Instructional Framework

Engineering Sciences
15.0000.00

Domain 1: Engineering Math and Science Principles 45% - 55% Instructional Time	
STANDARD 3.0 Apply mathematical laws and principles relevant to engineering and technology	
3.1 Use appropriate data collection and analysis methods to display data (e.g., graphs, tables, formulas, and texts)	● Significant Digits ● Graph Types ● Trend Lines ● Organization of data for display ● Interpret graph data
3.2 Use statistical measures of central tendency as needed in the structured problem-solving process	● Central Tendency and Calculation and meaning (mean, median, mode) ● Variation Calculation and meaning (standard deviation, range) ● Graphical Interpretation of Normal distributions (Empirical Rule)
3.3 Use algebraic, geometric, and trigonometric relationships, characteristics, and properties to solve engineering problems	● Sin/Cos/Tangent and Inverse Calculation and Meaning ● Algebraic substitution, order of operation, and system of equations solutions ● Formula Manipulation
3.4 Evaluate the validity of mathematical solutions	● Unit Analysis ● Estimation of Results
3.5 Use existing mathematical models as needed in the structured problem-solving process	● Formula Selection ● Prediction of results given a graph or equation of the phenomena ● Identify formula from graphical display of data
3.6 Use English and metric systems of measurement and dimensional analysis	● Unit Conversions ● Unit Notation ● Tolerances and Fit
STANDARD 4.0 Apply fundamental scientific laws and principles relevant to engineering and technology	
4.1 Use the relationships among energy, work, and power to solve a variety of problems involving mechanical, fluid, electrical, and thermal systems	● Mechanical - Simple Machines / Mechanical Power / Mechanical Efficiency ● Electrical- Ohms Law / Kirkoffs Law / Circuit Analysis / Electrical Power / Efficiency

	• Thermal- Heat Transfer Methods / Thermal Equilibrium / Zeroeth Law / Q Calculations
4.2 Use Newton's Laws of Motion to analyze static and dynamic systems with and without the presence of external forces	• Free Body Diagrams • Force / Mass / Acceleration Relationships • Statics / Truss Analysis • Kinematics - Projectile Motion
4.3 Use the laws of conservation of energy, charge, and momentum to solve a variety of problems involving mechanical, fluid, electrical, and thermal systems	• Momentum
4.4 Assess relevant properties of materials used in engineering projects, i.e., chemical, environmental, mechanical (tension, compression, torque), electrical, and physical	• Material Stress calculation and meaning • Moment of Inertia application to materials and structures • Electrical conduction principles of materials • Strength / hardness meanings (modulus of E, Brinell hardness)

Domain 2: Engineering Technology and Documentation

30% - 40% Instructional Time

STANDARD 5.0 Apply Engineering Technology and Tools	
5.1 Use spreadsheets and other mathematical software to solve problems, model, and display data	• Spreadsheets • Formula entry • Multiple graphs and entry • Data sorting
5.2 Use measurement devices such as calipers, oscilloscopes, and digital multimeters to gather data for analysis	• Use measuring devices to gather data (e.g. ruler, tape measure, multimeter)
5.3 Apply precision, accuracy, and tolerance in measurement systems	• Use precision accuracy with measurement devices (micrometer, caliper)
5.4 Use 3D CAD software to model and analyze engineering solutions	• Parametric modeling • Additive/subtractive modeling • Geometric constraints • Virtual prototyping and simulations • Produce drawings and types • Dimensioning • Multi-view
5.5 Interpret graphical data such as plans, diagrams, and working drawings	• Use graphical data to interpret dimensions • Section views • Multi-views • Auxiliary views • Specific and general tolerances • Electrical diagrams/schematics

	● Project flow charts
5.6 Practice safe use of tools, machines, equipment, and materials	● Safety regulations ● safety requirements ● OSHA knowledge ● General equipment safety rules ● Fire safety ● SDS
5.7 Verify calibration status of measurement tools	● Use of NIS traceable standards or known standards ● Check to zero, zero process on use
5.8 Fabricate models using multiple methods (e.g., 3D printing, metalwork, wood, and breadboards)	● Produce functioning model to meet the design intent
STANDARD 6.0 Apply documentation and communication skills	
6.1 Demonstrate accurate documentation of data and results	● Data table formats (labeling, significant digits, unit notation) ● Data source documentation (instrument used, calibration status, collection personnel, method of measurement) ● Inferences and conclusions from data tables (averages, mean, median, mode)
6.2 Communicate status, assumptions, results, and conclusions using written and oral techniques	● Verbal presentation (attributes of effective speaking / presenting) ● Ability to use multimedia presentation methods (powerpoint, slides) ● Written reporting use of grammar and effective language ● Source citations and bibliography use (attribute others work)

Domain 3: Engineering Problem Solving

20% -25% Instructional Time

STANDARD 2.0 Apply a structured problem-solving process to create solutions	
2.1 Determine the problem	● Problem identification
2.2 Interpret the problem based on known facts, research, and experience	● Interpret the problem
2.3 Brainstorm solutions to the problem	● Effective brainstorming techniques and pitfalls
2.4 Identify design criteria and constraints (e.g., cost, time, quality, manufacturability, testability, maintainability, human and environmental factors, and governmental regulatory requirements)	● Design criteria and constraints should be based on scientific principles and potential impacts on people and the environment

2.5 Assess potential solutions against design criteria and constraints to select a solution that meets all requirements	● Decision matrix ● Pro-con lists ● Design iteration
2.6 Implement the selected solution	● Construct a prototype or model
2.7 Validate the effectiveness of the implemented solution	● Develop a design evaluation plan that aligns to the constraints and design problem
2.8 Reiterate the process as necessary	● Design iteration from within the design process at any point
STANDARD 7.0 Develop a project management plan to implement a solution	
7.1 Estimate tasks and time needed to implement a solution	● Work breakdown structure - is a key project deliverable that organizes the team's work into manageable sections or chunking ● Outcome based ● Deliverable timeline
7.2 Identify resources needed (e.g., materials, funding, people, and approval)	● Resource identification (budget, material list, funding, people, and approval)
7.3 Demonstrate the use of automated tools used to create project management plans	● Create / Read Gantt Chart ● Create / Read tasks list ● Create / Read calendar ● Use software to create project gantt pro ● Demonstrate task dependency and predecessor relationships ● Use software to determine critical path, float, completion times, budget
7.4 Track progress from implementation to completion using the project management plan	● Update project management tools to predict completions costs and time

Domain 4: Engineering Career Explorations **5% - 10% Instructional Time**	
STANDARD 1.0 Investigate engineering as a human endeavor aimed to address the needs of a global society	
1.1 Explain how engineering integrates many fields of study and may lead to other occupations	● Engineer v scientist ● Spectrum of engineering careers from technical to professional
1.2 Debate the societal, legal, and ethical responsibilities of engineering	● Legal requirements (Licensure, School Accreditation, Licensure Process) ● Professional ethics and associations

1.3 Determine the impact of engineering from multiple perspectives, i.e., economic, environmental, political, sustainable, and health and safety	● Social impact of engineering
1.4 Compare and contrast various disciplines of engineering and how each contributes to the success of a solution	● Major Engineering Fields (i.e. electrical, mechanical, chemical, civil) ● Subset Engineering Fields (i.e. Aero, Construction, Bio-Medical) ● Systems Engineering combination of disciplines
1.5 Identify the skills and education needed to enter a particular engineering discipline	● Engineering Degree requirements (AZ college entry requirements) ● Engineering / STEM careers other than degree programs (tech, community college, apprenticeships, internships)