APS DISTRICT HIGH SCHOOL SCIENCE CURRICULUM FRAMEWORK

Course Title: Engineering Robotics I CEC **Course Number:** 445C3

Department: Science **ADS Number:** 17814944

Prerequisites: C or better in Algebra I and Geometry or concurrently enrolled in Geometry

Length of Course: One Year **Credit/PRI Area:** 1.50 per Sem/Elective/Practical Arts **Grade Level(s):** 10-12

Important Notes: ***The student who takes Engineering Robotics I receives 1.5 credits per semester – elective electronics mathematics, elective pre-engineering science, and practical arts. A course that offers more than .5 per semester allows the student additional opportunities for in-depth study and application of the course content. The student is required to take a placement exam.***

COURSE DESCRIPTION: This laboratory course* is designed to introduce the student to electronics while building a robot and allows career exploration in the field of technology and engineering. Activities include the following:

- Working with DC, AC, digital electronics, robotics, and semiconductors,
- Modeling in a 3-D environment [e.g., SolidWorks – designing in a circuit simulation software package (Multisim)],
- An introduction to programming advanced microcontrollers,
- Basic machining and tooling applications,
- Design and fabrication of various types of robots, and
- Application options to include competing in state and possibly national level robotic competitions.

* Lab Courses: A minimum of 250 minutes per week of directed class activity for 36 weeks, 40% of which must be lab oriented, for a total of 150 clock hours (90 hours of class plus 60 hours of lab) shall be required for one (1) unit of credit, excluding passing period. [APS Procedural Directives, Section I – Instruction, Basis for offering credit].

References in parentheses following each performance standard align with the National Council of Teachers of Mathematics Standards (NCTM), the State of New Mexico Mathematics Standards (NM), the State of New Mexico Career Readiness Standards (CR), WorkKeys, the Albuquerque Public Schools Mathematics Standards (APS), and the APS Language Arts Standards (APS – LA).

STRATEGIES:
The "Illustrations" column in the p*rogram of studies* provides exemplars of the performance standards, strategies, and best practices suggested by robotics teachers in the Albuquerque Public Schools (APS).

ASSESSMENTS:
Assessments may include the following: authentic and performance-based assessment, cooperative learning, teacher observations, checklists, tests and exams, formal and informal writing, small group and full class discussions, oral and multimedia presentations, projects, demonstrations, and portfolios. Assessments are based on appropriate rubrics.

SUGGESTED TEXTBOOKS AND INSTRUCTIONAL MATERIALS:
- *Foundations of Electronics: Circuits and Devices*, Meade, Delmar Publishers, Inc., 1994
- *Basic Mathematics for Electronics*, Cooke, Adams, Dell, Moore, Glencoe: McGraw-Hill, 1995
- Computers and computer software

SUGGESTED TITLES/AUTHORS WEB SITES:

• http://www.nmroborave.com/	The New Mexico ROBO RAVE (Robots Are Very Educational) is a state robot competition.
• http://www.werc.net/contest/	An environmental design contest including developing new technology to solve a real-world problem.
• http://parallax.com	Digital circuit board kits, online activity manuals, software
	NASA site. Cool robot of the week with archives of past robots

Approved by HSCA: 12/04

STRAND I: SCIENTIFIC THINKING AND PRACTICE
CONTENT STANDARD: The student understands the processes of scientific investigations and uses inquiry and scientific ways of observing, experimenting, predicting, and validating to think critically.

BENCHMARKS:
A. The student uses accepted scientific methods to collect, analyze, and interpret data and observations and to design and conduct scientific investigations and communicate results.
B. The student understands that scientific processes produce scientific knowledge that is continually evaluated, validated, revised, or rejected.
C. The student uses mathematical concepts, principles, and expressions to analyze data, develop models, understand patterns and relationships, evaluate findings, and draw conclusions.

GRADE 10 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	1. Describes the essential components of an investigation, including appropriate methodologies, proper equipment, and safety precautions (NM-I.I.I.1). 2. Designs and conducts scientific investigations that include (NM-I.I.I.2): • testable hypotheses, • controls and variables, • methods to collect, analyze, and interpret data, • results that address hypotheses being investigated, • predictions based on results, • re-evaluation of hypotheses and additional experimentation as necessary, and • error analysis.	**NOTE: Illustrations include suggested activities for attaining each performance standard. A check for (√) refers to a key feature to look for while assessing student performance.** 1 – 7, 12 – 16. The student properly and safely designs, diagrams, and assembles an electronic, robot sensor circuit to perform a task (e.g., detect various frequencies of light, proximity, motion). He/She then changes some timing parameters (e.g., circuit components) or environment variables while observing and recording the effects. The student discusses and explains the results orally and/or in a written format. √ reasonable and testable electronic task √ identification of independent/dependent variables and controls √ experimental design √ proper safety techniques √ selection and use of appropriate equipment √ explanation of circuit analysis √ accurate mathematical calculations √ organization of data √ analysis of data √ multiple trials to verify data √ defensible conclusion based on data √ critical thinking and insights √ use of technology √ effective communication skills √ writing conventions

	3. Uses appropriate technologies (e.g., computers, calculators, balances, microscopes) to collect, analyze, and communicate scientific data (NM-I.I.I.3). 4. Conveys results of investigations using scientific concepts, methodologies, and expressions, including (NM-I.I.I.4): • scientific language and symbols, • diagrams, charts, and other data displays, • mathematical expressions and processes (e.g., mean, median, slope, proportionality), • clear, logical, and concise communication, and • reasoned arguments. 5. Understands how scientific theories are used to explain and predict natural phenomena (e.g., plate tectonics, ocean currents, structure of atom) (NM-I.I.I.5). 6. Understands how scientific processes produce valid, reliable results, including (NM-I.I.II.1): • consistency of explanations with data and observations, • openness to peer review, • full disclosure and examination of assumptions, • testability of hypotheses, and • repeatability of experiments and reproducibility of results. 7. Uses scientific reasoning and valid logic to recognize (NM-I.I.II.2): • faulty logic, • cause and effect, • the difference between observation and unsubstantiated inferences and conclusions, and • potential bias. 8. Understands how new data and observations can result in new scientific knowledge (NM-I.I.II.3). 9. Critically analyzes an accepted explanation by reviewing current scientific knowledge (NM-I.I.II.4).	3, 4. The student integrates a PC and microcontroller. He/She programs (e.g., C, Assembly) a microcontroller to output data to an LCD display. √ appropriate assembly and integration of circuitry √ desired output attained √ effective programming (e.g., steps) 8 - 11. The student researches and reports on the historical factors that influenced changes and development of a modern technology microcontroller (e.g., nano-technology, space, medicine, industry). The research includes the following: • historical timeline, • scientific principles, • hazards,

	10. Examines investigations of current interest in science (e.g., superconductivity, molecular machines, age of the universe) (NM-I.I.II.5). 11. Examines the scientific processes and logic used in investigations of past events (e.g., using data from crime scenes, fossils), investigations that can be planned in advance but are only done once (e.g., expensive or time consuming experiments such as medical clinical trials), and investigations of phenomena that can be repeated easily and frequently (NM-I.I.II.6). 12. Creates multiple displays of data to analyze and explain the relationships in scientific investigations (NM-I.I.III.1). 13. Uses mathematical models to describe, explain, and predict natural phenomena (NM-I.I.III.2). 14. Uses technologies (e.g., calculators, computer spreadsheets and databases, graphing software, simulations, modeling) to quantify relationships in scientific hypotheses (NM-I.I.III.3; CR – 3A). 15. Identifies and applies measurement techniques and considers possible effects of measurement errors (NM-I.I.III.4). 16. Uses mathematics to express and establish scientific relationships (e.g., scientific notation, vectors, dimensional analysis) (NM-I.I.III.5).	• global /local impact, • electrical design, • impact on human interaction, and • societal advancements. The student uses technology (e.g., PowerPoint, robotic demonstrations, workable model) to present findings. √ thorough research √ effective presentation √ clear communication √ writing conventions √ technology applications √ all components present 13 – 16. The student determines the stall current and no-load current of a DC motor. Using a digital multimeter, he/she measures and calculates the current aspects for the motor in order to verify the manufacturer datasheet. He/She repeats the scenario three times, takes the average, and describes the forces or variables that cause the motor to vary in its measurements. √ accurate measurements of resistance and voltage drops √ analysis of sources of error √ accurate computations of current √ safety procedures

STRAND II: THE CONTENT OF PHYSICAL SCIENCE
CONTENT STANDARD: The student understands the structure and properties of matter, the characteristics of energy, and the interactions between matter and energy.

BENCHMARKS: A. The student understands the properties, underlying structure, and reactions of matter.
B. The student understands the transformation and transmission of energy and how energy and matter interact.

GRADE 10 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	Chemical Reactions 1. Understands types of chemical reactions (e.g., synthesis, decomposition, combustion, redox, neutralization) and identifies them as exothermic or endothermic (NM-II.I.I.13). 2. Describes how the rate of chemical reactions depends on many factors that include temperature, concentration, and the presence of catalysts (NM-II.I.I.15). **Energy Transformation and Transfer** 3. Identifies different forms of energy, including kinetic, gravitational (i.e., potential), chemical, thermal, nuclear, and electromagnetic (NM-II.I.II.1). 4. Explains how thermal energy (i.e., heat) consists of the random motion and vibrations of atoms and molecules and is measured by temperature (NM-II.I.II.2). 5. Understands that energy can change from one form to another (e.g., changes in kinetic and potential energy in a gravitational field, heats of reaction, hydroelectric dams) and knows that energy is conserved in these changes (NM-II.I.II.3). 6. Understands that the ability of energy to do something useful (work) tends to decrease (and never increases) as energy is converted from one form to another (NM-II.I.II.5).	1, 2. The student describes the process involved in etching a circuit board, including an overview of the chemical reactions that take place. He/She discusses hazards and byproducts and their disposal. √ accurate description of steps √ correct identification of reactions and reaction types (i.e., endothermic/exothermic) √ clear explanation of factors that might change rate of reactions √ description of proper disposal methods 3 - 6. The student diagrams and describes the energy changes and transfers from a chemical energy source (e.g., battery) through an electrical system to a mechanical source (e.g., switch, fan) to an electrical source (e.g., relays, solenoids), and to thermal source (e.g., resistor). He/She identifies the types of energy and the transfers, explains how temperature is a measure of thermal energy, and describes how energy is conserved; yet, available energy decreases. √ recognition of limits of these energy transfer technologies √ accurate diagram of energy flow chart showing forms of energy √ accurate identification of energy transformations √ clear communication of relationship between temperature and thermal energy

GRADE 10 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	Interactions of Energy and Matter 7. Understands that electromagnetic waves carry energy that can be transferred when they interact with matter (NM-II.I.II.7). 8. Describes the characteristics of electromagnetic waves (e.g., visible light, radio, microwave, X-ray, ultraviolet, gamma) and other waves (e.g., sound, seismic waves, water waves) (NM-II.I.II.8). **Forces** 9. Explains how electric currents cause magnetism and how changing magnetic fields produce electricity (e.g., electric motors, generators) (NM-II.I.III.5). 10. Represents the magnitude and direction of forces by vector diagrams (NM-II.I.III.6). 11. Knows that when one object exerts a force on a second object, the second object exerts a force of equal magnitude and in the opposite direction on the first object (i.e., Newton's Third Law) (NM-II.I.III.7). **Motion** 12. Applies Newton's Laws to describe and analyze the behavior of moving objects, including displacement, velocity, and acceleration of a moving object Newton's Second Law, $F = ma$ (NM-II.I.III.8).	7, 8. The student designs, implements, and programs the radio transmitter and receiver pair for serial communications via radio waves. The student uses an oscilloscope to identify and describes the properties and characteristics of the radio signal. √ proper use of safety equipment √ workable circuit √ accurate identification √ troubleshooting skills 9. The student integrates a solenoid into his/her robot circuitry. He/She describes and diagrams the magnetic flux lines for the induced magnetic field once the solenoid is engaged in activity. √ proper use of safety equipment √ workable circuit √ accurate identification √ troubleshooting skills 10. The student's prior mathematical background determines the complexity of the mathematical model he/she uses to represent magnitude and direction of forces. Using a robot's weight and a given coefficient of friction, the student draws a force diagram for a robot climbing an incline. √ accurate diagram 11, 12. As one of a pair, the student places a powered vehicle on a horizontal, flat surface rolling the vehicle across this surface which then becomes an inclined plane. Using a stopwatch, the student determines the time and distance for each of the two regions (i.e., flat, incline plane) and computes speeds and accelerations for each region. He/She repeats the scenario three times, takes the average, and describes forces that cause the vehicle to move and to slow down. √ safety procedures √ accurate measurements of time and distance √ analysis of sources of error √ accurate computations of speed and acceleration (i.e., equations of motion) and description of forces

STRAND III: MATHEMATICAL PRINCIPLES AND APPLICATIONS
CONTENT STANDARD: The student demonstrates understanding of mathematical principles through meaningful mathematical experiences.

BENCHMARK: The student applies mathematical procedures to measure, solve, and graph a variety of equations related to real-world situations.

GRADE 10 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	1. Applies the "rule of four" (i.e., represents mathematics graphically, symbolically, verbally, numerically) (APS – all of Strand I).	1 - 5. The student selects a piece of paper from a stack of varied sizes. He/She is told that he/she works for a company that makes packaging and is to create a container with maximum volume which uses the least amount of material. The work as it evolves must include the following: • an estimate of which piece of paper holds the most, • a table of different results – large group, • a prediction of what the maximum volume is, • a graph of the function, • an equation that represents the table results, • the zeros of the equation with an explanation of what that means in this situation, and • a reasonable domain and range for each individual box using the original polynomial. The student uses a graphing calculator to plot data from the table and uses regression capabilities to compare with the equation he/she came up with. √ multiple representations √ use of technology √ real-life connections √ problem-solving strategies √ teamwork, collaboration √ accurate calculations √ communication of ideas
	2. Prepares mathematically for future careers (APS – I. 14).	2. The student responds to the following scenario: You have a set of two each of filters with the following optical densities at 477 nm wavelength: 0.22, 0.65, 0.98, 1.21, and 1.67. You are required to achieve a transmittance of 2.3% at 477 nm wavelength. How would you accomplish this? √ accuracy √ connections

GRADE 10 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	3. Uses reasoning and problem-solving strategies to solve new problems [APS – I.3; NM – IIA (5-7)]. 4. Makes connections among mathematical concepts (APS – I.12; NM – IA.6). 5. Recognizes when to use previously learned strategies to solve new problems (APS – I.2; NM – IC.1, IID.2).	3 – 5. The student solves the following problem and justifies his/her work: The angle of elevation 100 feet from the base of a pole to its top is 32°. What is the height of the pole? √ reasoning √ connections √ strategies √ documentation of work AND Most of the illustrations in this strand deal with applying problem-solving techniques and strategies to new situations.
	6. Identifies how seemingly different mathematical situations may be essentially the same (e.g., The intersection of two lines is the same as the solution to a system of linear equations.) (APS – I.13; NM – IA.7, IA.10). 7. Develops a logical sequence of arguments leading to a valid conclusion or solution to a problem (APS – 1.7).	6, 7. The student uses a diagram to visually solve a problem and later a more complex problem, and presents solution to the class to include his/her rationale. As an example the student in the design of his/her robotic project first draws a diagram of the project before he/she starts to build it. √ visual representation √ accuracy √ reasonableness √ effective presentation
	8. Performs operations, converts to standard notation, and applies in appropriate context numbers in scientific notation (APS – II.2E; NM – IA.7).	8, 10. The student solves a variety of problems of the following nature: a) Express in scientific notation 3,200,000. b) Express in decimal form 2.03×10^{-3}. √ accuracy √ comprehension
	9. Uses estimation as a first step in calculations (APS – II.10E). 10. The student develops a deeper understanding of very large and very small numbers and various representations of them (APS – II.1E).	9, 12, 14. In an informal discussion the student gives examples of everyday life situations where an approximation and not an exact answer is adequate (e.g., number of students in attendance at a football game, cost of a new pair of sneakers). From there, the student looks at more precise ways to estimate. An example of such a problem is - estimate to one significant figure 23.57×782. √ individual participation √ real-life examples √ reasonableness √ accuracy of estimations

GRADE 10 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	11. Applies ratios, proportions, and percents in more complex mathematical situations (APS – II.8E; NM – IA.7, ID.2).	11. The student solves a variety of problems of this nature: a) One hundred pounds of force are applied over five square inches of area. What is the pressure? Justify work. b) Ten volts are applied across a resistor in 3mA of current. If the voltage were increased to 15 volts, what would be the resulting current? Justify work. √ accuracy √ understanding of ratios, proportions, and percents √ documentation of work
	12. Demonstrates number sense in solving problems with units and precision (APS – III.8E).	
	13. Performs calculations and conversions with metric units and uses appropriate tools and instruments.	13. The student finds the area of a poster that measures 1.2 m x 90 cm. √ conversion of units √ accuracy
	14. Judges the effects of such operations as multiplication, division, and computing powers and roots on the magnitudes of quantities (APS – II.9E).	
	15. Translates a real-life problem into an expression, equation, inequality, or matrix as a first step in working towards a solution (APS – V.11E; NM – IC.9).	15, 19. The student sets up and solves a system of equations to find the current in and voltage drop across each resistor in a given DC circuit: √ correct equations √ solutions (e.g., accuracy) √ documentation of work
	16. Solves linear equations in one variable (NM – IC.4).	16, 20. The student solves and graphs a variety of equations such as $3(x + 2) = 5x - 4$ and documents work. √ accuracy (e.g., calculations, graphs) √ justification of work
	17. Explains the meaning of and uses common algebraic symbols (APS – V.7E).	17, 21. In the study of robotics the student encounters many mathematical symbols and applies them in a variety of ways. He/She gives an example of the use of a symbol in robotics (e.g., exponents, logarithms) and describes how it is used. √ relevant example √ clear explanation OR The student describes orally or in writing what kind of function represents the voltage across a capacitor as a function of time in a DC circuit.
	18. Manipulates variables in formulas (NM – IA.13).	18. Working with formulas is a common occurrence in any scientific study. The student frequently solves for a given variable in formulas. An example

GRADE 10 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
		follows. Given that power in a circuit is $P = I^2R$ where I represents the current and R represents the resistance, the student solves for I in terms of the other two variables. √ correct manipulation of variables
	19. Creates and solves equations in two or three variables in a variety of ways (e.g., with and without technology) (APS – V.5L; NM – IC.4, IC.5).	
	20. Graphs linear equations (APS – V.12E; NM – IC.4).	
	21. Applies the law of exponents with integers to perform operations on expressions (APS – V.14E; NM – IC.11).	
	22. Identifies the amplitude, period, phase shift, and vertical shift of a graph of a trigonometric function from its equations (APS – V.7L; NM – VB.FS).	22 - 24. The student is given the following scenario to respond to: A musical tone is described by $y = 0.04 \sin 200\pi t - 0.03 \cos 200\pi t$. He/She writes the equation n the form $y = A \sin(Bt + C)$, computes C to three decimal places so that $\|C\|$ is minimum, graphs the equation, and indicates the amplitude, period, frequency, and phase shift. √ all required components √ accuracy √ connections
	23. Graphs more complex trig functions using knowledge of period, phase shift, vertical shift, and amplitude (APS – V.6L; NM – VB.FS).	
	24. Works with everyday problems and applications including integration with other subject areas studied at the same grade level (APS – V.7L, V.8L; NM – VB.F5).	
	25. Solves trigonometric equations by analytical and graphical methods (APS – III.8L; NM – VB. FS).	25, 29. The student solves and graphs $f(x) = 2\sin^2\theta - 3\sin\theta + 1 = 0$; $0 \leq \theta < 2\pi$. √ accuracy √ graphical representation
	26. Changes from degree to radian measure and radian to degree measure (APS – II.11E; NM – IID.5, NM – VB. FS).	26. The student converts a variety of problems (e.g, $7\pi/5$ to degrees or 150° to radians) from degree to radian measure and conversely. √ manipulation of formulas √ accuracy
	27. Uses trigonometry to find areas of triangles (NM – VB).	27. The student finds the area of a triangle for which a = 8, b = 6 and $\angle C = 30°$ in two different ways. (Hint: Use the Law of Cosines to find the length of side c). √ two methods √ application of Law of Cosines √ accuracy

GRADE 10 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	28. Masters the unit circle (NM – VB).	28. The student writes a paragraph describing the relationship of exact values of all six trigonometric functions on the unit circle. Prior to the assignment the class develops a rubric for grading the paragraph. √ relatedness between points √ relationship between the functions √ accuracy √ effective communication √ adherence to criteria
	29. Graphs trigonometric functions using radian measure and their domains and ranges (NM – VB).	29. The student sketches the graphs of trigonometric functions using radians and notes the domain, range, x-intercepts, y-intercepts, and asymptotes of each. He/She uses a graphing calculator to verify figures. √ graphical representations √ identification of required elements √ accuracy

STRAND IV: SAFETY
CONTENT STANDARD: The student exhibits the safe use of equipment and shop practices.

BENCHMARK: The student develops and demonstrates proficiency in shop safety and practice in completion of required activities

GRADE 10 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	1. Exhibits safe tool and machine usage and passes a certification test at a 100% level (CR - 4D). 2. Identifies individual responsibilities and personal traits of safe work habits (CR - 4D). 3. Demonstrates the use and care of appropriate personal protective equipment (WorkKeys). 4. Exhibits proper material handling (e.g., oversized material, lifting, chemicals, electrical hazards (WorkKeys; CR - 4E). 5. Discusses fire prevention and fire safety procedures (CR - 4D). 6. Demonstrates responsive behavior related to safety issues (CR – 4A, 4D, 4E).	1 – 3, 6. The student studies the safety data sheets for each machine to be used and demonstrates proficiency on each machine under teacher supervision. After a teacher demonstration, and before the student demonstrates proficiency on the machine, the student takes a safety test relevant to that machine. The results are kept on file for liability purposes. √ safety practices √ correct use of tools √ appropriate behavior 4. The student demonstrates safe and proper material handling during the construction of a project that has been approved by the instructor. √ safety practices 5. The student identifies locations of all fire extinguishers and exits and demonstrates drill, evacuation, and lock-down procedures. √ correct identification of locations and exits

STRAND V: CAREER READINESS
CONTENT STANDARD: The student develops skills necessary for responsible and ethical workplace behaviors, for effective teamwork, for attainment of project goals, and for marketable skills for future careers.

BENCHMARKS: A. The student develops effective interpersonal leadership, and team skills.
B. The student effectively produces a quality product.
C. The student develops and demonstrates the technological knowledge and skills required for future careers.

GRADE 10 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	Personal Skills 1. Integrates positive behavior, conduct, and social manners (e.g., Character Counts pillars) (CR - 4A). 1. Analyzes and applies appropriate safety standards (CR - 4E). 2. Works cooperatively with others from diverse backgrounds to accomplish goals (CR - 4B, 5C). 4. Identifies and utilizes individual interests, aptitudes, and skills with the group to accomplish goals (CR - 2B, 5A). 5. Demonstrates leadership within a group through effective communication, ability to motivate team members, and effective delegation of responsibilities (CR - 5D). **Production of Quality Product** 6. Identifies goals and required resources, prioritizes activities, and evaluates progress toward achievement of goals within a specified timeline (CR - 2A). 7. Prepares a budget, records costs, and makes adjustments within a specific maximum amount (CR - 2C). 8. Reassesses individual and group skills and makes adjustments in the delegation of responsibilities for efficient progress toward attainable goals (CR - 2B). 9. Demonstrates a high level of effort, patience, and perseverance toward goal attainment (CR - 4C).	1 – 12. As part of a group, the student chooses a final project, plans a timeline, formulates goals, produces a budget, tracks costs, designs, acquires materials, assembles, tests, and presents the project both orally and in written forms. The project incorporates the following concepts: • DC/AC circuitry, • digital circuitry, • sensors, • motors, • microcontrollers, and • usefulness. √ positive behavior and conduct √ safety practices √ cooperation √ delegation of responsibilities √ skills assessments √ leadership qualities √ goal setting with reevaluation if necessary √ budgeting and cost accounts √ effort and perseverance √ demonstration of electronics' knowledge √ usefulness of product √ clearly written presentation √ effective oral presentation √ effective visuals

GRADE 10 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	Technological Knowledge and Skills 10. Demonstrates marketable skills for entry into a post-secondary education training program leading to career fields of interest (CR - 1E, 3D). 11. Explains how technology is used in electronic technology, electrical engineering, or other science and engineering fields (CR - 3A). 12. Demonstrates knowledge of advanced technological systems/computer operations to design, develop, and maintain engineering products (CR - 3B, 3C).	10, 12. The student selects a project (with instructor approval) and completes an assigned activity utilizing the appropriate materials. √ completion of project √ quality of project √ safety practices √ correct use of materials and instruments

STRAND VI: SCIENCE AND SOCIETY
CONTENT STANDARD: The student understands how scientific discoveries, inventions, practices, and knowledge influence and are influenced by individuals and societies.

BENCHMARK: The student examines and analyzes how scientific discoveries and their applications affect the world and explains how societies influence scientific investigations and applications.

GRADE 10 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	1. Knows how science enables technology but also constrains it, and recognizes the difference between real technology and science fiction (e.g., rockets vs. antigravity machines, nuclear reactors vs. perpetual-motion machines, medical X-rays vs. Star-Trek tricorders) (NM – III.I.I.1). 2. Understands how advances in technology enable further advances in science (e.g., microscopes and cellular structure, telescopes and understanding of the universe) (NM – III.I.I.2). 3. Evaluates the influences of technology on society (e.g., communications, petroleum, transportation, nuclear energy, computers, medicine, genetic engineering) including both desired and undesired effects, and including some historical examples (e.g., the wheel, the plow, the printing press, the lightning rod (NM – III.I.I.3). 4. Understands the scientific foundations of common technologies (e.g., kitchen appliances, radio, television, aircraft, rockets, computers, medical X-rays, selective breeding, fertilizers and pesticides, agricultural equipment) (NM – III.I.I.4). 5. Analyzes the impact of digital technologies on the availability, creation, and dissemination of information (NM – III.I.I.6). 6. Describes how scientific knowledge helps decision makers with local, national, and global challenges [e.g., Waste Isolation Pilot Project (WIPP), mining, drought, population growth, alternative energy, climate change] (NM – III.I.I.9).	1 – 8. See Strand I, the illustration for performance standards # 8 – 11.

GRADE 10 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	7. Knows that societal factors can promote or constrain scientific discovery (NM – III.I.I.11). 8. Identifies how science has produced knowledge that is relevant to individual health and material prosperity (NM – III.I.I.15). 9. Understands that scientists have characteristics in common with other individuals (e.g., employment and career needs, curiosity, desire to perform public service, greed, preconceptions and biases, temptation to be unethical, core values including honesty and openness) (NM – III.I.I.18). 10. Knows that science plays a role in many different kinds of careers and activities (e.g., public service, volunteers, public office holders, researchers, teachers, doctors, nurses, technicians, farmers, ranchers) (NM – III.I.I.19).	9, 10. See Strand V, the illustration 10, 12.

STRAND VII: DESIGN/PLAN/LAYOUT/ASSEMBLY
CONTENT STANDARD: The student interprets and implements proper procedures and problem-solving techniques related to proper completion of projects.

BENCHMARK: The student successfully completes a project applying proper design, plan, layout, and assembly techniques and procedures.

GRADE 10 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	1. Designs a robotics project (CR – 1D). 2. Draws a project to the dimensions (CR – 1D).	1, 2, 4, 5. The student successfully completes the design of a robotics project to include a materials list with project costs and stretch out to transfer dimensions. √ completion of project √ accurate dimensions √ accurate cost calculations √ efficiency √ functionality
	3. Applies layout to actual material within acceptable tolerances (WorkKeys; CR – 1D). 4. Demonstrates efficient use of materials (CR – 1D, 2C). 5. Follows materials' list for course projects (CR – 2A, 2C).	3, 4. Using applicable operational and technical documents, the student lays out and cuts materials by choosing correct methods to make a project within acceptable tolerances. √ acceptable tolerances √ accuracy √ application of layout techniques
	6. Assembles robot using machining/tooling process (WorkKeys; CR – 1D).	6. The student fits up and welds the following in a flat position: butt weld, lap weld, tee weld, and edge weld. √ correct assembly processes
	7. Demonstrates proper use of fasteners (e.g., nuts, bolts, rivets) (WorkKeys; CR – 1D).	7. The student threads hammer, handle, and drills and taps hammer head. √ tolerances √ fits √ functionality

STRAND VIII: MACHINING AND TOOLING
CONTENT STANDARD: The student understands the proper use and application of a variety of tools and processing machines.

BENCHMARK: The student demonstrates proper use and maintenances of hand, power, and machine tools and metal processing machines (e.g., welding, foundry).

GRADE 10 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	1. Identifies the hand/hand-held power tools that are used in creating robotic projects (WorkKeys; CR – 1D). 2. Selects the appropriate tool to complete a project (WorkKeys; CR – 1D). 3. Applies machine usage to a project (WorkKeys). 4. Uses machines in combination with each other to produce a project (WorkKeys). 5. Recognizes other related technological machines not found in the classroom (CR – 3A). 6. Gains introductory, working knowledge, procedures in sheet metal operations, welding techniques, and metal fabrication techniques (CR – 1E).	1, 2. Using a variety of tools (e.g., hammer, grinder, files, drills) the student names the tool, describes its function, and in some cases, demonstrates its use. √ accurate identification of tools and functions √ proper handling √ appropriate selection 3, 4, 6. After the teacher demonstrates a particular procedure (e.g., good bead vs. a bad bead), the student practices the procedure. √ finish, size, and tolerances √ uniform bead appearance √ correct tool usage √ use of a combination of tools 5. Through videos and other supplements, the student gains exposure to other technological tools and equipment not found in the classroom and/or school shop. The student participates in class discussion relating what was seen in the videos to possible future practices. √ active participation in discussions √ insights √ effective communication Option: The student writes about what was seen in the videos emphasizing how he/she might use those technological tools in the future.

STRAND IX: LITERACY
CONTENT STANDARD: The student communicates robotic/engineering principles through reading, writing, and speaking opportunities.

BENCHMARK: The student demonstrates proficiency in reading comprehension, specialized vocabulary, and a variety of writing and speaking requirements.

GRADE 10 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	The Language Arts standards addressed in this strand come from the 11th grade sections.	Although the following examples are representative of the indicated performance standards, the student integrates the literacy strategies consistently by reading the text and numerous word problems, taking notes, participating in class discussions, communicating orally or in a written format, and through research. The student is presented with multiple opportunities which are demonstrated in some way in every strand.
	1. Accurately interprets information presented in a technical format (e.g., charts, diagrams, tables) (APS – LA I.7). 2. Uses critical analysis to gain meaning and synthesize ideas (APS – LA II.5).	1, 2. Because some student may be new to the shop environment or have not yet passed the safety tests to work on machines, the student fills out worksheets using the textbook for guidance in answering questions or completing drawings and outlines. √ interpretation of information √ synthesis √ process skills
	3. Demonstrates increased competence and fluency in using the writing process to create a final product (APS – LA III.1).	3, 5. See Strand I, the 1st illustration; Strand III, the illustrations for performance standards # 17, 21 and # 28; Strand V, the 1st illustration; and Strand VIII, the illustration for performance standard # 5.
	4. Demonstrates increased competence and fluency in using a variety of technology (APS – LA III.3). 5. Demonstrates increased competence and fluency in using writing conventions (i.e., grammar, spelling, punctuation, capitalization) (APS – LA III.4).	4, 12. See Strand III, the 1st illustration; Strand V – Career Readiness, the last illustration; and Strand VI – Science and Society.
	6. Participates in group discussions and/or presentations to the class (APS – LA IV.2).	6. Almost any of the illustrations where the student presents orally to a group meets this standard. Specifically, see Strand I, the 1st illustration; Strand II, the 1st and 2nd illustrations; Strand III, the illustration for performance standards # 17, 21; Strand V, the 1st illustration; and Strand VIII, the 1st illustration.

GRADE 10 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	7. Listens to and analyzes mathematical content (APS – LA V.1). 8. Analyzes the work of others for consistency of facts, ideas, clarity, and conciseness (APS – LA V.7). 9. Conducts research, collects data from in-depth field studies (APS – LA VI.1). 10. Obtains and sends information electronically to support advanced research (APS – LA VI.2). 11. Synthesizes and organizes information from a variety of sources to inform and persuade an audience (APS – LA VI.9). 12. Uses a variety of media and technology to research and explain insights to an audience (APS – LA VI.10). 13. Develops presentations by using clear research questions and creative research strategies (e.g., field studies, experiments) (APS – LA VI.11).	7, 8. See Strand VIII, the illustration for performance standard # 5. 9 – 13. See Strand I, the illustration for performance standards # 8 – 11 and Strand III, the 1st illustration.