MT. DIABLO UNIFIED SCHOOL DISTRICT
COURSE OF STUDY
DRAFT

COURSE TITLE:	**Principles of Engineering**
COURSE NUMBER:	**007717**
CALPADS NUMBER:	**5574**
CST:	**None**
DEPARTMENT:	**Academies**
NCLB TEACHER CREDENTIAL REQUIRMENTS:	**To be determined by the Credential Analyst in Personnel**
LENGTH OF COURSE:	**One Year**
CREDITS PER SEMESTER:	**5**
GRADE LEVEL(S):	**10^{th} -12^{th}**
GRADUATION REQUIREMENT OR ELECTIVE:	**Elective**
PREREQUISITES:	**None**

BOARD OF EDUCATION ADOPTION:

COURSE DESCRIPTION

Principles of Engineering (POE) is a one year Project Lead the Way Course in the Engineering Academy. POE explores technology systems and manufacturing processes; addresses the social and political consequences of technological change. This course engages high school students through a combination of activities-based, project-based, and problem-based (APPB) learning. APPB learning not only creates an environment for applying engineering concepts to real problems, but also prepares students to: solve problems, participate as part of a team, lead teams, speak to a public audience, conduct research, understand real-world impacts, analyze data, and learn outside the classroom. High school students involved in PLTW strive to complete a minimum of the three foundation courses, one specialization course, and the capstone course. The Pathway To Engineering system works in any standard four-year sequence and prepares students for two- or four-year college studies in engineering and E/T by exposing them to the true scope of the field.

COURSE OUTLINE:

1. MAJOR GOALS

1.1 To develop the ability to reason logically and think spatially
1.2 To improve the skills necessary to be successful in multiple careers.
1.3 To use critical thinking skills to develop solutions to real life related situations.
1.4 To develop their knowledge base, stimulate creative ideas, and make informed decisions.
1.5 To communicate innovative solutions related to real life situations

graphically, verbally, mathematically, and kinesthetically to targeted audiences.

1.6 To develop design processes and models using various techniques such as drawing, sketching, and computer modeling programs.

1.7 To gain an awareness of economics and resources and their impact on the global environment.

2. PERFORMANCE OBJECTIVES:

2.1 Engineering Technology Pathway

2.1.1 Know how to communicate and interpret information clearly in industry visual and written formats (D1.0)

2.1.1.1 Understand the classification and use of various electronic components, symbols, abbreviations, and media common to electronic drawings.(D1.1)

2.1.1.2 Understand, organize, and complete an assembly drawing by using information collected from detailed drawings. (D1.2)

2.1.1.3 Know the current industry standards for illustration and layout. (D1.3)

2.1.1.4 Draw flat layouts of a variety of objects by using the correct drafting tools, techniques, and media. (D1.4)

2.1.1.5 Prepare reports and data sheets for writing specifications. (D1.5)

2.1.2 Understand telecommunications systems, such as electromagnetic, fiber optic, and digital, that apply to the transmission of data: (D2.0)

2.1.2.1 Assemble the components of a telecommunications system or subsystem, including confirming operating parameters, applying test procedures, and making necessary adjustments. (D2.1)

2.1.2.2 Plan, install, and maintain copper and fiber optic cabling for telecommunications systems. (D2.2)

2.1.2.3 Test and maintain wireless communications components and systems. (D2.3)

2.1.2.4 Understand how to safely operate various data networking and telecommunications systems. (D2.4)

2.1.3 Students know the fundamentals of the theory, measurement, control, and applications of electrical energy, including alternating and direct currents: (D3.0)

2.1.3.1 Analyze relationships between voltage, current, resistance, and power related to direct current (DC) circuits. (D3.1)

2.1.3.2 Understand the characteristics of alternating current (AC) and how it is generated; the characteristics of the sine wave; the basic characteristics of AC circuits, tuned

circuits, and resonant circuits; and the nature of the frequency spectrum. (D3.2)

2.1.3.3 Calculate, construct, measure, and interpret both AC and DC circuits. (D3.3)

2.1.3.4 Use appropriate electronic instruments to analyze, repair, or measure electrical and electronic systems, circuits, or components. (D3.4)

2.1.3.5 Analyze and predict the effects of circuit conditions on the basis of measurements and calculations of voltage, current, resistance, and power. (D3.5)

2.1.3.6 Classify and use various electrical components, symbols, abbreviations, media, and standards of electrical drawings.

2.1.3.7 Understand how electrical control and protection devices are used in electrical systems. (D3.7)

2.1.3.8 Calculate loads, currents, and circuit-operating parameters. (D3.8)

2.1.4 Students understand how the principles of force, work, rate, power, energy, and resistance relate to mechanical, electrical, fluid, and thermal engineering systems(D4.0):

2.1.4.1 Understand scalars and vectors. (D4.1)

2.1.4.2 Solve problems by using the concept of vectoring to predict the resultant forces. (D4.2)

2.1.4.3 Know the six simple machines and their applications. (D4.3)

2.1.4.4 Know how energy is transferred; know the effects of resistance in mechanical, electrical, fluid, and thermal systems. (D4.4)

2.1.4.5 Solve problems by using the appropriate units applied in mechanical, electrical, fluid, and thermal engineering systems. (D4.5)

2.1.5 Students understand the design process and how to solve analysis and design problems: (D5.0)

2.1.5.1 Understand the steps in the design process. (D5.1)

2.1.5.2 Determine what information and principles are relevant to a problem and its analysis. (D5.2)

2.1.5.3 Choose between alternate solutions in solving a problem and be able to justify the choices made in determining a solution. (D5.3)

2.1.5.4 Translate word problems into mathematical statements when appropriate. (D5.4)

2.1.5.5 Understand the process of developing multiple details into a single solution. (D5.5)

2.1.5.6 Build a prototype from plans and test it. (D5.6)

2.1.5.7 Evaluate and redesign a prototype on the basis of collected test data. (D5.7)

2.1.6 Students understand industrial engineering processes, including the use of tools and equipment, methods of measurement, and quality assurance (D6.0):
- 2.1.6.1 Know the common structure and processes of a quality assurance cycle. (D6.1)
- 2.1.6.2 Understand the major manufacturing processes. (D6.2)
- 2.1.6.3 Use tools, fasteners, and joining systems employed in selected engineering processes. (D6.3)
- 2.1.6.4 Estimate and measure the size of objects in both Standard International and United States units. (D6.4)
- 2.1.6.5 Calibrate and measure objects by using precision measurement tools and instruments. (D6.5)

2.1.7 Students understand the concepts of physics that are fundamental to engineering technology (D7.0):
- 2.1.7.1 Understand Newton's laws and how they affect and define the movement of objects. (D7.1)
- 2.1.7.2 Understand how the laws of conservation of energy and momentum provide a way to predict and describe the movement of objects. (D7.2)
- 2.1.7.3 Analyze the fundamentals and properties of waveforms and how waveforms may be used to carry energy. (D7.3)
- 2.1.7.4 Understand how electric and magnetic phenomena are related and know common practical applications. (D7.4)

2.1.8 Students understand computer systems and solve computer-related problems from an engineering perspective(D8.0):
- 2.1.8.1 Understand how to design systems that use computer programs to interact with hardware. (D8.1)
- 2.1.8.2 Install and configure the main computer hardware and software components. (D8.2)
- 2.1.8.3 Understand the ethical issues in computer engineering. (D8.3)
- 2.1.8.4 Know the function and interaction of basic computer components and peripherals. (D8.4)
- 2.1.8.5 Understand the relationship among computer hardware, networks, and operating systems. (D8.5)
- 2.1.8.6 Understand the process of testing and troubleshooting computer equipment and systems. (D8.6)
- 2.1.8.7 Use utility software efficiently to diagnose and correct problems. (D8.7)

2.1.9 Students understand fundamental automation modules and are able to develop systems that complete preprogrammed tasks (D9.0):
- 2.1.9.1 Use appropriate tools and technology to perform tests, collect data, analyze relationships, and display data in a simulated or modeled automated system. (D9.1)
- 2.1.9.2 Understand the use of sensors for data collection and process correction in an automated system. (D9.2)

2.1.9.3 Program a computing device to control an automated system or process. (D9.3)

2.1.9.4 Use motors, solenoids, and similar devices as output mechanisms in automated systems. (D9.4)

2.1.9.5 Assemble input, processing, and output devices to create an automated system capable of accurately completing a preprogrammed task. (D9.5)

2.1.10 Students understand the fundamentals of systems and products as they are developed and released to production and marketing (D10.0):

2.1.10.1 Understand the process of product development. (D10.1)

2.1.10.2 Understand charting and the use of graphic tools in illustrating the development of a product and the processes involved. (D10.2)

2.1.11 Students understand the effective use of engineering technology equipment (D11.0):

2.1.11.1 Use methods and techniques for employing all engineering technology equipment appropriately. (D11.1)

2.1.11.2 Apply conventional engineering technology processes and procedures accurately, appropriately, and safely. (D11.2)

2.1.11.3 Apply the concepts of engineering technology to the tools, equipment, projects, and procedures of the Engineering Technology Pathway. (D11.3)

2.2 Academics

2.2.1 Mathematics

2.2.1.1 Number Sense (grade seven)

2.2.1.1.1 Read, write, and compare rational numbers in scientific notation (positive and negative powers of 10) with approximate numbers using scientific notation.(1.1)

2.2.1.1.2 Add, subtract, multiply, and divide rational numbers (integers, fractions, and terminating decimals) and take positive rational numbers to whole-number powers. (1.2)

2.2.1.1.3 Convert fractions to decimals and percents and use these representations in estimations, computations, and applications. (1.3)

2.2.1.1.4 Calculate the percentage of increases and decreases of a quantity. (1.6)

2.2.1.2 Mathematical Reasoning standards (grade seven):

2.2.1.2.1 Use estimation to verify the reasonableness of calculated results. (2.1)

2.2.1.2.2 Apply strategies and results from simpler problems to more complex problems. (2.2)

2.2.1.2.3 Estimate unknown quantities graphically and solve for them by using logical reasoning and arithmetic and algebraic techniques. (2.3)

2.2.1.2.4 Make and test conjectures by using both inductive and deductive reasoning. (2.4)

2.2.1.2.5 Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning. (2.5)

2.2.1.2.6 Express the solution clearly and logically by using the appropriate mathematical notation and terms and clear language; support solutions with evidence in both verbal and symbolic work. (2.6)

2.2.1.2.7 Indicate the relative advantages of exact and approximate solutions to problems and give answers to a specified degree of accuracy. (2.7)

2.2.1.2.8 Make precise calculations and check the validity of the results from the context of the problem. (2.8)

2.2.1.2.9 Evaluate the reasonableness of the solution in the context of the original situation. (3.1)

2.2.1.2.10 Note the method of deriving the solution and demonstrate a conceptual understanding of the derivation by solving similar problems. (3.2)

2.2.1.2.11 Develop generalizations of the results obtained and the strategies used and apply them to new problem situations. (3.3)

2.2.1.3 Algebra I standards (grades eight through twelve):

2.2.1.3.1 Students simplify fractions with polynomials in the numerator and denominator by factoring both and reducing them to the lowest terms. (12.0)

2.2.1.3.2 Students apply algebraic techniques to solve rate problems, work problems, and percent mixture problems. (15.0)

2.2.1.4 Geometry standards (grades eight through twelve):

2.2.1.4.1 Students use the Pythagorean theorem to determine distance and find missing lengths of sides of right triangles. (15.0)

2.2.1.4.2 Students use trigonometric functions to solve for an unknown length of a side of a right triangle, given an angle and a length of a side. (19.0)

2.2.1.5 Algebra II standards (grades eight through twelve):

2.2.1.5.1 Students are adept at operations on polynomials, including long division. (3.0)

2.2.1.5.2 Students add, subtract, multiply, and divide complex numbers. (6.0)

2.2.2 Science

2.2.2.1 Physics

2.2.2.1.1 Know heat flow and work are two forms of energy transfer between systems (3.a)

2.2.2.1.2 Know that that the work done by a heat engine that is working in a cycle is the difference between the heat flow into the engine at high temperature and the heat flow out at a lower temperature (first law of thermodynamics) and that this is an example of the law of conservation of energy. (3.b)

2.2.2.1.3 Know the internal energy of an object includes the energy of random motion of the object's atoms and molecules, often referred to as *thermal energy.* The greater the temperature of the object, the greater the energy of motion of the atoms and molecules that make up the object. (3.c)

2.2.2.1.4 Know how to solve problems involving heat flow, work, and efficiency in a heat engine and know that all real engines lose some heat to their surroundings. (3.g)

2.2.2.2 Investigation and Experimentation Standards:

2.2.2.2.1 Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data. (1.a)

2.2.2.2.2 Formulate explanations by using logic and evidence. (1.d)

2.2.2.2.3 Analyze situations and solve problems that require combining and applying concepts from more than one area of science. (1.1)

2.3 Communications: Students understand the principles of effective oral, written, and multimedia communication in a variety of formats and contexts.

2.3.1 Reading

Specific applications of Reading Comprehension standards (grade nine and ten)

2.3.1.1 Analyze the structure and format of functional workplace documents, including the graphics and headers, and explain how authors use the features to achieve their purposes. (2.1)

2.3.1.2 Prepare a bibliography of reference materials for a report using a variety of consumer, workplace, and public documents. (2.2)

2.3.1.3 Demonstrate use of sophisticated learning tools by following technical directions (e.g., those found with graphic calculators and specialized software programs and in access guides to World Wide Web sites on the Internet). (2.6)

2.3.2 Writing

Specific applications of Writing Strategies and Applications standards (grades nine and ten):

2.3.2.1 Use clear research questions and suitable research methods (e.g., library, electronic media, personal interview) to elicit and present evidence from primary and secondary sources. (1.3)

2.3.2.2 Develop the main ideas within the body of the composition through supporting evidence (e.g., scenarios, commonly held beliefs, hypotheses, definitions). (1.4)

2.3.2.3 Synthesize information from multiple sources and identify complexities and discrepancies in the information and the different perspectives found in each medium (e.g., almanacs, microfiche, news sources, in-depth field studies, speeches, journals, technical documents). (1.5)

2.3.2.4 Use appropriate conventions for documentation in the text, notes, and bibliographies by adhering to those in style manuals (e.g., *Modern Language Association Handbook, The Chicago Manual of Style).* (1.7)

2.3.2.5 Write technical documents (e.g., a manual on rules of behavior for conflict resolution, procedures for conducting a meeting, minutes of a meeting) (2.6):

a. Report information and convey ideas logically and correctly.
b. Offer detailed and accurate specifications.
c. Include scenarios, definitions, and examples to aid comprehension
(e.g., troubleshooting guide).
d. Anticipate readers' problems, mistakes, and misunderstandings.

2.3.3 Listening and Speaking

2.3.3.1 Use props, visual aids, graphs, and electronic media to enhance the appeal and accuracy of presentations. (1.7)

2.3.3.2 Produce concise notes for extemporaneous delivery. (1.8)

2.3.3.3 Evaluate the clarity, quality, effectiveness, and general coherence of a speaker's important points, arguments, evidence, organization of ideas, delivery, diction, and syntax. (1.12)

2.3.3.4 Deliver expository presentations (2.2):

a. Marshal evidence in support of a thesis and related claims, including information on all relevant perspectives.
b. Convey information and ideas from primary and secondary sources accurately and coherently.
c. Make distinctions between the relative value and significance of specific data, facts, and ideas.
d. Include visual aids by employing appropriate technology to organize and display information on charts, maps, and graphs.
e. Anticipate and address the listener's potential misunderstandings, biases, and expectations.
f. Use technical terms and notations accurately.

2.3.3.5 Deliver persuasive arguments (including evaluation and analysis of problems and solutions and causes and effects) (2.5):

a. Structure ideas and arguments in a coherent, logical fashion.
b. Use rhetorical devices to support assertions (e.g., by appeal to logic through reasoning; by appeal to emotion or ethical belief; by use of personal anecdote, case study, or analogy).
c. Clarify and defend positions with precise and relevant evidence, including facts, expert opinions, quotations, expressions of commonly accepted beliefs, and logical reasoning.
d. Anticipate and address the listener's concerns and counterarguments.

2.3.3.6 Multimedia: Understand the importance of technical and computer-aided design and drawing technologies essential to the language of the engineering and design industry, including reading, writing, interpreting, and creating drawings, sketches, and schematics using engineering and design industry conventions and standards; interpreting and understanding detailed information provided from available technical documents, both print and electronic, and from experienced people; and using computers, calculators, multimedia equipment, and other devices in a variety of applications.

2.4 Career Planning and Management: Understand how to make effective decisions, use career information, and manage personal career plans:

2.4.1 Know the personal qualifications, interests, aptitudes, knowledge, and skills necessary to succeed in a career. (3.1)

2.4.2 Understand the scope of career opportunities and know the requirements for education, training, and licensure. (3.2)

2.4.3 Develop a career plan that is designed to reflect career interests, pathways, and postsecondary options. (3.3)

2.4.4 Understand the role and function of professional organizations, industry associations, and organized labor in a productive society. (3.4)

2.4.5 Understand the past, present, and future trends that affect careers, such as technological developments and societal trends, and the resulting need for lifelong learning. (3.5)

2.5 Technology: Know how to use contemporary and emerging technological resources in diverse and changing personal, community, and workplace environments:

2.5.1 Understand past, present, and future technological advances as they relate to a chosen pathway. (4.1)

2.5.2 Understand the use of technological resources to gain access to, manipulate, and produce information, products, and services. (4.2)

2.5.3 *Understand the influence of current and emerging technology on selected segments of the economy. (4.3)*

2.6 Problem Solving and Critical Thinking: Understand how to create alternative solutions by using critical and creative thinking skills, such as logical reasoning, analytical thinking, and problem-solving techniques:

2.6.1 Apply appropriate problem-solving strategies and critical thinking skills to work-related issues and tasks. (5.1)

2.6.2 Understand the systematic problem-solving models that incorporate input, process, outcome, and feedback components. (5.2)

2.6.3 *Use critical thinking skills to make informed decisions and solve problems. (5.3)*

2.7 Responsibility and Flexibility: Know the behaviors associated with the demonstration of responsibility and flexibility in personal, workplace, and community settings:

2.7.1 Understand the qualities and behaviors that constitute a positive and professional work demeanor. (7.1)

2.7.2 Understand the importance of accountability and responsibility in fulfilling personal, community, and workplace roles. (7.2)

2.7.3 Understand the need to adapt to varied roles and responsibilities. (7.3)

2.7.4 Understand that individual actions can affect the larger community. (7.4)

2.8 Ethics and Legal Responsibilities: Understand professional, ethical, and legal behavior consistent with applicable laws, regulations, and organizational norms.

2.8.1 Understand the concept and application of ethical and legal behavior consistent with workplace standards. (8.2)

2.8.2 Understand the role of personal integrity and ethical behavior in the workplace. (8.3)

2.9 Leadership and Teamwork

2.9.1 Understand the characteristics and benefits of teamwork, leadership, and citizenship in the school, community, and workplace settings. (9.1)

2.9.2 Understand how to organize and structure work individually and in teams for effective performance and the attainment of goals. (9.3)

2.9.3 Know multiple approaches to conflict resolution and their appropriateness for a variety of situations in the workplace. (9.4)

2.9.4 Understand how to interact with others in ways that demonstrate respect for individual and cultural differences and for the attitudes and feelings of others. (9.5)

2.10 Technical Knowledge Skills

2.10.1 Use and maintain industrial and technological products and systems. (10.1)

2.10.2 Understand the importance of technical and computer-aided technologies essential to the language of the engineering and design industry. (10.2)

2.10.3 Understand the role of the engineering and design industry in the California economy. (10.5)

2.10.4 *Understand and apply the appropriate use of quality control systems and procedures. (10.6)*

2.11 Demonstration and Application: Demonstrate and apply the concepts contained in the foundation and pathway standards

3 CONTENT OUTLINE:

3.1 Energy Forms

3.1.1 Energy comes in various forms.

3.1.2 Within an electrical system functions are carried out through a variety of specially designed components.

3.1.3 An electrical series circuit provides one path for current follow, whereas a parallel circuit provides multiple paths.

3.1.4 A material's R-value is an indication of its insulating ability.

3.2 Energy, Work and Power

3.2.1 Energy often needs to be converted from one form to another to meet the needs of a given system.

3.2.2 Electrical, mechanical, and fluid power forms can be converted from one to another.

3.2.3 Energy is neither created nor destroyed; however, within mechanical systems energy is lost between the input and the output.

3.2.4 Electrical power can be converted from the rotary motion of a turbine.

3.3 Energy Sources

3.3.1 Energy sources can be classified as nonrenewable, renewable, or inexhaustible.

3.3.2 Energy can come from many sources, but challenges include harnessing, storing, transportation, and their ability to be used for work.

3.3.3 Engineers must consider tradeoffs and consequences regarding emerging energy technology.

3.3.4 Energy must be distributed to the end user and generally converted to a useable form based on user need.

3.4 Opportunities in Engineering and Engineering Technology

3.4.1 Engineers and engineering technologists apply math, science, and discipline-specific skills to solve problems.

3.4.2 Engineering and engineering technology careers offer creative job opportunities for individuals with a wide variety of backgrounds and goals.

3.4.3 Engineers are typically involved with conceptual design and research, while engineering technologists generally deal less with theory and more with the implementation of current technology to solve problems.

3.4.4 Technical communication can be accomplished in oral, written, and visual forms.

3.4.5 Technical communication must be organized in a clear and concise manner so that the intended audience is able to perform tasks or make informed decisions based on the information given.

3.5 Mechanisms

3.5.1 Most mechanisms are composed of one or more of the six simple machines.

3.5.2 Engineers and technologists design mechanisms to manipulate force, speed, and distance to redirect energy in a system.

3.5.3 Ratios are used to mathematically analyze input work versus output work in order to design systems that meet design parameters.

3.6 Machine Control

3.6.1 Programs are designed with a sequence of operations for use by computers and microprocessors to make logical decisions and react based on information received.

3.6.2 Digital inputs are best used if only two discrete possible conditions are desired, whereas analog inputs allow for a wide range signal.

3.6.3 Some systems are designed to function without feedback, while others utilize feedback in order to adjust and react accordingly.

3.7 Fluid Power

3.7.1 Fluid power systems are categorized as either pneumatic, which utilizes gas, or hydraulic, which utilizes liquid

3.7.2 Fluid power is possible because in a system of confined fluid, pressure acts equally in all directions.

3.7.3 The decision to use a liquid versus a gas-based fluid system depends on the degree of motion control that is required and the mechanical behavior of the fluid under pressure.

3.7.4 The most basic components of all fluid power systems include a reservoir or receiver, a pump or compressor, a valve, and a cylinder.

3.7.5 Fluid power systems are designed to transmit force over great distances, multiply an input force, and increase the distance that an output will move.

3.7.6 Laws about the behavior of fluid systems and standard conventions for calculating values within fluid systems aid in the design and understanding of such systems.

3.7.7 Standard schematic symbols and conventions are used to communicate fluid power designs.

3.8 Design Problem-Control Systems

3.8.1 Design problems can be solved by individuals or in teams.

3.8.2 Engineers use a design process to create solutions to existing problems.

3.8.3 Design briefs are used to identify the problem specifications and to establish project constraints.

3.8.4 Teamwork requires constant communication to achieve the desired goal.

3.8.5 Design teams conduct research to develop their knowledge base, stimulate creative ideas, and make informed decisions.

3.9 Material Properties

3.9.1 Material properties and cost are important considerations for engineers when choosing appropriate materials for a design.

3.9.2 Synthetic materials allow for innovative solutions to design problems.

3.9.3 Raw materials undergo various manufacturing processes in the production of consumer goods.

3.9.4 Governmental agencies play a vital role in establishing and reinforcing recycling codes.

3.10 Material Testing

3.10.1 Engineers utilize a design process and mathematical formulas to solve design problems.

3.10.2 Engineers must document and clearly communicate the calculations for a design problem through documentation.

3.10.3 Technological advances in materials increase options for design solutions.

3.10.4 Material testing aids in determining a product's reliability, safety, and predictability in function.

3.10.5 Engineers perform destructive and non-destructive tests on material specimens for the purpose of identifying and verifying the properties of various materials.

3.10.6 Statistical analysis of material test data is performed to determine the loads that are applied to a structure.

3.11 Design Problem-Materials

3.11.1 Design problems can be solved by individuals or in teams.

3.11.2 Engineers use a design process to create solutions to existing problems.

3.11.3 Design briefs are used to identify the problem specifications and establish project constraints.

3.11.4 Teamwork requires constant communication to achieve the desired goal.

3.11.5 Design teams conduct research to develop their knowledge base, stimulate creative ideas, and make informed decisions.

3.12 Statics

3.12.1 Engineers create free body diagrams so that they can identify all forces acting upon a given body.

3.12.2 The centroid of a cross-sectional area of a beam and its moment of inertia are important considerations for structure design.

3.12.3 Scalar quantities include magnitude, while vectors include magnitude, direction, and sense.

3.12.4 Forces acting at a distance from an axis or point attempt or cause an object to rotate.

3.12.5 In a statically determinate truss, equations of equilibrium can be used to calculate external and internal forces.

3.13 Dynamics

3.13.1 When working with bodies in motion, engineers must be able to differentiate and calculate distance, displacement, speed, velocity, and acceleration.

3.13.2 When air resistance is not taken into account, released objects will experience acceleration due to gravity, also known as freefall.

3.13.3 Projectile motion can be predicted and controlled using kinematics equations.

3.13.4 When a projectile is launched, velocity in the x direction remains constant; whereas, with time, the velocity in the Y direction in magnitude and direction changes due to gravity.

3.14 Design Problem-Statics and Dynamics

3.14.1 Design problems can be solved by individuals or in teams.

3.14.2 Engineers use a design process to create solutions to existing problems.

3.14.3 Design briefs are used to identify the problem specifications and establish project constraints.

3.14.4 Teamwork requires constant communication to achieve the desired goal., stimulate creative ideas, and make informed decisions.

3.14.5 Design teams conduct research to develop their knowledge base

4. INSTRUCTIONAL METHODS AND/OR STRATEGIES:

4.1 Lecture and demonstration
4.2 Bloom's Taxonomy and Maslow's Hierarchy of Needs
4.3 Modeling
4.4 Sketching for planning and presentation
4.5 Engineering journal, notes, drawings and plans
4.6 Opportunity to build reading and writing skills
4.7 Vocabulary building skills
4.8 Use research based student engagement strategies such as SDAIE
4.9 Portfolio
4.10 Computer Technology and instruction
4.11 Group and individual activities
4.12 Guest speakers
4.13 Fieldtrips

5. EVALUATION OF STUDENT PROGRESS:

Students communicate mathematically and demonstrate content knowledge in a variety of ways that lead to mathematical competence in their chosen careers.

5.1 Teacher observation
5.2 Written assignments and projects
5.3 Quizzes and tests
5.4 Rubrics
5.5 Peer Evaluation
5.6 Panel Review

6. TIME ESTIMATES:

6.1 Instructional sequences vary in length from a few days to several weeks.

7. INSTRUCTIONAL MATERIALS:

7.1 District adopted textbooks
7.2 Supplementary and teacher-created materials that may include a career focus
7.3 Technology materials
7.4 Project Lead the Way materials

Sample Lesson Plan (using backward planning model)

Sample Lesson: Statics (lesson 5.1)

Standard to be taught: Mathematics (seventh grade standards): 2.5, 2.6, 2.7, 2.8, 3.1
Science: 1.1 1.1d
History: 10.3
Communication: Writing: 1.3, 1.7, 2.6
Listening: 1.7, 1.8, 2.4

Reading:
Technology: 4.1, 4.2
Problem-Solving and Critical Solving: 5.1, 5.2, 5.3

Assessment:

1. Students will be assessed on the accuracy and completeness of term definitions and notes on kinematics recorded in their lab notebooks.
2. Students will be assessed on the design and completeness of the bridge design.
3. Students will be evaluated on the application of mathematical formulas to engineering problems associated with structure problems.
4. Students will be evaluated on the graphing of vector problems
5. Students will be evaluated on the graphs produced to show relationship between deflection and area or second moment of area.
6. Students will be evaluated on the accuracy and clarity of the calculations produced from their statistical data.
7. Students will be evaluated on their oral presentation of their bridge design and analysis according to the **presentation rubric**.
8. Students will be evaluated on their responses to essential and key questions.

- What are the forces that act on a bridge and how is failure prevented?
- What factors are considered for the type of bridge selected for a given location?

Teaching strategies:

1. Introductory PowerPoint lesson on a number of different aspects of bridge building will be utilized throughout this lesson.
   - Lesson on the history and types of bridges
   - Lesson on strength of shapes and forces
   - Lesson on static equilibrium
   - Lesson on the concept of vectors
   - Lesson on Free body diagrams
   - Lesson on truss calculations with MDSolids
2. Introduction of the key questions and assigns a due date for the unit
3. Student centered problem based learning with teacher intervention through question and answer exchanges
4. Teacher will show examples of balsa wood bridges.

Student activities:

1. Students will begin researching the essential questions regarding the essential questions.
2. Students will complete a number of hands-on activities directly related each presented lesson to reinforce concepts in real world context.
3. Students define important definitions and concepts related to anticipatory set and keep detailed notes of their research.

4. Students create PowerPoints and bridge models to demonstrate knowledge gained during lesson.

Resources:

1. Project Lead The Way Curriculum
2. PowerPoints
3. Word Documents
4. Model Bridges
5. West Point Bridge Software

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