techniques, tools, and formulas to determine measurements.

EDU:	12	AD
	I	P

Competency C.S. 11.2: Examine and apply the most appropriate machine process

TPO: After watching a machining process video and handouts from lecture, demonstrate an awareness of various machining processes by completing a worksheet to 100% accuracy.

Clear Learning Target: I can
Descriptors:

11.2.1 Recognize the need to limit the number of processes used to manufacture a product
11.2.2 Develop an understanding of process routing
11.2.3 Interpret data, which has been statistically analyzed, to ensure product quality
11.2.4 Identify the need to evaluate the areas of manpower and facility requirements

Standards for Technological Literacy

Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.

BM H: Changes caused by the use of technology can range from gradual to rapid and from subtle to obvious.

BM I: Making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.

BM J: Ethical considerations are important in the development, selection, and use of technologies.

BM K: The transfer of a technology from one society to another can cause cultural, social, economic, and political changes affecting both societies to varying degrees.

Standard 5: Students will develop an understanding of the effects of technology on the environment.

BM I: With the aid of technology, various aspects of the environment can be monitored to provide information for decision-making.

BM J: The alignment of technological processes with natural processes maximizes performance and reduces negative impacts on the environment.

BM K: Humans devise technologies to reduce the negative consequences of other technologies.

BM L: Decisions regarding the implementation of technologies involve the weighing of tradeoffs between predicted positive and negative effects on the environment.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes—

- Evidence, models, and explanation
- Change, constancy, and measurement

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop—

- Understandings about science and technology

Science in Personal and Social Perspectives Standard F: As a result of activities in grades 9-12, all students should develop understanding of—

- Natural resources
- Environmental quality
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

Standards for English Language Arts

Standard 7: Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, and people) to communicate their discoveries in ways that suit their purpose and audience.

EDU:	12	AD
	P	R

Competency C.S.11.3: Discuss trends in automated manufacturing

TPO: After watching an automated manufacturing process video and handouts from lecture, demonstrate an awareness of various automated manufacturing processes by completing a worksheet to 100% accuracy.

Clear Learning Target: I can
Descriptors:
11.3.1 Distinguish the differences between CNC, FMS, and CIM
11.3.2 Identify applications for CNC, FMS, and CIM

Standards for Technological Literacy

Standard 4:	Students will develop an understanding of the cultural, social, economic, and political effects of technology.
BM H:	Changes caused by the use of technology can range from gradual to rapid and from subtle to obvious.
BM I:	Making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.
BM J:	Ethical considerations are important in the development, selection, and use of technologies.
BM K:	The transfer of a technology from one society to another can cause cultural, social, economic, and political changes affecting both societies to varying degrees.
Standard 5:	Students will develop an understanding of the effects of technology on the environment.
BM I:	With the aid of technology, various aspects of the environment can be monitored to provide information for decision-making.
BM J:	The alignment of technological processes with natural processes maximizes performance and reduces negative impacts on the environment.
BM K:	Humans devise technologies to reduce the negative consequences of other technologies.
BM L:	Decisions regarding the implementation of technologies involve the weighing of tradeoffs between predicted positive and negative effects on the environment.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes—

- Evidence, models, and explanation
- Change, constancy, and measurement

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop—

- Understandings about science and technology

Science in Personal and Social Perspectives Standard F: As a result of activities in grades 9-12, all students should develop understanding of—

- Natural resources
- Environmental quality
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

Standards for English Language Arts

Standard 7: Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, and people) to communicate their discoveries in ways that suit their purpose and audience.

EDU:	12	AD
	I	P

Competency C.S, 11.4: Explain material procurement, handling, and cost analysis

TPO: after watching a material procurement, handling and cost analysis video and handouts from lecture, demonstrates an awareness of various manufacturing processes by completing a worksheet to 100% accuracy.

Clear Learning Target: I can

Descriptors:

11.4.1 Explain the need for a company to minimize material handling by procurement of materials in a timely fashion.

11.4.2 Identify the need to perform a cost analysis of a product

11.4.3 Explain the JIT process

11.4.4 Explain how a business creates value

Standards for Technological Literacy

Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.

BM H: Changes caused by the use of technology can range from gradual to rapid and from subtle to obvious.

BM I: Making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.

BM J: Ethical considerations are important in the development, selection, and use of technologies.

BM K: The transfer of a technology from one society to another can cause cultural, social, economic, and political changes affecting both societies to varying degrees.

Standard 5: Students will develop an understanding of the effects of technology on the environment.

BM I: With the aid of technology, various aspects of the environment can be monitored to provide information for decision-making.

BM J: The alignment of technological processes with natural processes maximizes performance and reduces negative impacts on the environment.

BM K: Humans devise technologies to reduce the negative consequences of other technologies.

BM L: Decisions regarding the implementation of technologies involve the weighing of tradeoffs between predicted positive and negative effects on the environment.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes—

- Evidence, models, and explanation
- Change, constancy, and measurement

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop—

- Understandings about science and technology

Science in Personal and Social Perspectives Standard F: As a result of activities in grades 9-12, all students should develop understanding of—

- Natural resources
- Environmental quality
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

Standards for English Language Arts

Standard 7: Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, and people) to communicate their discoveries in ways that suit their purpose and audience.

Unit 12: Marketing

EDU:	12	AD
	I	P

Competency C.S. 12.1: Demonstrate a working knowledge of product cost analysis
TPO: Given teacher presentation, worksheets, vocabulary drills and sample product cost analysis, formulate a product cost analysis for a product of the student's choice o 85% accuracy.
Clear Learning Target: I can
Descriptors:
12.1.1 Define common vocabulary words used in association with product cost analysis
12.1.2 Formulate a product cost analysis for a given product

Standards for Technological Literacy

Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.
BM H: Changes caused by the use of technology can range from gradual to rapid and from subtle to obvious.
BM I: Making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.
BM J: Ethical considerations are important in the development, selection, and use of technologies.
BM K: The transfer of a technology from one society to another can cause cultural, social, economic, and political changes affecting both societies to varying degrees.
Standard 5: Students will develop an understanding of the effects of technology on the environment.
BM I: With the aid of technology, various aspects of the environment can be monitored to provide information for decision-making.
BM J: The alignment of technological processes with natural processes maximizes performance and reduces negative impacts on the environment.
BM K: Humans devise technologies to reduce the negative consequences of other technologies.
BM L: Decisions regarding the implementation of technologies involve the weighing of tradeoffs between predicted positive and negative effects on the environment.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes—

- Evidence, models, and explanation
- Change, constancy, and measurement

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop—

- Understandings about science and technology

Science in Personal and Social Perspectives Standard F: As a result of activities in grades 9-12, all students should develop understanding of—

- Natural resources
- Environmental quality
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

Standards for English Language Arts

Standard 7: Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, and people) to communicate their discoveries in ways that suit their purpose and audience.

EDU:	12	AD
	I	P

Competency C.S.12.2: Design a package for a given product (e.g., egg drop)

TPO: Given teacher presentation, Power Point handout, examples of packaging, student will create a package for a product that meets rubric to 85%.

Clear Learning Target: I can

Descriptors:

12.2.1 Explain packaging design requirements

12.2.2 Recognize the need to protect a product for shipping

12.2.3 Illustrate aesthetic requirements to enhance packaging for the customer

Standards for Technological Literacy

Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.

BM H: Changes caused by the use of technology can range from gradual to rapid and from subtle to obvious.

BM I: Making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.

BM J: Ethical considerations are important in the development, selection, and use of technologies.

BM K: The transfer of a technology from one society to another can cause cultural, social, economic, and political changes affecting both societies to varying degrees.

Standard 5: Students will develop an understanding of the effects of technology on the environment.

BM I: With the aid of technology, various aspects of the environment can be monitored to provide information for decision-making.

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National Science Education Standards

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- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

Standards for English Language Arts

Standard 7: Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, and people) to communicate their discoveries in ways that suit their purpose and audience.

PRINCIPLES OF ENGINEERING

PRINCIPLES OF ENGINEERING

Unit 13: Definition and Types of Engineering and Engineering Technology

BIL: **Essential**

EDU:	12	AD
	P	R

Competency 13.1: Define engineers as innovators/problem solvers

TPO: Class discussions regarding the descriptors and the targeting real-world scenarios to highlight the topics, will be the focus of teacher directed learning. Students will be encouraged to participate bringing their backgrounds and general knowledge to the discussions.

Clear Learning Target: I can
Descriptors:

13.1.1 Define engineering and identify engineering and engineering technology achievements through history
13.1.2 Identify five historical engineering and engineering technology role models, including minorities and women
13.1.3 Identify problems for engineers to solve in the future
13.1.4 Define attributes associated with being a successful engineer
13.1.5 Explore the resources and constraints within the engineering environment
13.1.6 Compare and contrast differences in the role of an engineer and a scientist
13.1.7 Envision an emerging technology and describe the impact on the world (e.g. macro, micro, nanofabrication)

Correlated Content Benchmark: Standards: Math 1.1, 6.3, 8.3; Science 6.3, 4.2, 5.5, 5.6; Tech 1.1, 2.1, 2.3, 3.3

BIL: **Essential**

EDU:	12	AD
	I	P

Competency 13.2: Interpret the role of an engineering and engineering technology team

TPO: Students will create and identify flow charts and graphs regarding the specific dutes of an engineer and a technician. Following discussions, students will write brief paragraphs regarding race, gender, pay equity, and job demands, as regards the engineering field.

Clear Learning Target: I can
Descriptors:

13.2.1 Describe why an engineering team must work together to solve problems, with each team member having individual and collective responsibilities.
13.2.2 Discuss the role of out-sourcing in the engineering and engineering technology process, and how effective communication is essential.
13.2.3 Indicate how gender-bias, racial-bias and other forms of stereotyping and discrimination can adversely affect communications within an engineering and engineering technology team
13.2.4 Recognize how ethics influences the engineering and engineering technology process
13.2.5 Describe how social, environmental, regulatory, and financial constraints influence the engineering and engineering technology process

Correlated Content Benchmarks: Math 6.3, 6.4, 10.3, 6.2; Science 1.1, 3.6, 5.1, 5.6; Tech 2.1, 2.3, 4.1

BIL: Essential

EDU:	12	AD
	P	R

Competency 13.3: Explore careers in engineering and engineering technology

TPO: Students will create a document of a particular branch of engineering. The document will contain and history and description of the field. An interview with someone in that field should provide the student with information such as typical work day, starting salaries, employment forecast, and reasons for entering the field. The student will also give a Power Point presentation to the class highlighting the more salient points of the paper.

Clear Learning Target: I can
Descriptors:

13.3.1 Recognize the difference between engineering (macro, micro and nanofabrication) and engineering technology disciplines and job functions
13.3.2 Identify the professional and legal responsibilities associated with being an engineer (e.g. patent, copyright protection)
13.3.3 Identify the educational requirements to become an engineer
13.3.4 Examine an area of engineering by preparing for and conducting an interview with an engineer in that field of engineering or engineering technology

Correlated Content Benchmarks: Math 6.2, 8.3, 9.3; Science 4.2, 6.1, 6.2;Tech 1.2, 2.1, 2.3

Unit 14: Communication and Documentation

BIL: Essential

EDU:	12	AD
	P	R

Competency 14.1: Compose sketches using proper sketching techniques in the solution of design problems

TPO: Students will individually select a design problem, and sketching style, utilizing the skills they have acquired in the previous course on design. It is important that the procedures used in the design class be developed, honed, and improved.

Clear Learning Target: I can
Descriptors:
14.1.1 Select the appropriate sketching styles for presentation of a design problem to a group
14.1.2 Use proper proportioning while producing annotated sketches

Correlated Content Benchmarks: Math 1.1, 2.2, 2.3, 10.1; Science 1.2, 4.1, 6.1, 6.2, 6.3; Tech 1.1, 2.1, 3.1, 3.2, 4.1, 4.3

BIL: Essential

EDU:	12	AD
	P	R

Competency 14.2: Plan and compose a written technical report about the research conducted about a career field in engineering and engineering technology

TPO: The student will demonstrate throughout the organization of this project, that they can communicate the details of a technical paper, so that someone reading the data for the first time, can have some basic understanding of the particular field of research.

Clear Learning Target: I can
Descriptors:
14.2.1 Formulate an organized outline for a technical paper
14.2.2 Design and create tables, charts, and graphs to illustrate data they have collected
14.2.3 Select an appropriate type of table, chart, or graph to accurately communicate collected data for written work or presentations

Correlated Content Benchmarks: Math 1.1, 2.2, 2.3, 10.1; Science 1.2, 4.1, 6.1, 6.2, 6.3; Tech 1.1, 2.1, 3.1, 3.2, 4.1, 4.3

BIL: **Essential**

EDU:	12	AD
	P	R

Competency 14.3: Prepare and deliver a technical presentation

TPO: Students will demonstrate that they can present and communicate orally, the important aspects of the research being conducted. (Note it is critical that students can both articulate ideas with the written word and orally.)

Clear Learning Target: I can
Descriptors:
14.3.1 Design and deliver a presentation utilizing appropriate support materials about a research project
14.3.2 Create and assemble support materials to appropriately demonstrate concepts in the presentation

Correlated Content Benchmarks: Math 8.1, 8.2, 10.1, 10.3; Science 1.1, 4.2: Tech 4.2, 5.4

Unit 15: Design Process

BIL: Essential

EDU:	12	AD
	P	R

Competency 15.1: Compose and diagram the product development lifecycle of an invention

TPO: Students will be assessed on the accuracy, completeness, and evaluation of the invention selected. A PowerPoint presentation should reflect their understanding of the product development lifecycle.

Clear Learning Target: I can
Descriptors:
15.1.1 Trace the history of an invention and evaluate its effects on society and the environment
15.1.2 Examine the evolution of an invention to observe and report on how the design process is applied to continuously redesign and improve the product
15.1.3 Identify and explain the assumptions that relate to the development of a product and constraints of commercialization

Correlated Content Benchmarks: Math 1.1, 2.2, 2.3, 10.1; Science 1.2, 4.1, 6.1, 6.2, 6.3; Tech 1.1, 2.1, 3.1, 3.2, 4.1, 4.3

BIL: Essential

EDU:	12	AD
	P	R

Competency 15.2 Design a product

TPO: Students will examine a hypothetical invention, articulating its function and researching aspects of the final coast from design through manufacturing and distribution.

Clear Learning Target: I can
Descriptors:
15.2.1 Develop a scope statement
15.2.2 Determine a cost analysis

Correlated Content Benchmarks: Math 1.1, 2.2, 2.3, 10.1; Science 1.2, 4.1, 6.1, 6.2, 6.3; Tech 1.1, 2.1, 3.1, 3.2, 4.1, 4.3

Unit 16: Engineering and Engineering Technology Systems

BIL: Essential

EDU:	12	AD
	P	R

Competency 16.1: Select simple machines to create mechanical systems in the solution of design problem

TPO: Students will be able to articulate the formulas for determining the Mechanical Advantage of the six simple machines. The model-building portion of the project can be assembled with no understanding of the mathematics involved. It is essential that the students understand the numbers associated with a particular setting of their SMET device. A traditional written examination will be given to insure student understanding of the formulas utilized. This should be accomplished with 85% accuracy.

Clear Learning Targets: I can
Descriptors:

16.1.1 Identify and explain the function of the essential components of a mechanical system on a display they create

16.1.2 Create a display of a mechanical system from a household item they disassemble

16.1.3 Explain mathematically the mechanical advantage gained and function of the six different types of simple machines

16.1.4 Construct a model of the six different types of simple machines SMET (Simple Machine Energy Transformation device)

Correlated Content Benchmarks: Math 3.1, 3.4, 4.1,4.2, 8.1, 8.4; Science 2.2, 2.4, 4.1, 4.2; Tech 2.1, 3.1, 3.2, 4,2, 4.3, 5.5, 5.6

BIL: Essential

EDU:	12	AD
	I	P

Competency 16.2: Create an energy transfer model of a structure and calculate the heat loss through walls and windows

TPO: Students will convey back to their parents, how much money is being lost, through the conduction of BTU'S escaping from inside their homes, based upon their home construction. Formulas will be provided, but the student must sketch and then calculate the resistance barriers of their exterior walls, and then transfer to an actual dollar amount. This should be done with 100% accuracy. It is critical to know the current rate of natural gas pricing.

Clear Learning Target: I can
Descriptors:
16.2.1 Describe the heat transfer concepts of conduction, convection, and radiation
16.2.2 Sketch a room and calculate heat loss through walls and windows

Correlated Content Benchmarks: Math 2.2, 2.3, 4.1, 4.2, 6.3, 6.4, 8.1, 8.2; Science 2.2, 2.5, 2.6, 5.4, 5.5, 5.6; Tech 2.2, 2.3, 3.3, 4.3, 5.3, 5.7

BIL: **Essential**

EDU:	12	AD
	P	R

Competency 16.3: Configure proper setup and adjustment of a fluid power system

TPO: Students will be able to demonstrate from a traditional written examination an understanding of Pascal's Law, Bernoulli's Principle, Charles's Law, and Boyle's Law. Because the movement of liquids is of vital importance, students will also be introduced to the functions of different valves and regulators in fluid systems. The testing should reflect 85% accuracy.

Clear Learning Target: I can
Descriptors:
16.3.1 Select specific fluid power sources for different functions
16.3.2 Create a flow diagram schematic sketch and compare it to an actual fluid power circuit
16.3.3 Calculate mathematically and explain the work being done by a specific fluid power device

Correlated Content Benchmarks: Math 4.1. 4.2, 5.3, 6.3, 10., 10.2; Science 1.2, 2.4, 2.5, 5.1; Tech 3.1, 3.2, 4.2, 4.3, 5.3

BIL: **Essential**

EDU:	12	AD
	P	R

Competency 16.4: Estimate current flow through a circuit and be able to compare estimates to accurate measurements

TPO: Students will show their basic understanding of Ohm's and Watt's Law through a traditional written examination. The written examinations should reflect an 85% degree of accuracy. The need for a basic understanding of the power grid system of the country as related to engineering and engineering technology is critical in this section.

Clear Learning Target: I can

Descriptors:

16.4.1 Create schematic drawings to facilitate experimental measurements of electrical circuits

16.4.2 Apply Ohm's and Watt's laws in designing safe electrical circuits

16.4.3 Identify community needs and describe the impact supplying electrical generation has on their communities

16.4.4 Describe mathematical relationship between voltage, resistance and the current found in all electronics circuits

16.4.5 Construct electrical circuits and test for voltage, current and resistance using electronic test equipment and calculate power

Correlated Content Benchmarks: Math 2.2, 4.1, 4.2, 6.2, 8.3 10.1, 10.3; Science 2.1, 2.2, 2.6, 4.1, 5.5, 5.6, 6.3; Tech 3.1, 3.2, 3.3, 4.2, 5.3

BIL: Essential

EDU:	12	AD
	P	R

Competency 16.5: Design, diagram, and implement a program to control a device constructed to perform a sorting operation

TPO: This extensive lesson (the Marble Sorter with Fischer-Technics) will integrate students abilities to problem solve along with solidifying their understanding of the role of devices, which alter paths, change directions, stop or start operations, or sense color. Aligned with computer software which defines the role of each device, the student will additionally learn the protocol which drives the system. It is imperative here that all the students in each groups are proficient with the software. The role of initial sketching becomes critical to their understanding of foreseeing future problems.

Clear Learning Target: I can

16.5.1 Apply concepts of mechanical, electrical, and control systems in solving design problems

16.5.2 Formulate a plan for evaluating the functions of a sorting device and to make appropriate changes in design, circuitry or programming

16.5.3 Defend the solution to the design problem

Correlated Content Benchmarks: Math 3.4, 4.1, 4.2, 5.1, 6.2, 9.1; Science 1.2, 2.1, 2.4, 4.2,6.1; Tech 3.3, 4.2, 4.3, 5.3, 5.4, 5.5, 5.6

Unit 17: Statics and Strength of Materials

BIL: Essential

EDU:	12	AD
	P	R

Competency 17.1: Evaluate a simple truss mathematically to determine types and magnitude of forces supported in the truss

TPO: Students will be introduced to the vector analysis of truss systems. With the aid of geometric applications, the software of MD Solids and the West Point Bridge Project, students should be able to calculate the stress on particular truss members. This knowledge will then be transferred to the construction of their own bridge systems. The bridge will then be tested to find its maximum load. The calculations should be able to be done with 85% accuracy.

Clear Learning Target: I can
Descriptors:
17.1.1 Define, describe, and analyze the stresses and forces acting on an object
17.1.2 Design, construct, and test a model bridge to support the greatest amount of weight per gram of bridge mass
17.1.3 Prepare and present a mathematical analysis of a truss design

Correlated Content Benchmarks: Math 2.2, 3.1, 3.2, 3.4, 4.1, 6.1, 10.1; Science 2.2, 2.4, 4.1,5.6; Tech 3.1, 3.1, 3.3, 4.1, 5.7

BIL: Essential

EDU:	12	AD
	P	R

Competency 17.2: Explain the effects that stress has on a material and explain how the material will react

TPO: Students will examine the mathematics involved with centroid, moments of inertia, and shear, as it relates to the strength of a particular shade. Some mention of the history of failed engineering projects, will help to illuminate the disastrous consequences of poor design. Students will demonstrate with 85 % accuracy their understanding of the mathematics involved.

Clear Learning Target: I can
Descriptors:
17.2.1 Explain the use of factors of safety in the design process

17.2.2 Explain the difference between the area of a cross section of an object and the second moment of the area (Moment of Inertia) and predict the relative strength of one shape vs. another

17.2.3 Use a computer aided engineering package to analyze a shape

Correlated Content Benchmarks: Math 2.3, 3.4, 5.2, 5.4, 6.2, 10.1, 10.2; Science 2.2, 2.4, 5.5, 5.6; Tech 3.2, 3.3, 4.2, 4.3, 5.6, 5.7

Unit 18: Materials and Materials Testing in Engineering and Engineering Technology

BIL: Essential

EDU:	12	AD
	I	P

Competency 18.1: Compare/contrast and analyze the physical properties of organics, metals, polymers, ceramics, and composites

TPO: Students will choose a material to analyze. That analysis will involve the history of its discovery, its properties and characteristics, uses, availability, method of mining or production, and recycling and/or reintroduction back to materials cycle. A presentation will be made to the entire class highlighting the essential points of their research.

Clear Learning Targets: I can
Descriptors:

18.1.1 Identify and differentiate the five basic categories of solid engineering and engineering technology materials
18.1.2 Trace the production of raw material to finished product
18.1.3 Identify practical applications of each material category to engineering and engineering technology products and processes
18.1.4 Collect, analyze, and test samples of the four basic materials
18.1.5 Document and present laboratory data related to studies of material classifications

Correlated Content Benchmarks: Math 2.1, 2.2, 5.1, 6.4, 10.1; Science 2.1, 3.1, 5.3, 5.4; Tech 2.2, 3.1, 4.1, 4.2, 5.2, 5.6

BIL: Essential

EDU:	12	AD
	P	R

Competency 18.2: Assess and document the properties of materials

TPO: Student should be able to identify with 85% accuracy the six major properties of materials. The introduction of engineering problems involving stress, strain, and Modulus of

Elasticity will highlight for the students the rigor that mathematics plays in the examinations of materials. Students will perform with 85% accuracy the intricacies associated with the properties of some materials.

Clear Learning Targets: I can
Descriptors:
18.2.1 Design an experiment to identify an unknown material
18.2.2 Formulate conclusions through analysis of recorded laboratory test data in the form of charts, graphs, written, verbal, and multimedia formats

C**orrelated Content Benchmarks**: Math 2.2, 2.3, 3.4, 4.2, 5.2, 5.3, 6.2, 6.3; Science 2.2, 2.3, 3.2, 5.3, 6.2; Tech 2.2, 4.3, 5.2, 5.4

BIL: Essential

EDU:	12	AD
	I	P

Competency 18.3: Specify the production processes used to create products from categories of materials

TPO: Students will be tested on, and be proficient with 85% accuracy on some of the following terms: Cohesion, Flame Hardening, Knurling, Forging, Blow Molding, Shearing, and Tempering. Depending on metal lab or wood shop availability, student will create a test sample of some product.

Clear Learning Target: I can
Descriptors:
18.3.1 Define and state examples of the major categories of Production Processes
18.3.2 Analyze a component of a product and describe the processes used in its creation
18.3.3 Interpret a drawing and produce a part

Correlated Content Benchmarks: Math 1.3, 3.1, 4.2, 5.1, 8.1; Science 2.2, 2.3, 5.4, 5.5, 5.6; Tech 1.2, 3.1, 3.3, 5.6

BIL: Essential

EDU:	12	AD
	I	P

Competency 18.4: Explain the difference between the characteristics of quality in a final product and the control of quality in each step of a process

TPO: Students will use precise measuring tools (accuracy .001) to determine the size of various dimensions of a given object. They will be required to sketch the object (to scale) in their sketch-books. They will be tested with the expectation of 85% accuracy the mean, mode and median of similar objects. They will be expected to understand what tolerance levels mean in industry.

Clear Learning Targets: I can
Descriptors:

18.4.1 Utilize a variety of precision measurement tools to measure appropriate dimensions, mass, and weight
18.4.2 Explain why companies have a need for quality control and describe what customers and companies refer to when the term "quality" is used
18.4.3 Calculate the mean, median, mode, and standard deviation for a set of data and apply that information to quality assurance
18.4.4 Explain the difference between process and product control
18.4.5 Explain how control charts are used in industry and will predict whether a process is "in or out of control" by using a control chart
18.4.6 Explain the role of diagnostics and diagnostics technology in accessing product quality

Correlated Content Benchmarks: Math 4.1, 4.2, 5.1, 5.2, 8.1; Science 1.1, 2.2, 4.1, 4.2, 5.3; Tech 1.3, 2.2, 3.3, 4.4, 5.6

BIL: Essential

EDU:	12	AD
	I	P

Competency 18.5: Analyze a material failure

TPO: Students will test samples ("dog bones") of steel, brass, and aluminum (if available) for examination in the Stress Analyzer. They will create stress/strain bar graphs, either from the computer model or by hand, indicating the major points on the graph: Yield Point, Proportional Limit, Rupture Point, and Break point. They will be tested, with an expected 85% accuracy to determine stress, strain, or Modulus of Elasticity from given information.

Clear Learning Targets: I can
Descriptors:

18.5.1 Describe the various material testing processes
18.5.2 Describe and safely conduct destructive and non-destructive material testing and use the data collected through these tests to compute and document mechanical properties
18.5.3 Explain how the material failed

Correlated Content Benchmarks: Math 1.2, 2.2, 4.1, 5.1, 5.2; Science 2.2, 2.4, 2.6; Tech 1.2, 2.3, 4.2

Unit 19: Engineering and Engineering Technology for Reliability

BIL: Essential

EDU:	12	AD
	I	P

Competency 19.1: Determine mathematically the chance of failure of a system given information on certain components

TPO: Students will examine the mathematics involved with project or production failure. They will be tested with an expectation of 85% accuracy, on the sample spaces taken from products produced. Before they can be released to the public, they (the students) should demonstrate what constitutes an acceptable margin of error. Because the cost of a product is also a major consideration in production, the students will discuss the ethics of releasing products to the public that are not quite 100% safe.

Clear Learning Targets: I can
Descriptors:
19.1.1 Diagram a system and identify the critical components
19.1.2 List the causes of failure and be able to propose solutions
19.1.3 Prepare and defend a position on an ethical engineering and engineering technology dilemma

Correlated Content Benchmarks: Math 3.2, 3.4, 5.3, 5.4, 6.1, 6.3; Science 1.2, 4.1, 4.2, 5.3, 5.4, 5.5: Tech 2.1, 3.3, 4.3, 5.4

BIL: Essential

EDU:	12	AD
	I	P

Competency 19.2: Analyze an engineering failure which identifies causes, damage done, design failures, and other areas where the failure has impacted the environment or society

TPO: Students will examine a catastrophic event that can be traced to an engineering design flaw. The paper will examine the history of the project, why the failure occurred, and what steps were subsequently put into place to avert a similar failure in future construction. The student will demonstrate their ability to communicate these ideas, in both the written word in the form of a submitted paper, and orally displayed with a presentation to the class.

Clear Learning Targets: I can

Descriptors:

19.2.1 Research the engineering and engineering technology, legal, social, and ethical issues related to a final design developed in a case study

19.2.2 Prepare a written report explaining their analysis of an engineering and engineering technology failure (e.g. Root Cause Analysis)

Correlated Content Benchmarks: Math 3.2, 3.4, 5.3, 5.4, 6.1, 6.3; Science 1.2, 4.1, 4.2, 5.3, Tech 4.2, 4.3, 5.4

Unit 20: Introduction to Dynamics/Kinematics

BIL: **Essential**

EDU:	12	AD
	P	R

Competency 20.1: Construct a device that will illustrate linear motion

TPO: The students, working in groups, will build a ping-pong ball launcher. They will be required to launch the object from nine different settings and propel a distance of at least 30 feet. Again, as in previous projects, the students must have an initial design recorded in their sketchbook, and make necessary modifications throughout the construction of their device. A rubric detailing the key portions of the project will help to direct the points of emphasis that will be graded.

Clear Learning Targets: I can

Descriptors:

20.1.1 Explain the difference between distance traveled and displacement

20.1.2 Design and build a device for the purpose of conducting experiments of acceleration, displacement, and velocity

20.1.3 Identify the different analytical tools used to predict performance and failure of parts, systems and materials

Correlated Content Benchmarks: Math 3.2, 6.1, 9.2; Science 2.4, 6.2; Tech 4.1 3.3, 5.3

BIL: **Essential**

EDU:	12	AD
	P	R

Competency 20.2: Summarize test data to explain trajectory motion

TPO: The students will examine the mathematics involved with determining velocity, range, and maximum elevation for their ballistic device. The parabolic curve traced by the object will be transferred to an Excel Program, graphing the actual curve versus the anticipated outcome. Students will be graded on the accuracy of the device, their use of Excel graphing to explain the trajectory, and a summary of modification they could make to increase the success rate.

Clear Learning Targets: I can
Descriptors:

20.2.1 Explain how velocity and acceleration are calculated
20.2.2 Calculate range and initial acceleration from data they record from experiments
20.2.3 Design and produce a presentation to include an explanation of their ballistic device, drawings and summarization of data recorded from experiments
20.2.4 Analyze test data and utilize the results to make decisions

Correlated Content Benchmarks: Math 2.2, 2.3, 5.1, 5.2, 8.1, 8.3; Science 1.1, 2.4, 4.2, 6.2; Tech 3.1, 3.3, 4.1, 5.4

Note: All the **Correlated Content Benchmarks** are aligned with the following National Standards Organizations: *Standards for Technology Literacy*, *National Science Educational Standards*, and *Principles and Standards for School Mathematics*

DIGITAL ELECTRONICS

DIGITAL ELECTRONICS

Unit 21: Fundamentals

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 21.1: Appraise hazards in the lab, record locations of the safety equipment, and describe how to use the safety equipment

TPO: Within a lab environment working in groups appraise hazards in the lab, record locations of the safety equipment, and describe how to use the safety equipment. Each student will score 100% on true/false safety test.

Clear learning target: I can
Descriptors:
21.1.1 Describe the causes and the dangers of electric shock and explain methods to prevent it
21.1.2 Specify the process of designing an electronic circuit taking into account many factors, including environment concerns, and precautionary measures

Correlated Content Benchmark: Standards: Math 9.3; Science 5.1, 5.4, 5.5, 5.6; Tech 1.3, 2.3, 4.2, 4.3, 5.3, 5.4, 5.5

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 21.2: Explain basic electron theory

TPO: Given a written diagram, explain basic electron theory by labeling all parts of the atom. Create a list of conductors and insulators.

Clear learning target: I can
Descriptors:
21.2.1 Label the parts of the atom
21.2.2 Explain the relationship of energy required to strip away electrons from atoms to being classified as an insulator or conductor
21.2.3 Define and explain the difference between direct and alternating currents

Correlated Content Benchmark: Standards: Math 9.1, 2.3; Science 2.1, 2.2, 2.3, 2.6, 6.2; Tech 1.3, 3.3, 5.3

BIL: **Essential**

EDU:	12	AD
	P	R

Competency C.S. 21.3: **Utilize prefixes and engineering and engineering technology notation**

TPO: Given a list of numbers, convert into a three decimal number utilizing engineering notation with 75% accuracy.

Clear learning target: I can
Descriptors:
21.3.1 Define prefixes and engineering notations (e.g., pico, nano, micro, etc.)
21.3.2 Re-write any number using conventional prefix definitions

Correlated Content Benchmark: Standards: Math 1.1; Science 4.2; Tech 1.3

BIL: **Essential**

EDU:	12	AD
	P	R

Competency C.S. 21.4: **Calculate the tolerance levels of various resistors to determine if the measured value is within specifications**

TPO: Using a volt-ohm meter, test a group of resistors and analyze what their value is and if they are within the proper tolerance value.

Clear learning target: I can
Descriptors:
21.4.1 Describe the material makeup of resistors and how they are used in circuit design
21.4.2 Identify the symbols associated with resistors
21.4.3 Setup lab equipment to measure resistor values in order to compare measured and rated values

Correlated Content Benchmark: Standards: Math 2.1, 2.2, 2.3, 4.1, 4.2; Science 1.1, 1.2, 2.1, 2.2, 4.1; Tech 1.2, 1.3, 3.3, 4.3, 5.3

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 21.5: Select and utilize electrical meters to determine voltage, resistance, and current in simple circuits

TPO: Using a functioning electric circuit measure voltage, current, and resistance within a specified tolerance value.

Clear learning target: I can
Descriptors:
21.5.1 Draw and label the parts of a simple circuit
21.5.2 Build and test a variety of series and parallel circuits, using simulation software and proto-boards, to prove the accuracy of Ohm's and Kirchhoff's laws
21.5.3 Calculate the resistance, current, and voltage in a circuit using Ohm's law

Correlated Content Benchmark: Standards: Math 1.1, 1.2, 1.3, 2.2, 2.3, 4.1, 4.2, 5.3; Science 1.1, 1.2, 2.6, 4.2; Tech 1.2, 3.1, 3.3, 4.2, 4.3, 5.3

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 21.6: Calculate the value of capacitors mathematically and through the use of instrumentation

TPO: Using computer simulation software, given values for resistance and capacitance complete a chart for RC time and full charge time compared to calculated values.

Clear learning target: I can
Descriptors:
21.6.1 Describe the component parts of a capacitor and describe how a capacitor holds a static charge
21.6.2 Use and describe the units of measurement for capacitors
21.6.3 Identify different types of capacitors and their voltage polarity requirements

Correlated Content Benchmark: Standards: Math 1.1, 4.1, 4.2, 9.3, 10.3; Science 1.1, 1.2, 2.2, 2.3, 4.2; Tech 3.2, 4.2, 4.3, 5.3

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 21.7: Calculate the output frequency of circuits using observations and the oscilloscope

TPO: Given a voltage vs. time graph, calculate the frequency of the waveform and the time required to complete one cycle.

Clear learning target: I can
Descriptors:
21.7.1 Draw a digital waveform and identify the anatomy of the waveform
21.7.2 Differentiate between digital and analog signals when given the waveforms
21.7.3 Wire and test a free-running clock circuit using a 555 timer

Correlated Content Benchmark: Standards: Math 2.1, 2.2, 6.2, 6.4; Science 1.1, 1.2, 4.1, 4.2; Tech 1.2, 1.3, 3.1, 3.3, 4.1, 4.2, 5.4

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 21.8: Obtain electronic component data sheets

TPO: Given different semiconductor companies and integrated circuits use the internet to find datasheets for that specific companies' IC.

Clear learning target: I can
Descriptors:
21.8.1 Successfully complete an Internet search for data sheets for integrated circuits
21.8.2 Describe the information contained on a data sheet

Correlated Content Benchmark: Standards: Math 9.3; Science 1.2, 4.2; Tech 4.2, 5.4

Unit 22: Number Systems

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 22.1 Identify and describe the number systems appropriate to electronic components

TPO: Given a chart with binary, decimal and hexadecimal, convert that number into the equivalent binary, decimal and hexadecimal with 75% accuracy.

Clear learning target: I can
Descriptors:
22.1.1 Describe numerical place value
22.1.2 Use mathematical symbols to represent different bases and communicate concepts using different number systems

Correlated Content Benchmark: Standards: Math 1.1, 2.1, 2.3, 8.1, 8.2, 8.3, 9.1; Science 1.1, 4.1, 4.2, 6.3; Tech 1.2, 1.3, 4.1, 4.2, 5.4

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 22.2: Convert values from one number system to another

TPO: Given a chart with binary, decimal and hexadecimal, convert that number into the equivalent binary, decimal and hexadecimal with 75% accuracy.

Clear learning target: I can
Descriptors:
22.2.1 Demonstrate the relationship of binary and hexadecimal to bits and bytes of information used in computers
22.2.2 Calculate converted values from one system to another

Correlated Content Benchmark: Standards: Math 1.1, 2.1, 2.3, 8.1, 8.2, 8.3, 9.1; Science 1.1, 4.1, 4.2, 6.3; Tech 1.2, 1.3, 4.1, 4.2, 5.4

Unit 23: Gates

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 23.1: Identify and recognize the gates and their truth table

TPO: Using computer simulation software, create a circuit to test the function of the following IC's; 7400, 7402, 7404, 7408, 7432. Demonstrate this working circuit to these circuits to your teacher.

Clear learning target: I can
Descriptors:
23.1.1 Identify the name and symbol of each gate
23.1.2 Identify function and create the truth table

Correlated Content Benchmark: Standards: Math 2.2, 6.1, 8.1, 10.1, 10.2; Science 1.1, 4.1, 4.2; Tech 1.3, 3.3, 4.1, 4.2

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 23.2: Apply logic gates to solve a problem

TPO: Create a truth table for the given logic problems and choose the logic gates that will best solve the problem. Draw and computer simulate the circuit then demonstrate the working circuit to your teacher.

Clear learning target: I can
Descriptors:
23.2.1 Use schematics and symbolic Algebra to represent digital gates in the creation of solutions to design problems
23.2.2 Solve using software
23.2.3 Verify with experimentation

Correlated Content Benchmark: Standards: Math 2.2, 6.1, 8.1, 10.1, 10.2; Science 1.1, 4.1, 4.2; Tech 1.3, 3.3, 4.1, 4.2

Unit 24: Boolean Algebra

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 24.1: Create Boolean expressions, logic circuit diagrams or truth tables from information provided in the solution of design problems

TPO: Given a series of logic circuits, create an un-simplified Boolean expression. From that Boolean expression, create a truth table. Label the expression Sum of Products or Product of sums. Simulate the Boolean expression and demonstrate the working circuit to your teacher.

Clear learning target: I can
Descriptors:

24.1.1 Recognize the relationship between the Boolean expression, logic diagram, and truth table

24.1.2 Select the Sum-of-Products or the Product-of-Sums form of Boolean expression to use in the solution of a problem

Correlated Content Benchmark: Standards: Math 2.2, 2.2, 8.1, 8.2, 9.1, 9.3; Science 4.1, 4.2, 5.6; Tech 1.3, 3.1, 3.3, 4.1

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 24.2: Apply the rules of Boolean algebra to logic diagrams and truth tables to minimize the circuit size necessary to solve a design problem

TPO: Given a series of un-simplified circuits, write the Boolean expressions and create the truth tables. Using the rules of Boolean algebra, simplify the Boolean expression and create a simplified truth table. Simulate the circuits and demonstrate the working circuits to your teacher.

Clear learning target: I can
Descriptors:

24.2.1 Use DeMorgan's theorem to simplify a negated expression and to convert a SOP to a POS and vise versa in order to save resources in the production of circuits

24.2.2 Formulate and employ a Karnaugh Map to reduce Boolean expressions and logic circuits to their simplest forms

Correlated Content Benchmark: Standards: Math 2.2, 8.1, 8.2, 9.1, 9.3; Science 4.1, 4.2, 5.6; Tech 1.3, 3.1, 3.3, 4.1

BIL: **Essential**

EDU:	12	AD
	P	R

Competency C.S. 24.3: **Assess duality of logic functions**

TPO: Using computer simulation software, convert a series of AIO logic circuits into their equivalent NAND and NOR forms and complete a truth table for each. Demonstrate these working circuits to your teacher.

Clear learning target: I can
Descriptors:

24.3.1 Create circuits to solve a problem using NAND or NOR gates to replicate all logic functions

24.3.2 Summarize the working of NOR and NAND gates to make comparisons with standard combinational logic solutions to determine amount of resource reduction

Correlated Content Benchmark: Standards: Math 5.1, 6.2, 6.4, 7.2, 8.4, 9.3; Science 4.1, 5.3, 5.4; Tech 1.2, 2.2, 3.1, 3.2, 4.2

Unit 25: Combinational Circuit Design

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 25.1: Design a paradigm for combinational logic problems

TPO: Given a word problem, create a simplified Boolean expression. Create a truth table for the Boolean expression. Design an AIO circuit for the simplified Boolean expression and using a breadboard trainer, wire the AIO circuit and demonstrate the working circuit it to your teacher.

Clear learning target: I can
Descriptors:
25.1.1 Restate and simplify a digital design problem as part of the systematic approach to solving a problem
25.1.2 Design, construct, build, troubleshoot, and evaluate a solution to a design problem
25.1.3 Present a solution and evaluation of a design problem

Correlated Content Benchmark: Standards: Math 2.2, 6.1, 6.2, 6.3, 8.1, 8.3; Science 1.1, 4.1, 4.2, 6.1; Tech 1.2, 1.3, 3.2, 4.2, 5.4

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 25.2: Design a specific MSI Gate application

TPO: Using a BCD encoder and breadboard trainer display a 4 bit binary count from 0-9. Demonstrate the circuit to your teacher.
Design a circuit using a truth table and the simplified Boolean expressions that will display your birth date on a seven-segment display. Demonstrate the circuit to your teacher.
Design a circuit using computer simulation software to transfer an 8 bit number through a Multiplexer to a Demultiplexer to display different bits at different decimals. Demonstrate working circuit to your teacher.

Clear learning target: I can
Descriptors:
25.2.1 Discover the code to create numbers on a seven segment display by experimentation
25.2.2 Design a circuit to control a seven segment display with a decimal to BCD encoder and a display driver
25.2.3 Control the flow of data by utilizing Multiplexers and Demultiplexers

Correlated Content Benchmark: Standards: Math 2.1, 2.2, 3.4, 6.1, 6.3, 9.1, 9.3; Science 1.1, 1.2, 2.6, 4.1, 4.2; Tech 1.3, 3.1, 3.2, 4.2, 4.3, 5.4

BIL: **Essential**

EDU:	12	AD
	P	R

Competency C.S. 25.3: **Evaluate programmable logic devices (PLD)**

TPO: Given a simplified Boolean expression, implement the truth table by programming a PLD device. Using a breadboard trainer, demonstrate the working circuit to your teacher.

Clear learning target: I can
Descriptors:
25.3.1 Describe programmable logic devices (PLD)
25.3.2 Design and implement combinational logic circuits using reprogrammable logic devices

Correlated Content Benchmark: Standards: Math 2.2, 2.3, 5.1, 6.1, 6.2, 6.3, 6.4, 8.4, 9.2, 9.3, 10.1, 10.2, 10.3, ; Science 2.2, 2.3, 2.6, 4.1, 4.2; Tech 1.3, 3.1, 3.3, 4.1

Unit 26: Adding

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 26.1: Design, construct and test adder circuits using discrete gates

TPO: Using computer simulation software, design a circuit using XOR ICs to add two one-bit binary numbers. Demonstrate working circuit to your teacher.

Clear learning target: I can
Descriptors:
26.1.1 Create and prove the truth table for both half and full adders
26.1.2 Demonstrate binary addition and subtraction by designing circuits to produce correct answers

Correlated Content Benchmark: Standards: Math 1.1, 1.2, 2.2, 2.3, 3.4, 6.1, 6.3; Science 1.2, 4.1, 4.2, 6.2; Tech 1.3, 2.4, 3.1, 3.3, 4.1, 4.3

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 26.2: Design, construct and test adder circuits using MSI gates

TPO: Using computer simulation software, create a circuit implementing a 74LS83 IC to add or subtract any two 4 bit binary numbers. Demonstrate working circuit to your teacher.

Clear learning target: I can
Descriptors:
26.2.1 Create and prove the truth table for both half and full adders
26.2.2 Demonstrate binary addition and subtraction by designing circuits to produce correct answers

Correlated Content Benchmark: Standards: Math 1.1, 1.2, 2.2, 2.3, 3.4, 6.1, 6.3; Science 1.2, 4.1, 4.2, 6.2; Tech 1.3, 2.4, 3.1, 3.3, 4.1, 4.3

Unit 27: Flip-Flops

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 27.1: Interpret, design, draw, and evaluate circuits using the logic symbols for latches and flip-flops

TPO: Using computer simulation software, design an active high input latch, an active low input latch, a gated R-S latch and a gated D latch. Breadboard each circuit and fill out the corresponding truth table. Demonstrate each working circuit to your teacher. Given a timing diagram for a flip-flop, complete the diagram for Q and Qnot with 75% accuracy.

Clear learning target: I can
Descriptors:
27.1.1 Construct and test simple latches and flip-flops from discrete gates
27.1.2 Interpret waveform diagrams from constructed circuits and compare them with combinational waveforms

Correlated Content Benchmark: Standards: Math 2.1, 9.1, 10.1, 10.2, 10.3; Science 1.2 ,4.1; Tech 1.1, 3.2, 5.6

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 27.2: Compare and contrast operation of synchronous with asynchronous flip-flop circuits they construct

TPO: Using computer simulation software, build an Asynchronous counter using three 47LS76 ICs. On graph paper copy the waveform diagram with Q output and the clock input. Demonstrate the working circuit to your teacher on a breadboard trainer.

Clear learning target: I can
Descriptors:
27.2.1 Identify synchronous and asynchronous flip-flop circuits
27.2.2 Interpret timing diagrams and truth tables from J-K Flip-Flops

Correlated Content Benchmark: Standards: Math 2.2, 6.1, 6.2, 6.3, 8.2, 9.1, 9.3, 10.1, 10.2, 10.3 ; Science 1.1, 1.2, 4.1, 4.2; Tech 3.2, 3.3, 4.1, 4.3, 5.4

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 27.3: Evaluate triggers used by latches and flip-flops

TPO: Using computer simulation software, create a positive edge trigger, negative edge trigger, positive level trigger and negative level trigger flip-flop. Using oscilloscope copy on graph paper the timing diagrams for the pulse, output and clock. Breadboard the circuits and demonstrate the working circuits to your teacher.

Clear learning target: I can
Descriptors:

27.3.1 Identify the different types of triggers used by latches and flip-flops and select the appropriate one for the circuits they design

27.3.2 Analyze timing diagrams that reflect triggering to identify distinguishing characteristics

Correlated Content Benchmark: Standards: Math 2.1, 2.2, 9.1, 10.2; Science 1.1, 2.6, 4.2; Tech 1.3, 4.3, 5.4

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 27.4: Assemble circuits and interpret information about the various applications of flip flops

TPO: Using computer simulation software, create a circuit using asynchronous flip-flops to divide a waveform's frequency by 8. Copy the output waveforms on graph paper. Demonstrate working circuit to your teacher. Create a synchronized circuit using four D-latch flip-flops. Complete the corresponding truth table for the data input/output and a trigger switch. Demonstrate the working simulation to your teacher.

Clear learning target: I can
Descriptors:

27.4.1 Describe flip-flops timing considerations

27.4.2 Conduct experiments with clock pulse width to determine the effect on the accuracy of data transmission

Correlated Content Benchmark: Standards: Math 6.1, 6.2, 6.3; Science 4.1; Tech 3.2, 3.3, 5.4

Unit 28: Shift Registers and Counters

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 28.1: Evaluate the use of shift registers in product design and the speeds at which those products run

TPO: Using a breadboard trainer, create an 8-bit Serial-in, parallel-out Shift Register. Change the logic level of S1, S2, and Clear. Record changes and demonstrate working circuit to your teacher.

Clear learning target: I can
Descriptors:
28.1.1 Define Shift registers
28.1.2 Conduct experiments to determine the basic principles of how shift registers work

Correlated Content Benchmark: Standards: Math 2.2, 6.1, 6.3, 9.1, 9.3; Science 1.1, 4.1, 4.2; Tech 3.2, 3.3, 4.2, 4.3, 5.4

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 28.2: Evaluate asynchronous counter operations and characteristics

TPO: Using computer simulation software, create a MOD-10 counter using 74LS93 MSI. Record waveform outputs for QA, QB, QC, and QD. Demonstrate working circuit to your teacher.

Clear learning target: I can
Descriptors:
28.2.1 Create a circuit using discrete flip-flops to discover the operation and characteristics of asynchronous counters
28.2.2 Design, simulate, build, and test Mod counters using discrete gates in the solution to a design problem
28.2.3 Design, simulate, build, and test asynchronous Mod counters using an integrated counter chip (MSI)

Correlated Content Benchmark: Standards: Math 2.1, 2.2, 2.3, 6.1, 6.2, 6.3, 6.4, 7.2, 9.1, 9.2, 9.3, 10.2; Science 1.1, 1.2, 4.1; Tech 3.1, 3.3, 5.4, 5.6

BIL: **Essential**

EDU:	12	AD
	P	R

Competency C.S. 28.3: Evaluate synchronous counter operations and characteristics

TPO: Using computer simulation software, design and create a synchronous BCD counter from discrete JK Flip-flops. Using breadboard trainer, test and demonstrate working circuit to your teacher. Using computer simulation software, create a circuit to test the operations of a 74LS163 IC. Record your observations and demonstrate working circuit to your teacher.

Clear learning target: I can
Descriptors:

28.3.1 Design, simulate, build, and test synchronous Mod counters using discrete gates to solve a problem

28.3.2 Design, simulate, build, and test synchronous Mod counters using an integrated counter chip in the solution to a design problem

Correlated Content Benchmark: Standards: Math 2.1, 2.2, 2.3, 6.1, 6.2, 6.3, 6.4, 7.2, 9.1, 9.2, 9.3, 10.2; Science 1.1, 4.1; Tech 3.1, 5.4

Unit 29: Families and Specifications

BIL: Essential

EDU:	12	AD
	I	P

Competency C.S. 29.1: Define, calculate, and measure fan-out delay

TPO: Using data sheet for 74TTL, 74LSTTL, and 74HC CMOS calculate fan-out and noise margin with 75% accuracy.

Clear learning target: I can
Descriptors:
29.1.1 Calculate the fan-out for TTL and CMOS
29.1.2 Calculate the noise margin based on information for a data sheet

Correlated Content Benchmark: Standards: Math 2.2, 4.1, 4.2, 9.3; Science 1.1, 2.3, 2.6, 4.1, 4.2, 9.3; Tech 3.1, 3.2, 4.1, 4.2, 5.4

BIL: Essential

EDU:	12	AD
	I	P

Competency C.S. 29.2: Define, calculate, and measure propagation delay

TPO: Using computer simulation software, create a circuit using (16) 74LS04 in series. Using oscilloscope determine the time difference between input wave and output wave. From this time difference calculate Propagation Delay and compare to your data sheet.

Clear learning target: I can
Descriptors:
29.2.1 Describe switching delays that occur in Integrated Circuits
29.2.2 Calculate propagation delay and compare an actual delay to the delay time on a data sheet

Correlated Content Benchmark: Standards: Math 2.2, 4.1, 4.2, 9.3; Science 1.1, 2.3, 2.6, 4.1, 4.2, 9.3; Tech 3.1, 3.2, 4.1, 4.2, 5.4

Unit 30: Microprocessors

BIL: Essential

EDU:	12	AD
	I	P

Competency C.S. 30.1: Assess microcontrollers

TPO: Using paper and pencil, create a flow chart for using the six most often used programming symbols for three different logic problems with 100% accuracy.
Using BASIC STAMP EDITOR, create a program to oscillate two LED's at a prescribe rate. Demonstrate working circuit to your teacher.

Clear learning target: I can
Descriptors:

30.1.1 Formulate a flow chart to apply basic programming concepts in the planning of a project

30.1.2 Design and create a program, using correct syntax, to evaluate data and make decision based on information gathered from the environment using external digital and analog sensors

30.1.3 Create an interface to be able to inspect, evaluate and manage program parameters in the microprocessor during the operation of a program

Correlated Content Benchmark: Standards: Math 3.2, 3.4, 4.2, 5.1, 5.3, 6.1, 6.3, 6.4, 8.1, 8.2, 8.3, 9.3, 10.1; Science 1.1, 1.2, 2.2, 2.3, 4.1, 5.3, 5.4, 5.5, 5.6; Tech 1.3, 3.1, 3.3, 4.2, 4.3, 5.4

BIL: Essential

EDU:	12	AD
	I	P

Competency C.S. 30.2: Assess interfacing with motors

TPO: Using BASIC STAMP EDITOR and an H-Bridge Driver (LM298), create a flow chart and program to control the position of a stepper motor based on input data. Demonstrate on a breadboard trainer the working circuit to your teacher.

Clear learning target: I can
Descriptors:

30.2.1 Design and create a program in correct syntax allowing a microprocessor to evaluate external data in order to operate motors and other devices to control the external environment

30.2.2 Select, size, and implement interface devices to control external devices

30.2.3 Design and create programming to control the position of stepper motors

Correlated Content Benchmark: Standards: Math 2.3, 3.4, 4.1, 4.2, 6.1, 6.2, 6.3, 8.2, 9.3, 10.3; Science 2.2, 2.3, 2.4, 2.6, 4.1, 5.4, 5.6; Tech 1.3, 3.2, 4.2, 4.3, 5.3, 5.4

Note: All the **Correlated Content Benchmarks** are aligned with the following National Standards Organizations: *Standards for Technology Literacy*, *National Science Educational Standards*, and *Principles and Standards for School Mathematics*

ENGINEERING DESIGN AND DEVELOPMENT

Unit 31: Introduction to Engineering and Engineering Technology Design and Development

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 31.1: Identify the scope and purpose of an engineering design and development research project

TPO: · Identify the design process steps used in given scenarios and be able to list the steps.

· Explain the process used to organize a research project.

· Apply engineering notebook standards and protocols when documenting work.

· Define and demonstrate time management skills as related to his or her project.

· Distinguish between when it is appropriate to use technical writing and expository writing styles.

Clear learning target: I can
Descriptors:

31.1.1 Describe and define the purpose and rationale of the course skills and knowledge base

31.1.2 Describe the characteristics of a successfully completed project based on previously completed projects

31.1.3 Distinguish the differences between the goals of this class and the type of projects done in other classes

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S 31.2: Determine the structure for evaluating a research project

TPO: · Identify the design process steps used in given scenarios and be able to list the steps.

· Explain the process used to organize a research project.

· Apply engineering notebook standards and protocols when documenting work.

· Define and demonstrate time management skills as related to his or her project.

· Distinguish between when it is appropriate to use technical writing and expository writing styles.

Clear learning target: I can

Descriptors:

31.2.1 List examples of levels of performance within the grading structure of this course

31.2.2 Create a resume to record their academic achievements and extra-curricular activities in school

31.2.3 Construct a portfolio of past accomplishments and research projects

Correlated Content Benchmarks: Standards: Tech Standard 2 Bench Mark EE, FF, Tech Standard 8 Bench Mark H; English Standards 4, 5, 6, 12.

Unit 32: Elements of Formal Research

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S 32.1: Use a journal as the source for returning to any desired previously encountered information

TPO: Document the project process in an engineering notebook.

Clear learning target: I can
Descriptors:
32.1.1 Recognize a need for retaining in one location all information relevant to the research project
32.1.2 Identify information encountered in the research process that belongs in the journal
32.1.3 Identify a format for the journal, which is well-organized and easy to use

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 32.2: Use conventional library resources as a starting point for all research

TPO: · Research and identify patents related to their identified problem.
· Conduct research to identify the difference between innovation and invention.
· Conduct research and perform a trend analysis on a technical problem.

Clear learning target: I can
Descriptors:
32.2.1 Describe the procedure for accessing library resources
32.2.2 Choose the appropriate media to obtain the desired information

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 32.3: Use the computer as a research tool

TPO: Using on-line media resources students will:
- Research and identify patents related to their identified problem.
- Conduct research to identify the difference between innovation and invention.

- Conduct research and perform a trend analysis on a technical problem.

Clear learning target: I can
Descriptors:
32.3.1 Distinguish relevant from irrelevant web sites
32.3.2 Manipulate search engines to find specific information
32.3.3 Classify strategies for identifying key terms that narrow their search topic
32.3.4 Examine on-line databases to search for patents, people, business, Government and Academic information
32.3.5 Correspond by e-mail including the use of attachments
32.3.6 Differentiate between an e-mail address and web site address

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 32.4: Contact the experts

TPO:

- Be able to speak to experts appropriately.
- Use strong oral and written skills to communicate with experts.
- Based on an example create a phone call script
- Using professional letter head create a donation letter.
- Develop research strategies for his or her solution, including the use of surveys, phone interviews, and personal contact with experts related to the field of his or her technical problem

Clear learning target: I can
Descriptors:
32.4.1 Compose a business letter and a thank you letter
32.4.2 Define the positive characteristics for personal interviewing (e.g. courtesy, professionalism, listening skills, personal hygiene, etc.)
32.4.3 Employ communication skills to converse over the phone and conduct a face to face interview

Correlated Content Benchmarks: Standards: Tech Standard 12 Bench Mark L, P, Tech Standard 13 Bench Mark J, Tech Standard 17 Bench Mark P, Bench Mark Q; English Standards 3, 4, 5, 6, 7, 8, 12.

Unit 33: Guided Research

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 33.1: Demonstrate methods of brainstorming

TPO:

- Create a description of the product specifications of the design solution.
- Objectively evaluate proposed design solutions using specific criteria
- Select the best design solution option using a decision matrix
- Graphically represent the results of the design solution evaluation using a matrix

Clear learning target: I can
Descriptors:

33.1.1 Use a decision matrix in narrowing a topic of research
33.1.2 Define constraints and specifications for use in a decision matrix
33.1.3 Use a decision matrix to rank order alternatives
33.1.4 Use decision matrices to develop a concise problem statement

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 33.2: Research a topic

TPO:

- Use a list of specifications and constraints identified in a decision matrix to develop a list of alternative solutions to the stated problem.
- Create a matrix table to analyze the data found from the patent research
- Conduct research to investigate and determine the merit of his or her alternative solution based on past solutions to the problem
- Graphically represent the results of the design solution evaluation using a matrix
- Orally explain the results of the decision matrix

Clear learning target: I can
Descriptors:

33.2.1 Discuss and explain key issues and terminology within the topical area
33.2.2 Narrow the topic focus using the decision matrix
33.2.3 Give an oral presentation
33.2.4 Evaluate the quality of research material (e.g., creditability, source, accuracy, error analysis, etc.)

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 33.3 Formulate a hypothesis and a problem statement

TPO:

- Write a problem statement as well as verify and justify the statement
- Use strong oral and written skills to communicate with experts
- Use a list of specifications and constraints identified in a decision matrix to develop a list of alternative solutions to the stated problem.

Clear learning target: I can
Descriptors:

33.3.1 Based on the research, develop hypothesis and a problem statement
33.3.2 Apply the decision matrix to a problem, justifying the hypothesis and problem statements based on previous research findings and decision matrices

BIL: Essential

EDU:	12	AD
	I	P

Competency C.S. 33.4: Research and develop alternative solutions

TPO:

- Write a problem statement as well as verify and justify the statement
- Use strong oral and written skills to communicate with experts
- Use a list of specifications and constraints identified in a decision matrix to develop a list of alternative solutions to the stated problem.
- Discuss the pros and cons of the alternative solutions decision matrix

Clear learning target: I can
Descriptors:

33.4.1 Generate a list of existing solutions to the research problem
33.4.2 Evaluate the advantages and disadvantages of present solutions to the research problem using decision matrices
33.4.3 Develop a list of alternative solutions to the stated problem following a review of the specifications and constraints identified in the decision matrices

BIL: Essential

EDU:	12	AD
	I	P

Competency C.S. 33.5: Redefine and justify alternative solutions

TPO:

- Research and identify patents related to their identified problem
- Use strong oral and written skills to communicate with experts
- Conduct research and perform a trend analysis on a technical problem

Clear learning target: I can
Descriptors:

33.5.1 Conduct preliminary patent searches to determine the originality of their alternative choices

33.5.2 Conduct research to determine the merit of their alternative choices based on the state of the art in the field

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 33.6: Demonstrate presentation methods

TPO:

- Gather data and information compiled throughout the project and create a technical research paper, PowerPoint, and three panel display of their design solution
- Orally present an effective technical presentation on the chosen design solution
- Create marketing materials such as pamphlets, commercials, and demonstrations

Clear learning target: I can
Descriptors:

33.6.1 Identify techniques for delivering formal presentations

33.6.2 Choose an appropriate formal presentation format and prepare a presentation

33.6.3 Construct and deliver a PowerPoint presentation centered on the topic of research

Correlated Content Benchmarks: Standards: Tech Standard 12 Bench Mark L, P, Tech Standard 13 Bench Mark J, Tech Standard 17 Bench Mark P, Bench Mark Q; English Standards 3, 4, 5, 6, 7, 8, 12.

Unit 34: Independent Research

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 34.1: Describe procedures to completing an independent research project

TPO:

- Compile a materials list that includes vendors and cost for all necessary materials and equipment to build their prototype
- Explain the process used to organize a research project
- Create a Gantt chart with the sequence of events need to complete and present the whole project

Clear learning target: I can
Descriptors:

34.1.1 Define and demonstrate time management planning skills as they pertain to a project

34.1.2 Identify methods and sources for obtaining materials and supplies

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 34.2: Develop a prototype

TPO:

- Compile a materials list that includes vendors and cost for all necessary materials and equipment to build their prototype
- Explain the process used to assemble project; create assembly instructions
- Create a Gantt chart with the sequence of events need to complete and present the whole project
- Complete machine tool safety training and score 100% on safety test
- Given a testing procedure template, compile a test report, perform the testing, compile the data and draw conclusions which will drive further design refinements

Clear learning targets: I can
Descriptors:

34.2.1 Provide a detailed set of instructions for producing a testable prototype based upon the research and the information gained through the research
34.2.2 Identify safe practices for the use of tools and equipment
34.2.3 Create and justify a process for testing the prototype design that will yield valid data concerning the design's attempt at solving the problem statement
34.2.4 Review their testing procedures to determine the validity of the testing procedures
34.2.5 Apply the appropriate statistical analysis tools to the test results to ensure the validity and significance
34.2.6 Identify, define, and implement needed modifications to the design based upon the ongoing research
34.2.7 Examine and explain the effectiveness of the design at solving the problem

BIL: **Essential**

EDU:	**12**	**AD**
	P	R

Competency C.S. 34.3: Prepare a research paper

TPO:

- Study cases (articles supplied by teacher) regarding research and development and its impact on the invention and innovation of products, processes, or services.
- Create market research to investigate and determine the merit of their solution.
- Self-assess their performance and research based on the goals for developing a solution to a problem

Clear learning targets: I can
Descriptors:

34.3.1 Arrange the data and information compiled throughout the project and compose a technical research paper
34.3.2 Use a standardized format for composing the research paper

Correlated Content Benchmarks: Standards: Tech Standard 12 Bench Mark L, P, Tech Standard 13 Bench Mark J, Tech Standard 17 Bench Mark P, Bench Mark Q; English Standards 3, 4, 5, 6, 7, 8, 12.

Unit 35: Formal Presentations

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 35.1: Create a presentation

TPO:

- Gather data and information compiled throughout the project and create a technical research paper, Power Point, and three panel display of their design solution.
- Create a website, if they choose, in order to depict all aspects of their design solution
- Choose one of the formats used to depict the design solution, such as technical research paper, Power Point, three panel display, or website, if created, for the presentation of the solution to their problem

Clear learning targets: I can
Descriptors:

35.1.1 Gather data pertaining to the topic
35.1.2 Organize data sequentially
35.1.3 Create a topical outline of the presentation
35.1.4 Select delivery method for presentation

BIL: Essential

EDU:	12	AD
	P	R

Competency C.S. 35.2: Make a formal presentation

TPO:

- Identify appropriate techniques for delivering formal presentations
- Orally present an effective technical presentation on the chosen design solution
- Write a resume to prepare for an interview in college or the workforce
- Update their portfolio with accompanying resume as professional documentation of their knowledge, skill and work completed in this course

Clear learning targets: I can
Descriptors:
35.2.1 Discuss research findings in a formal presentation before an audience
35.2.2 Utilize presentation aids to enhance and clarify the presentation

Correlated Content Benchmarks: Standards: Tech Standard 12 Bench Mark L, P, Tech Standard 17 Bench Mark P, Bench Mark Q, Bench Mark N; English Standards 4, 5, 8, 12.

Note: All the **Correlated Content Benchmarks** are aligned with the following National Standards Organizations: *Standards for Technology Literacy (ITEA)*, *National Science Educational Standards (NSES)*, *Standards for the English Language Arts (SELA)*, and *Principles and Standards for School Mathematics (PSSM)*

STUDENT ASSESSMENT POLICY
PROJECT LEAD THE WAY
WEST SHORE CAREER AND TECHNICAL EDUCATION DISTRICT

The student shall perform competencies and competency and key indicators in a manner acceptable to the Standards of the Project Lead The Way advisory committee members and employers in the business community and evaluated by the teacher following these guidelines. Competencies will be identified which must be mastered in order to receive credit for course.

In order to measure the progress of each student in the program and to measure the effectiveness of the total program, the following assessment procedures will be used:

- Post tests
- Teacher observation and assessment
- Self-assessments
- Class discussions
- Sketch Books
- Project development
- Daily grades
- Quarterly progress reports
- Daily grades
- Lab performance
- Notebook

Measurement of learning will be an on-going activity with emphasis on laboratory activities and core standard improvement. Evaluation will be done through pre-assessment of student skills, frequent formative assessment, both visual and written, and summative assessment to determine mastery of competencies. The number of competencies mastered will be translated into appropriate grades consistent with the school's grading system and consistent with district and school policy.

Lakewood City School District's Grading Scale

Grade	Percent Range
A+	96.50 – 100
A	92.50 – 96.49
A-	89.50 – 92.49
B+	86.50 – 84.49
B	82.50 – 86.49
B-	79.50 – 82.49
C+	76.50 – 79.49
C	72.50 – 76.49
C-	69.50 – 72.49
D+	66.50 – 69.49
D	62.50 – 66.49
D-	59.50 – 62.49
F	0.00 – 59.49

The **Project Lead The Way** programs will take a final examination as released by the advisory committee of Project Lead The Way national assessment team, attesting to the students' abilities.

THE END