APS DISTRICT HIGH SCHOOL SCIENCE CURRICULUM FRAMEWORK

Course Title: Electronics Engineering and Robotics I: CEC **District Course Number:** 446C4C

Department: Science **NM STARS Number:** 17814934

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

Length of Course: One Year **Credit/PRI Area:** .50 per Sem /Science **Grade Level(s):** 10 - 12

Important Notes:
The student who takes Engineering Robotics I receives .5 credits per semester –elective pre-engineering science.
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., CAD – designing in a circuit simulation software],
- 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: 02/08

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 changes certain 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). 10. Examines investigations of current interest in science (e.g., superconductivity, molecular machines, age of the universe) (NM-I.I.II.5).	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, • global /local impact, • electrical design, • impact on human interaction, and

	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, Boolean Algebra) (NM-I.I.III.5).	• 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. Identifies, measures and uses a variety of physical and chemical properties (e.g., electrical conductivity, density, viscosity, chemical reactivity, pH, melting point) (NM-II.I.I.2). 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). **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,	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 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.

GRADE 10 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	radio, microwave, X-ray, ultraviolet, gamma) and other waves (e.g., sound, seismic waves, water waves) (NM-II.I.II.8).	✓ proper use of safety equipment ✓ workable circuit ✓ accurate identification ✓ troubleshooting skills
	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).	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. Represents the magnitude and direction of forces by vector diagrams (NM-II.I.III.6).	10. The student's prior mathematical background determines the complexity of he 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
	Motion 11. 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).	11. 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

GRADE 10 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	12. Identifies, measures, and tests electric circuit components (e.g., resistors capacitors, inductors, transistors, LEDs, amplifiers, oscillators, integrated circuits, regulated power supplies) (NM-II.I.II.1).	12. Given a schematic circuit diagram, the student identifies the components, verifies them by measurements (e.g., finds the actual resistance of a resistor with a meter), constructs a circuit, and tests its operation. ✓ correct identification of components ✓ accurate measurements ✓ selection of proper equipment and appropriate lab safety ✓ working circuit verified with appropriate tests
	13. Applies circuit principals (e.g., Ohm's Law, Kirchoff's Law, power formulas) for schematic diagrams and calculations (NM.II.I.III.8).	13. The student analyzes a combinational circuit diagram and determines total input and output through each leg, voltages at various points with respect to ground or between two points, and the power requirements for the components. ✓ appropriate application of Ohm's and Kirchhoff's Laws ✓ accurate calculations ✓ correct choice of power requirements
	14. Explains how electronic components function in AC and/or DC circuits (NM.II.I.III.5).	14. The student describes the voltage biases necessary and current flows through transistors and explains their operation on the atomic level (i.e., p-type and n-type materials) in a DC circuit. ✓ accurate description of necessary voltage biases ✓ correct identification of current flow directions ✓ clear description of transistor properties and operation on the atomic level
	15. Analyzes a circuit diagram and its input/output signals (e.g., power, voltage, current, resistance) (NM.III.I.I.6).	15. Given a digital logic circuit diagram (e.g., counter, R latch, J-K flip-flop), the student predicts the output signal(s) (e.g., high or low) based on the input signal(s). ✓ correct signal progression at each point in the circuit ✓ correct output signal(s)
	16. Understands logic symbols and truth tables for digital logic circuits (NM.III.I.I.4).	16. Given a diagram with a string of logic gates, the student constructs a truth table for the input/output signals. ✓ accurate truth table
	17. Understands the usefulness of sensors (e.g., motion, light, temperature, carbon monoxide, pH, radiation, noise) (NM-III.I.I.4).	17. The student, as part of a small group, constructs a circuit and simple counter that detects motion and moves a digital display up one number. Variations can include a digital thermometer, traffic switching, and light levels. ✓ efficient and neatly laid-out circuit ✓ efficient use of detectors and display

GRADE 10 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	18. Employs scientific trouble-shooting methods in circuit (NM.III.I.I.6).	18. The student uses efficient trouble-shooting techniques to find a fault in a circuit. ✓ portions of circuit divided/isolated ✓ repetition of process to demonstrate an understanding that faults cause voltage/resistance changes

STRAND III: 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 in 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 IV: 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). 2. Analyzes and applies appropriate safety standards (CR - 4E). 3. 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 V: 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 (e.g., Microcontrollers and FPGA's, LASERs and computers) enable further advances in science (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). 7. Knows that societal factors can promote or constrain scientific discovery (NM – III.I.I.11).	1 – 8. See Strand I, the illustration for performance standards # 8 – 11.

GRADE 10 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	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 VI: 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 VII: 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 machine operations and 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 VIII: 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.	NOTE: 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.
	7. Listens to and analyzes mathematical content (APS – LA V.1).	7, 8. See Strand VIII, the illustration for performance standard # 5.

GRADE 10 - 12	PERFORMANCE STANDARDS	ILLUSTRATIONS
	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).	9 – 13. See Strand I, the illustration for performance standards # 8 – 11 and Strand III, the 1st illustration.