LA PUENTE VALLEY
REGIONAL OCCUPATIONAL PROGRAM
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Robotics

Course Outline

COURSE TITLE:	ROBOTICS		
Career Pathway:	Engineering and Architecture	**LPVROP Board Approval**	08/10/10
Articulation:	None	**Advisory Date:**	11/30/15
Total Hours	525		
O-Net Code:	17-302401	**Job Titles:**	
CBED Title & Code:	Robotics – 4647	Electro-Mechanical Technician	
Prerequisites:	None	Mechanical Engineering	
US Department of Education (USDOE) Career Cluster)	Engineering and Technology	Technician	
		Sequence: Introductory	**A-G Approval:** G

COURSE DESCRIPTION:

This course is designed to provide students with classroom and lab experience in current and emerging robotics technology that will empower them to enter employment and/or further education and training. Content standards are based on a task analysis of current industry/occupational standards, including manufacturing technology, basic electricity and electronics, and aerospace technology. Particular emphasis is given to the use of decision-making and problem-solving techniques in applying science, mathematics, communication and other concepts to engineering and technology. Integrated throughout the course are career preparation standards which include; basic academic skills, communication, interpersonal skills, problem solving, safety, technology, and other employment skills.

	SUMMARY COURSE OUTLINE	CR= CLASSROOM	CC=WORKSITE LEARNING	CCTE=COOPERATIVE CAREER TECHNICAL EDUCATION
1.0	Career Preparation	20		
2.0	Overview of Robotics	30	10	
3.0	Design Process/Problem Solving	30	20	
4.0	Modern Robots	35	10	
5.0	Logo Programming	35	10	
6.0	Communication and Teamwork	35	20	
7.0	Robot Construction	35	20	
8.0	Lego Construction	35	20	
9.0	Robot – C	35	15	
10.0	Basic Electricity and Electronics	35	20	
11.0	Mechanical Engineering	35	20	
	Total Hours	**360**	**165**	

COURSE OUTLINE

1.0 Career Preparation

A. Define professionalism, including punctual attendance, positive attitude, responsibility, initiative, honesty and respect for others.
B. Identify appropriate characteristics, attitude and appearance.
C. Understand the importance of prioritizing tasks and meeting deadlines.
D. Display determination, enthusiasm and commitment.

1.1 Understand principles of effective interpersonal skills, including group dynamics, conflict resolution, and negotiation.

A. Use teamwork.
B. Understand laws dealing with sexual harassment in the workplace.

1.2 Understand the importance of good academic skills, critical thinking, and problem-solving skills in the workplace.

A. Recognize the importance of good reading, writing, and math skills.
B. Apply estimation, measurement, and calculation skills on the job.
C. Read, write, give, and follow directions.
D. Apply critical thinking and problem-solving skills in workplace situations.
E. Identify math skills and demonstrate skill and accuracy in measurements.

1.3 Understand principles of effective communication.

A. Communicate effectively orally and in writing.
B. Identify non-verbal communication techniques.

1.4 Understand occupational safety issues and observe safety rules.

A. Identify job site hazards.
B. Describe a safe work environment.
C. Demonstrate safe use of tools and equipment.

1.5 Understand career paths and strategies of obtaining employment.

A. Identify career paths and further training.
B. Apply effective job search skills, including locating employment information. Fill out application forms completely and correctly.
C. Prepare a resume and identify effective interviewing techniques by participating in a mock interview.

1.6 Understand and adapt to changing technology.

A. Uses and maintains equipment appropriately.
B. Understand the importance of lifelong learning in adapting to changing technology.

2.0 Overview of Robotics

2.1 Describe common engineering practices

A. Solve problems by applying principles of mathematics, science and technology.

2.2 History and role of robotics / engineering in our society.

A. Examples of engineering process on American industry.
B. List of major engineering / robotics feats.

COURSE OUTLINE

3.0 Design Process/Problem Solving

3.1 Demonstrate an understanding of the design process and how to solve analysis and design problems.

A. Identify principles that are relevant to a problem
B. Outline the steps in the design process
C. Determine what known information is relevant to a problem
D. Analyze options for the solution of the engineering problem
E. Select between alternate solutions and develop details to justify the choice
F. Translate word problems into mathematical statements
G. Develop the details of one solution
H. Build a prototype from plans and test the prototype
I. Design the prototype based on test data

3.2 Understand how to design a competition based on pre-determined parameters

A. Identify materials/parts available
B. Determine tasks to be achieved with given materials/parts
C. Create a basic set of competition rules

4.0 Modern Robots

4.1 Identify and understand robots in modern society

A. Identify advances in robot technology
B. Understand sensors in modern robots
C. Identify purposes / uses of robots in modern society

5.0 Logo Programming

5.1 Basic Functions

A. Forward/Back
B. Left/Right

5.2 Procedures
5.3 Printing/Saving
5.4 Turtle's Pen

A. Pinup/Pen down
B. Pen erase
C. Pen color/Background color
D. Filling

5.5 Logo Math
5.6 Variables
5.7 Shapes

5.8 Sounds

6.0 Communication and Teamwork

6.1 Demonstrate communication skills necessary in the field of engineering

A. Determine what known information is relevant
B. Understand design documentation and technical reports
C. Write technical reports
D. Make an oral presentation
E. Contribute to the successful completion of a team project

7.0 Robot Construction

7.1 Geometric Strengths
7.2 Connectors
7.3 Plates/Beams
7.4 Pins/Screws

8.0 Lego Programming

8.1 Basic Commands
8.2 Basic Movement
8.3 Speed and Direction
8.4 Sensing

A. Walls
B. Lines
C. Light
D. Sound

8.5 Variables

9.0 Robot – C

9.1 Basic Commands
9.2 Basic Movement
9.3 Speed and Direction
9.4 Sensing

A. Walls
B. Lines
C. Light
D. Sound

9.5 Variables

COURSE OUTLINE

10.0 Basic Electricity and Electronics

10.1 Introduction to electrical concepts and history of electronics

- A. Physics of electrical resistance
- B. Voltage and potential energy
- C. Current and electrical circuits
- D. Energy and energy storage
- E. Electrical power

10.2 Ohm's and Power Law

- A. Apply Ohm's and Watt's Laws
- B. Provide a physical description of inductors and capacitors and describe how they function
- C. Use appropriate electrical units to solve problems
- D. Identify series, parallel, and combination circuits
- E. Draw a circuit diagram and lay out the circuit
- F. Identify the difference between analog and digital signals
- G. Describe the functions of a safety device
- H. Provide examples of common AC and DC systems

10.3 Practical Applications

- A. Learn to select appropriate gage wire with respect to current carrying capacity or "ampacity"
- B. Select and use soldering equipment safely and correctly
- C. Identify, select, and use solderless connectors

11.0 Mechanical Engineering

11.1 Related Physical Science

- A. Simple machines
- B. Mechanical advantage
- C. Energy
- D. Electricity
- E. Forces/Motion/Energy
- F. Work
- G. Rotating mass rings, solid discs, and bars
- H. Power
- I. Friction
- J. Density
- K. Unit and measurement

11.2 Pneumatics

A. List and identify the components of a pneumatic system
B. Explain the function of common pneumatic components
C. Describe safety precautions associated with pneumatic components
D. Provide examples of how a pneumatic system could be used in robot

11.3 Dimensional Measurements

A. Use the standard system of measurement
B. Use steel rules
C. Demonstrate care and use of measuring tools

ANCHOR STANDARDS	
1.0	**Academics**
	Analyze and apply appropriate academic standards required for successful industry sector pathway completion leading to postsecondary education and employment. Refer to the Engineering and Architecture academic alignment matrix for identification of standards.
2.0	**Communications**
	Acquire and accurately use Engineering and Architecture sector terminology and protocols at the career and college readiness level for communicating effectively in oral, written, and multimedia formats. (Direct alignment with LS 9-10, 11-12.6)
2.1	Recognize the elements of communication using a sender–receiver model.
2.3	Interpret verbal and nonverbal communications and respond appropriately.
2.4	Demonstrate elements of written and electronic communication such as accurate spelling, grammar, and format.
2.5	Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
2.6	Advocate and practice safe, legal, and responsible use of digital media information and communications technologies.
3.0	**Career and Planning Management**
3.1	Identify personal interests, aptitudes, information, and skills necessary for informed career decision making
3.2	Evaluate personal character traits such as trust, respect, and responsibility and understand the impact they can have on career success.
3.3	Explore how information and communication technologies are used in career planning and decision making.
3.4	Research the scope of career opportunities available and the requirements for education, training, certification, and licensure.
3.8	Understand how digital media are used by potential employers and postsecondary agencies
3.9	Develop a career plan that reflects career interests, pathways, and postsecondary options.
4.0	**Technology**
4.1	Use electronic reference materials to gather information and produce products and services.
4.5	Research past, present, and projected technological advances as they impact a particular pathway.
4.6	Assess the value of various information and communication technologies to interact with constituent populations as part of a search of the current literature or in relation to the information task.
5.0	**Problem Solving and Critical Thinking**
5.1	Identify and ask significant questions that clarify various points of view to solve problems.
5.2	Solve predictable and unpredictable work-related problems using various types of reasoning (inductive, deductive) as appropriate.
5.3	Use systems thinking to analyze how various components interact with each other to produce outcomes in a complex work environment.
5.4	Interpret information and draw conclusions, based on the best analysis, to make informed decisions.
6.0	**Health and Safety**
6.3	Use health and safety practices for storing, cleaning, and maintaining tools, equipment, and supplies.
6.4	Set up a work area, or shop, to avoid potential health concerns and safety hazards including but not limited to ergonomics, electrical (shock), wires (tripping), fumes (lung health), noise (hearing loss), fire (burns), and so forth, incorporating ergonomics.
6.5	Practice personal safety when lifting, bending, or moving equipment and supplies.

6.6	Demonstrate how to prevent and respond to work-related accidents or injuries and emergencies.
8.0	**Ethics and Legal Responsibility**
8.3	Demonstrate ethical and legal practices consistent with Manufacturing and Product Design sector workplace standards.
8.4	Explain the importance of personal integrity, confidentiality, and ethical behavior in the workplace.
9.0	**Leadership and Teamwork**
9.10	Define leadership and identify the responsibilities, competencies, and behaviors of successful leaders.
9.20	Identify the characteristics of successful teams, including leadership, cooperation, collaboration, and effective decision-making skills, as applied in groups, teams, and career technical student organization activities.
9.30	Understand the characteristics and benefits of teamwork, leadership, and citizenship in the school, community, and workplace setting.
10.0	**Technical Knowledge and Skills**
10.1	Interpret and explain terminology and practices specific to the Engineering and Architecture sector.
10.2	Comply with the rules, regulations, and expectations of all aspects of the Engineering and Architecture sector.
10.3	Construct projects and products specific to the Engineering and Architecture sector requirements and expectations.
11.0	**Demonstration and Application**
11.1	Utilize work-based/workplace learning experiences to demonstrate and expand upon knowledge and skills gained during classroom instruction and laboratory practices specific to the Engineering and Architecture sector program of study.

PATHWAY STANDARDS

B. Engineering Technology Pathway

B1.2	Describe the current industry standards for illustration and layout.
B3.0	Identify the fundamentals of the theory, measurement, control, and applications of electrical energy, including alternating and direct currents.
B3.1	Understand the characteristics of alternating current (AC) and how it is generated; the characteristics of the sine wave; and of AC, tuned, and resonant circuits; and the nature of the frequency spectrum.
B3.2	Analyze relationships between voltage, current, resistance, and power related to direct current (DC) circuits.
B3.3	Calculate, construct, measure, and interpret both AC and DC circuits.
B3.4	Understand how electrical control and protection devices are used in electrical systems.
B3.6	Classify and use various electrical components, symbols, abbreviations, media, and standards of electrical drawings.
B3.8	Predict the effects of circuit conditions on the basis of measurements and calculations of voltage, current, resistance, and power.
B4.0	Demonstrate a cutoff saw operation(s) to produce a length of bar stock to specification.
B4.1	Describe Newton's laws and how they affect and define the movement of objects.
B4.2	Cut one steel bar and one aluminum plate determining the correct or optimal blade material (carbon steel, high speed, or bimetal), the proper saw tooth set to use for each, and explain why.
B5.2	Solve problems by using the concept of vectoring to predict resultants.
B5.3	Compare and explore the six simple machines and their applications.
B5.4	Evaluate how energy is transferred and predict the effects of resistance in mechanical, electrical, fluid, and thermal systems.
B5.5	Formulate and solve problems by using the appropriate units applied in mechanical, electrical, fluid, and thermal engineering systems.
B6.1	Understand the steps in the design process.
B6.2	Determine what information and principles are relevant to a problem and its analysis.
B6.3	Choose between alternate solutions in solving a problem and be able to justify the choices made in determining a solution.
B6.4	Translate word problems into mathematical statements when appropriate.
B6.7	Evaluate and redesign a prototype on the basis of collected test data.
B7.1	Know the structure and processes of a quality assurance cycle.
B7.2	Describe the major manufacturing processes.
B7.3	Use tools, fasteners, and joining systems employed in selected engineering processes.
B7.4	Estimate and measure the size of objects in both Standard International and United States units.
B7.5	Apply appropriate geometric dimensioning and tolerancing (GD&T) practices.
B7.6	Calibrate precision measurement tools and instruments to measure objects.
B8.1	Identify the elements and processes necessary to develop a controlled system that performs a task.
B8.2	Demonstrate the use of sensors for data collection and process correction in controlled systems.
B8.3	Perform tests, collect data, analyze relationships, and display data in a simulated or modeled system using appropriate tools and technology.
B8.4	Program a computing device to control systems or process.
B8.5	Use motors, solenoids, and similar devices as output mechanisms in controlled systems.
B9.1	Understand the process of product development.

PATHWAY STANDARDS

B9.2 Understand decision matrices and the use of graphic tools in illustrating the development of a product and the process involved.

COMMON CORE STANDARDS	
Language Standards	
LS 11-12.1	Demonstrate command conventions of standard English grammar and usage when writing or speaking.
LS 11-12.2	Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.
Reading Standards for Information Text	
RSIT 11-12.2	Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text.
RSIT 11-12.7	Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.
Reading Standards for Literacy in Science and Technical Subjects	
RLST 11-12.2	Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
RLST 11-12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
RLST 11-12.7	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
RLST 11-12.10	By the end of grade 12, read and comprehend science/technical texts in the grades 11-12 text complexity band independently and proficiently.
Writing Standards for Literacy in History/Social Studies, Science and Technical Subjects	
WHSST 11-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
WHSST 11-12.5	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
WHSST 11-12.6	Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.
WHSST 11-12.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
WHSST 11-12.8	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
Algebra – Creating Equations	
A-CED 1	Create equations and inequalities in one variable including ones with absolute value and use them to solve problems in and out of context, including equations arising from linear functions.
A-CED 1.1	Judge the validity of an argument according to whether the properties of real numbers, exponents, and logarithms have been applied correctly at each step. (CA Standard Algebra II - 11.2)
A-CED 2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
A-CED 3	Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.
A-CED 4	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.
Algebra – Reasoning with Equations and Inequalities	
A-REI 1	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

COMMON CORE STANDARDS	
A-REI 2	Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.
A-REI 3	Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.
A-REI 3.A	Solve equations and inequalities involving absolute value. (CA Standard Algebra I - 3.0 and CA Standard Algebra II - 1.0)
A-REI 4	Solve quadratic equations in one variable.
A-REI 4.A	Use the method of completing the square to transform any quadratic equation in x into an equation of the form (x - p)2 = q that has the same solutions. Derive the quadratic formula from this form.
A-REI 4.B	Solve quadratic equations by inspection (e.g., for x2 = 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real numbers a and b.
A-REI 5	Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.
A-REI 6	Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.
A-REI 7	Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line y = -3x and the circle x2 + y2 = 3.
Functions – Interpreting Functions	
F-IF 1	Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).
F-IF 7	Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
F-IF 7.A	Graph linear and quadratic functions and show intercepts, maxima, and minima.
F-IF 7.B	Graph square foot, cube root, and piecewise-defined functions, including step functions and absolute value functions.
F-IF 7.C	Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.
F-IF 7.D	(+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.
F-IF 7.E	Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.
F-IF 8	Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the functions.
F-IF 8.A	Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.
F-IF 8.B	Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as y = (1.02)t, y = (0.97)t, y = (1.01)12t, y = (1.2)t/10, and classify them as representing exponential growth or decay.
Functions – Linear, Quadratic, and Exponential Models	
F-LE 1	Distinguish between situations that can be modeled with linear functions and with exponential functions.
F-LE 1.A	Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.

COMMON CORE STANDARDS	
F-LE 1.B	Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.
F-LE 1.C	Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.
Functions – Trigonometric Functions	
F-TF 1	Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.
F-TFF 1.1	Understand the notion of an angle and how to measure it, in both degrees and radians. Convert between degrees and radians.
F-TF 2	Explain how the unit circle in the coordinate plane enable the extension of trigonometric function to all real numbers, interpreted as radian measure of angles traversed counterclockwise around the unit circle.
F-TF 3	Use special triangles to determine geometrically the values of sine, cosine, tangent for $\pi/3$, $\pi/4$ and $\pi/6$, and use the unit circle to express the values of sine, cosine, and tangent for $\pi - x$, $\pi + x$, and $2\pi - x$ in terms of their values for X, where x is any real number.
F-TF 3.1	Know the definitions of the tangent and cotangent functions and graph them. (CA Standard Trigonometry - 5.0)
F-TF 3.2	Know the definitions of the secant and cosecant functions and graph them. (CA Standard Trigonometry - 6.0)
F-TF 5	Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.
F-TF 6	Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.
F-TF 6.1	Know the definitions of the inverse trigonometric functions and graph the functions. (CA Standard Trigonometry - 8.0)
Geometry – Congruence	
G-CO 12	Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.
G-CO 13	Construct an equilateral trianle, a square, and a regular hexagon inscribed in a circle.
Geometry – Geometric Measurement and Dimensions	
G-GMD 5	Determine how changes in dimensions affect the perimeter, area, and volume of common geometric figures and solids.
Geometry – Modeling with Geometry	
G-MG 3	Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios)
Geometry – Similarity, Right Triangles, and Trigonometry	
G-SRT 1	Verify experimentally the properties of dilations given by a center and a scale factor:
G-SRT 1.A	A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing throught he center unchanged.
G-SRT 1.B	The dilation of a line segment is longer or shorter in the ratio given by the scale factor.
Number and Quantity - Quantities	
N-Q 1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
N-Q 2	Define appropriate quantities for the purpose of descriptive modeling.
N-Q 3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
Number and Quantity – Vector and Matrix Quantities	
N-VM 1	Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., v, lvl, Ilvll, v).

COMMON CORE STANDARDS	
N-VM 2	Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.
N-VM 3	Solve problems involving velocity and other quantities that can be represented by vectors.
N-VM 4	Add and subtract vectors.
N-VM 4.A	Add vectors end-to-end, component-wise and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.
N-VM 4.B	Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.
N-VM 4.C	Understand vector subtraction v – w as v + (-w), where –w is the additive inverse of w, with the same magnitude as w and pointing in the opposite direction. Represent vector subtraction component – wise.
N-VM 5	Multiply a vector by a scalar.
N-VM 5.A	Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplaction component –wise, e.g., as c(vx, vy,) = (cvx2, cvy).
N-VM 5.B	Compute the magnitude of a scalar multiple cv using llcvll = lclv. Compute the direction of cv knowing that when lclv ≠ 0, the direction of cv is either along v (for c > 0) or against v (for c < 0).
N-VM 6	Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.
N-VM 7	Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.
N-VM 8	Add, subtract, and multiply matrices of appropriate dimensions.
N-VM 9	Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties.
N-VM 10	Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.
N-VM 11	Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.
N-VM 12	Work with 2 x 2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.
Statistics and Probability – Interpreting Categorical and Quantitative Data	
S-ID 1	Represent data with plots on the real number line (dot plots, histograms, and box plots).
S-ID 2	Use statistics appropriate to the shape of the data distribution to compare center (median mean) and spread (interuartile range, standard deviation) of two or more different data sets.
S-ID 3	Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).
S-ID 4	Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.
S-ID 5	Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.
S-ID 6	Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

COMMON CORE STANDARDS	
S-ID 6.A	Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.
S-ID 6.B	Informally assess the fit of a function by plotting and analyzing residuals.
S-ID 6.C	Fit a linear function for a scatter plot that suggests a linear association.
Statistics and Probability – Advanced Placement Probability and Statistics	
A-PPS 1	Students solve probability problems with finite sample spaces by using the rules for addition, multiplication, and complementation for probability distributions and understand the simplifications that arise with independent events.
A-PPS 2	Students know the definition of conditional probability and use it to solve for probabilities in finite sample spaces.
A-PPS 3	Students demonstrate an understanding of the notion of discrete random variables by using this concept to solve for the probabilities of outcomes, such as the probability of the occurrence of five or fewer heads in 14 coin tosses.
A-PPS 4	Students understand the notion of a continuous random variable and can interpret the probability of an outcome as the area of a region under the graph of the probability density function associated with the random variable.
A-PPS 5	Students know the definition of the mean of a discrete random variable and can determine the mean for a particular discrete random variable.
A-PPS 6	Students know the definition of the variance of a discrete random variable and can determine the variance for a particular discrete random variable.
A-PPS 7	Students demonstrate an understanding of the standard distributions (normal, binomial, and exponential) and can use the distributions to solve for events in problems in which the distribution belongs to those families.
A-PPS 8	Students determine the mean and the standard deviation of a normally distributed random variable.
A-PPS 9	Students know the central limit theorem and can use it to obtain approximations for probabilities in problems of finite sample spaces in which the probabilities are distributed binomially.
A-PPS 10	Students know the definitions of the mean, median and mode of distribution of data and can compute each of them in particular situations.
A-PPS 11	Students compute the variance and the standard deviation of a distribution of data.
A-PPS 12	Students find the line of best fit to a given distribution of data by using least squares regression.
A-PPS 13	Students know what the correlation coefficient of two variables means and are familiar with the coefficient's properties.
A-PPS 14	Students organize and describe distributions of data by using a number of different methods, including frequency tables, histograms, standard line graphs and bar graphs, stem-and-Ieaf displays, scatterplots, and box-and-whisker plots.
A-PPS 15	Students are familiar with the notions of a statistic of a distribution of values of the sampling distribution of a statistic. And of the variability of a statistic.
A-PPS 16	Students know basic facts concerning the relation between the mean and the standard deviation of a sampling distribution and the mean and the standard deviation of the population distribution.
A-PPS 17	Students determine confidence intervals for a simple random sample from a normal distribution of data and determine the sample size required for a desired margin of error.
A-PPS 18	Students determine the P- value for a statistic for a simple random sample from a normal distribution.
A-PPS 19	Students are familiar with the chi- square distribution and chi- square test and understand their uses.

COMMON CORE STANDARDS	
Life Sciences	
LS 1	From Molecules to Organisms: Structures and Processes
LS1.A	Structure and Function
LS1.B	Growth and Development of Organisms
LS4	Biological Evolution: Unity and Diversity
LS4.B	Natural Selection
Principles of American Democracy and Economics	
AD 12.7	Students Analyze and compare the pwers nd procedures of the national, state, tribal, and local governments
AD 12.75	Explain how public policy is formed, including the setting of the public agenda and implementation of it through regulations and executive orders.
AD 12.8	Students evaluate and take and defend positions on the influence of the media on American political life.
AD 12.82	Describe the roles of broadcast, print, and electronic media, including the Internet, as means of communication in American politics.
AD 12.83	Explain how public officials use the media to communicate with the citizenry and to shape public opinion.
U.S. History and Geography	
US 11.8	Students analyze the economic boom and social transformation of post Word War II America
US 11.87	Describe the effects on society and the economy of technological developments since 1945, including the computer revolution, changes in communication, advances in medicine, and improvements in agricultural technology.
Scientific and Engineering Practices	
SEP 1	Asking questions (for science) and defining problems (for engineering)
SEP 2	Developing and using models
SEP 3	Planning and carrying out investigations
SEP 4	Analyzing and interpreting data
SEP 5	Using mathematics and computational thinking
SEP 6	Constructing explanations (for science) and designing solutions (for engineering)
SEP 7	Engaging in argument from evidence
SEP 8	Obtaining, evaluating, and communicating information
Crosscutting Concept	
CC 1	Patterns
CC 2	Cause and effect: Mechanism and explanation
CC 3	Scale, proportion, and quantity
CC 4	Systems and system models
CC 5	Energy and matter. Flows, cycles, and conservations
CC 6	Structure and function

COMMON CORE STANDARDS	
CC 7	Stability and change
Physical Sciences	
PS 1	Matter and Its Interactions
PS 1.A	Structure and Properties of Matter
PS 1.B	Chemical Reactions
PS 1.C	Nuclear Processes
PS 2	Motion and Stability: Forces and Interactions
PS 2.A	Forces and Motion
PS 2.B	Types of interactions
PS 2.C	Stability and Instability in Physical Systems
PS 3	Energy
PS 3.A	Definitions of Energy
PS 3.B	Conservation of Energy and Energy Transfer
PS 3.C	Relationship Between Energy and Forces
PS 3.D	Energy in Chemical Processes and Everyday Life
PS 4	Waves and Their Applications in Technologies for Information Transfer
PS 4.A	Wave Properties
PS 4.B	Electromagnetic Radiation
PS 4.C	Information Technologies and Instrumentation
Earth and Space Sciences	
ESS 2	Earth's Systems
ESS 2.A	Earth Materials and Systems
ESS 2.B	Plate Tectonics and Large-Scale System Interactions
ESS 2.C	The Roles of Water in Earth's Surface Processes
ESS 2.D	Weather and Climate
ESS 2.E	Biogeology
ESS 3	Earth and Human Activity
ESS 3.A	Natural Resources
ESS 3.B	Natural Hazards
ESS 3.C	Human Impacts on Earth Systems
ESS 3.D	Global Climate Change
Engineering, Technology, and Application of Science	
ETS 1	Engineering Design
ETS 1.A	Defining and Delimiting an Engineering Problem

COMMON CORE STANDARDS	
ETS 1.B	Developing Possible Solutions
ETS 1.C	Optimizing the Design Solution
ETS 2	Links Among Engineering, Technology, Science, and Society
ETS 2.A	Interdependence of Science, Engineering, and Technology
ETS 2.B	Influence of Engineering, Technology, and Science on Society and the Natural World
Principles of American Democracy and Economics	
AD 12.3	Students evaluate and take and defend positions on what the fundamental values and principles of civil society are (i.e., the autonomous sphere of voluntary personal, social, and economic relations that are not part of government), their Interdependence, and the meaning and importance of those values and principles for a free society.
AD 12.7	Students Analyze and compare the powers and procedures of the national, state, tribal, and local governments
AD 12.75	Explain how public policy is formed, including the setting of the public agenda and implementation of it through regulations and executive orders.

Principles of Economics	
PE 12.1	Students understand common economic terms and concepts and economic reasoning.
PE 12.1.4	Evaluate the role of private property as an incentive in conserving and improving scarce resources, including renewable and nonrenewable natural resources.
PE 12.2	Students analyze the elements of America's market economy in a global setting.
PE 12.6	Students analyze issues of international trade and explain how the U.S. economy affects, and is affected by economic forces beyond the United States borders.
U.S. History and Geography	
US 11.2	Students analyze the relationship among the rise of industrialization, large-scale rural-to-urban migration, and massive immigration from Southern and Eastern Europe.
US 11.5	Students analyze the major political, social, economic, technological, and cultural developments of the 1920s.
US 11.5.7	Discuss the rise of mass production techniques, the growth of cities, the impact of new technologies (e.g., the automobile, electricity), and the resulting prosperity and effect on the American landscape.
US 11.6	Students analyze the different explanations for the Great Depression and how the New Deal fundamentally changed the role of the federal government.
US 11.6.4	Analyze the effects of and the controversies arising from New Deal economic policies and the expanded role of the federal government in society and the economy since the 1930s (e.g., Works Progress Administration, Social Security, National Labor Relations Board, farm programs, regional development policies, and energy development projects such as the Tennessee Valley Authority, California Central Valley Project, and Bonneville Dam).
US 11.8	Students analyze the economic boom and social transformation of post-World War II America.
US 11.11	Students analyze the major social problems and domestic policy issues in contemporary American society.
World History	
WH 10.3	Students analyze the effects of the Industrial Revolution in England, France, Germany, Japan, and the United States.
WH 10.11	Students analyze the integration of countries into the world economy and the information, technological, and communications revolutions (e.g., television, satellites, and computers).

ROP/CTE RECOMMENDED COURSE SEQUENCE

Introductory	Concentrator	Capstone
Robotics	Pre-Engineering	Applied Engineering
		Engineering manufacturing Technology

COURSE RESOURCES

Textbooks

Title	Author	Publisher	Primary (Y/N)
7 habits of Highly Effective Teens	Steven Covey	Simon & Schuster	Yes
Century 21 Accounting	Claudia Bienias Gilbertson, CPA; Mark Lehman, CPA; Kenton Ross, CPA	Thomson- SouthWestern	Yes
Business Management	James L. Burrow, Ph.D.; Brad A. Kleindl, Ph.D	Cengage Learnings	Yes
Other Resources			
Title	**Author**	**Website**	
How the Market Works.com StockTrak	How the Market Works.com StockTrak	How the Market Works.com StockTrak	
Future Business Leaders of America National Website	Laura Morgan	www.fbla.org	
California Future Business Leaders of America	Sue Christensen	www.cafbla.org	
The Stock Market Game	Melanie Mortimer	stockmarketgame.com	
iGrad Financial Literacy for College Students and Recent Graduates	Anna Stoefen, Kris Alban	www.iGrad.com	
H & R Block Budget Challenge	ProperLiving, LLC.	h&rbudgetchallenge.com	
Practical Money Skills for Life	Jim Charkins, Ph.D	http://www.practicalmoneyskills.com/personalfinance/	
Knowledge @ Wharton High School	Michael R. Gibbons, Mukul Pandya, Robbie W. Shell, Steve Guglielmi, Rachel Kipp, Diana Drake	http://kwhs.wharton.upenn.edu/	
California Career Zone	Iradix Consulting	www.cacareerzone.org	