Silicon Valley
Career Technical Education

AI Engineering

Course Outline

Course Description

Silicon Valley CTE's 519-hour, year-long Applied AI course is a beginning AI and computer programming course. This year-long laboratory science course introduces artificial intelligence as a computational science grounded in scientific inquiry, data analysis, and mathematical modeling. The main objective is to design and develop intelligent systems using modern machine learning techniques, which students investigate, test, and refine through hypothesis-driven experimentation and evidence-based reasoning.
The course has three main sections:

(1) Foundations, including mathematics for AI, Python programming, data analysis, and essential development tools like Git and Jupyter notebooks used as tools for scientific investigation and quantitative analysis;

(2) Core AI concepts, including supervised and unsupervised learning, key algorithms such as linear regression, logistic regression, decision trees, and Naive Bayes, plus neural networks and deep learning fundamentals, examined as scientific models for prediction and classification;

(3) Applied AI projects using computer vision, natural language processing for chatbots and text classifiers, supported by structured laboratory investigations and data-driven evaluation. Ethical AI practices are integrated throughout, including analysis of bias, reliability, limitations, and real-world impacts. The course aligns with NGSS Scientific and Engineering Practices, emphasizing modeling, data analysis, and argument from evidence.

Board Approved, 12/10/25

Silicon Valley Career Technical Education

Course Details

Length of Program and Academic Credits Earned:
Year-long 3 hour course = 519 hours total (~261/semester) 30 total units (15/semester):

- 20 non-a–g elective credits (10/semester)
- 10 UC a-g "d" elective credits (5/semester)

Pre-Requisites:

- High School Junior or Senior, or 16 years or older

CTE Classification:

- **Industry Sector:** Information and Communication Technologies
- **Industry Pathway:** Software and Systems Development
- **CA Basic Education Data System (CBEDS) Code:** 4616

Work Based Learning:

- Guest speakers
- Field trips

Certifications & State Tests:
SVCTE Certificate of Completion awarded with "C" or better average for both semesters.

Possible Education & Career Pathways

College & Career Pathways:	Career Opportunities	O*NET Codes
Post-Secondary: Students with a high school diploma and having successfully completed this course have a number of entry-level career opportunities, as well as continuing their education	• AI/ML Technician • Data Analyst • Junior Data Scientist	15-1299.08 15-2051.00 15-2051.01
Community College Majors & Degrees: • AA, AS or certificate in Computer Science • AA, AS or certificate in Data Science • AA, AS or certificate in Artificial Intelligence • AA, AS or certificate in Machine Learning	• Data Analyst • AI/ML Technician • Computer Programmer • Junior Data Scientist	15-2051.00 15-1299.08 15-1131.00 15-2051.01

University Majors & Degrees: ● BA or BS in Computer Science ● BA or BS in Data Science ● BA or BS in Artificial Intelligence	● Data Scientist 15-2051.01 ● Machine Learning Engineer 15-1299.08 ● Computer Programmer 15-1131.00 ● AI Research Scientist 19-1029.01 ● Software Developer 15-1132.00 ● Computer Programmer 15-1131.00
Post-Baccalaureate Degrees ● MA or MS in Computer Science ● MA or MS in Artificial Intelligence	● Data Scientist 15-2051.01 ● Machine Learning Engineer 15-1299.08 ● AI Research Scientist 19-1029.01 ● Software Developer 15-1132.00 ● Research Data Analyst 15-2051.00

Unit 1: Career Readiness & Professionalism — 3.4 weeks (51 hours)

Students will develop personal and professional skills in the classroom that will transfer to the workplace.

- Time management and organization
- Interpersonal skills
- Work with a variety of technology
- Creative thinking and problem solving
- Job search skills including: resume, job applications and effective interview skills

Students will write resumés, explore college and career options, investigate FAFSA, participate in class, and demonstrate employable demeanor and attire in class.

- Resumé writing in several different formats
- College and career workshops
- Team collaboration/empathy

Course Competencies Addressed in this Unit:
1.1, 1.2, 1.3,

Standards Alignments:

CCSS: LS 11-12.1, 11-12.2, 11-12.3, 11-12.6; **WS** 11-12.4, 11-12.5, 11-12.6

Key Assignments	CTE Anchor Standards	CTE Pathway Standards
✓ **Key Assignments:** Students will write their resumes in a printable format such as Pages, MS Word, or Google Docs. **Assessment:** rubric, observation, peer and self- assessment.	2.4, 2.5, 2.7, 2.8, 3.0, 7.0, 8.0	
✓ **Key Assignments:** Students will participate in paired mock interviews where they practice answering both behavioral questions (teamwork, problem-solving scenarios) and technical questions. **Assessment:** rubric, observation, peer and self- assessment.	2.4, 2.5, 2.7, 2.8, 3.0, 7.0, 8.0	
✓ **Key Assignments:** Students will complete individual portfolios that demonstrate their technical skills, including case studies, resumes and other writing samples. **Assessment:** rubric, observation, peer and self- assessment	2.4, 2.5, 2.7, 2.8, 3.0, 7.0, 8.0, 11.5	

Unit 2: Language Skill Development and Research Skills — 2.2 weeks (36 hours)

Students will perform research, read articles, write coherent summaries or responses.

- Python documentation and libraries (NumPy, Pandas, Scikit-learn, TensorFlow)
- AI/ML research platforms (Kaggle, Papers with Code, arXiv)
- Developer communities and forums (Stack Overflow, GitHub Discussions, Reddit ML communities)
- Popular general search engines (e.g Google)
- AI ethics resources and case studies

Standards Alignments:

CCSS: LS 11-12.1, 11-12.2, 11-12.6; **RSIT** 11-12.1; **WS** 11-12.3, 11-12.6; **SLS** 11-12.1 A, B, C, D, 11-12.2, 11-12.3, 11-12.4, 11-12.5, 11-12.6

Key Assignments	CTE Anchor Standards	CTE Pathway Standards
✓ **Key Assignments:** Students will create technical documentation, Jupyter notebooks, and project reports that use appropriate technical language and have proper grammar, spelling, and punctuation. Documentation will include code comments, explanations of algorithms, and analysis of results **Assessment:** rubric, observation	2.4, 2.5, 2.7, 2.8, 5.0	

✓ **Key Assignments:** Students will write project proposals identifying real-world problems that could be solved with AI/ML, including problem statements, target audiences or beneficiaries, required datasets, proposed algorithms, and ethical considerations. **Assessment:** rubric, observation	2.4, 2.5, 2.7, 2.8, 5.0	C 2.3, C 2.4, C 2.5
✓ **Key Assignments:** Students will read and summarize current AI research articles or case studies, explaining key findings, methodologies, and implications in accessible language for non-technical audiences. **Assessment:** rubric, written summary	2.4, 2.5, 2.7, 2.8, 5.0	C 2.3, C 2.4

Unit 3: Mathematics Modeling for Scientific Predication For AI — 2.6 weeks (39 hours)

Students will explore how data, features, and labels form the foundation of artificial intelligence systems, learning how mathematical models and coding structures work together to recognize patterns, make predictions, and analyze real-world problems through algebraic reasoning, geometry, probability, and statistics. Students investigate how mathematical models are used in science to represent and predict real-world phenomena. Through controlled experiments, students test how changes in variables affect model accuracy and reliability. Students build and interpret linear, polynomial, and logistic regression models, visualize geometric relationships in data, analyze distributions to assess accuracy and identify bias, and use vectors and matrices to represent multi-dimensional data. They examine how Python variables, functions, and logic reflect underlying mathematical structures and justify solutions by comparing predicted to observed results.

CCSS: A-SSE, A-REI, G-GPE, S-ID, S-IC, S-CP; AD 12.8.2, 12.8.3; **WH** 10.11

Key Assignments	CTE Anchor Standards	CTE Pathway Standards
✓ **Key Assignments:** Individually, students will demonstrate their understanding of algebra, geometry, probability, and statistics as applied to machine learning by solving a series of math problems. Model Construction Analysis, Prediction Accuracy Comparison, and Scientific Explanation Task, where students construct models, evaluate prediction accuracy, and justify model selection using quantitative evidence. **Assessment:** rubric, observation	4.0, 6.0, 10.0	C 2.2
✓ **Lab-Regression Models & Prediction Accuracy:** Students will conduct an experiment using a dataset of their choice, apply linear, polynomial, and logistic regression models, compare predictions to actual results, and analyze which model provides the most accurate fit. Laboratory Investigations: Regression Modeling Lab, where students design experiments to test linear, polynomial, and logistic regression	4.0, 6.0, 10.0	C 2.2

models on datasets, analyze accuracy using statistical measures, and use evidence to support conclusions. Ethical AI practices are integrated throughout, including evaluation of bias, reliability, limitations, and real-world impacts. The course aligns with NGSS Scientific and Engineering Practices, emphasizing modeling, data analysis, and argument from evidence. Topics to include: ● Compare how different regression types (linear, polynomial, logistic) fit a given dataset ● Describe how prediction accuracy is measured using statistical tools (RMSE, error residuals, R^2) ● Discuss how model structure influences the accuracy, bias, and generalization of predictions **Assessment:** rubric, quiz, coding assessment, observation, peer and self assessment		

Unit 4: Computational Tools for Scientific Investigation — 2.6 weeks (39 hours)

Students will learn essential programming tools and environments used in Artificial Intelligence and software development. Students use computational tools to conduct scientific investigations, document experimental procedures, and analyze results. Emphasis is placed on reproducibility and accuracy.

- Use Python to write, run, and debug code.
- Open and edit Jupyter Notebooks to document, test, and visualize code and output.
- Use the Mac Terminal to navigate directories, create folders, and run Python programs from the command line.
- Apply Git commands to track changes and manage version control.
- Use GitHub to upload, share, and collaborate on coding projects.
- Understand basic file organization and best practices for managing project repositories.

Standards Alignments: **CCSS: AD** 12.8.2, 12.8.3; **WH** 10.11

Key Assignments	CTE Anchor Standards	CTE Pathway Standards
✓ **Key Assignments:** Individually, students will demonstrate their understanding of Mac Terminal and its commands by creating a maze of directories with a file to distinguish the end of the maze. Model Construction Analysis, Prediction Accuracy Comparison, and Scientific Explanation Task, where students construct models, evaluate prediction accuracy, and justify model selection using quantitative evidence. **Assessment:** rubric, observation, peer assessment	12.8.2, 12.8.3	WH 10.11
✓ **Key Assignments:** Students will learn to initialize a Git repository, make commits, and push their work to GitHub. They will practice using git add, git commit, and git push commands to update their project repository.	2.2, 4.0, 10.0	B1.2, B1.3, B2.1

Assessment: rubric, observation,		
✓ **Key Assignments:** Students will define variables, use operators to perform addition, subtraction, multiplication, and division, and display the results using print() statements. **Assessment:** rubric, observation,	2.2, 4.0, 10.0	B1.2, B2.1

Unit 5: Introduction to AI & Ethics — 3 weeks (45 hours)

Students will explore what artificial intelligence is, how it works, and the ethical implications of its use in society. Students explore artificial intelligence as a scientific system and examine ethical considerations as part of scientific evaluation. Bias and fairness are analyzed as measurable properties of models. They will examine real-world AI applications, analyze potential biases, and evaluate the social, economic, and legal consequences of AI decisions.

- Explain the basic components of AI systems (data, models, algorithms).
- Analyze case studies of AI applications in different industries (healthcare, finance, autonomous vehicles).
- Identify ethical concerns such as bias, privacy, transparency, and accountability in AI systems.
- Debate potential consequences of AI decision-making and propose responsible solutions.
- Apply scientific reasoning to evaluate the reliability, fairness, and accuracy of AI predictions.
- Collaborate in teams to evaluate sample AI scenarios and propose solutions to reduce bias and increase fairness.

Standards Alignments: **CCSS: AD** 12.8.2, 12.8.3; **WH** 10.11

Key Assignments	CTE Anchor Standards	CTE Pathway Standards
✓ **Key Assignments:** Students will analyze a real-world AI ethics case study involving bias or fairness (e.g., facial recognition, hiring algorithms, or predictive policing). Case Study Analysis: Students analyze an AI system and identify sources of bias using data-driven evidence. **Assessment:** rubric, observation	2.2, 4.0, 5.0, 7.0, 10.0	B3.1, B3.3
✓ **Key Assignments:** They will identify the source of bias, explain how it affects outcomes, and propose methods to reduce or eliminate the bias through responsible AI practices. Scientific Argument Writing: Students construct arguments evaluating the reliability and fairness of a model. **Assessment:** rubric, observation	2.2, 4.0, 5.0, 7.0, 10.0	B3.1, B3.3

✓ **Lab – AI Ethics Workshop:** Students will explore ethical challenges in AI, analyze real-world scenarios, and propose strategies to reduce bias and improve fairness in algorithmic decision-making. Ethics Evaluation Report: Students propose scientifically grounded strategies to reduce bias decision-making. Topics to include: ● Sources of bias in AI systems ● Evaluation of fairness in AI applications ● Ethical frameworks and industry guidelines for responsible AI ● Strategies for reducing bias and increasing transparency **Assessment:** rubric, observation, group presentation	2.2, 4.0, 5.0, 7.0, 10.0	

Unit 6: Data & Machine Learning Basics — 4 weeks (60 hours)

Students will be introduced to the foundational concepts of machine learning and how data is used to train models.

- Understand the difference between supervised and unsupervised learning and identify examples of each.
- Learn how regression is used to predict continuous values and how classification is used to group data into categories.
- Explore how datasets are split into training and testing sets and how model accuracy is evaluated.
- Interpret data patterns through visualizations such as scatter plots and decision boundaries.
- Examine real-world applications of machine learning, including prediction, recommendation, and pattern recognition systems.

Standards Alignments:
CCSS: AD 12.8.2, 12.8.3; **WH** 10.11

Key Assignments	CTE Anchor Standards	CTE Pathway Standards
✓ **Key Assignments:** They will determine whether the problem is best suited for regression or classification and justify their reasoning. **Assessment:** rubric, observation, and self- assessment	2.2, 4.0, 10.0	B1.3, B2.1, B2.2
✓ **Key Assignments:** Students will explore a sample dataset to identify features (inputs) and labels (outputs). Ethics Evaluation Report: Students propose scientifically grounded strategies to reduce bias. **Assessment:** rubric, observation, and self- assessment	2.2, 4.0, 10.0	B1.3, B2.1, B2.2

✓ **Lab-Data Modeling & Analysis:** Students will work with real or simulated datasets to explore the relationships between variables, test hypotheses, and understand how different data features influence predictions. They will pose questions, design experiments, analyze results, and communicate their findings scientifically. Topics to include: ● Explain how mathematical models represent relationships between variables ● Data features, labels, and structure ● Correlation, regression, and basic predictive modeling ● Accuracy, error, and model evaluation ● Scientific reasoning in interpreting results **Assessment:** rubric, quiz,observation, peer and self assessment		

Unit 7: Core Machine Algorithms — 7.2 weeks (108 hours)

Students will explore the fundamental algorithms that form the foundation of machine learning and Artificial Intelligence and experimentally analyze and compare machine learning algorithms to determine their strengths, limitations, and appropriate scientific applications.

- Students will explore the fundamental algorithms that form the foundation of machine learning and Artificial Intelligence.
- Examine decision trees as models that split data based on features to make step-by-step predictions.
- Understand how Naive Bayes applies probability and statistics to make predictions based on prior likelihoods.
- Explore k-Nearest Neighbors (k-NN) and how it uses distance and similarity to classify or predict outcomes.
- Compare algorithm strengths, weaknesses, and best-use scenarios.

Standards Alignments:
CCSS: A-REI 1, 2; **F-IF** 4; **F-LE** 6; **C** 5; **G-GPE** 4, 5, 6; **G-MG** 1, 3; **N-Q** 1, 2, 3; **N-CN** 4, 5, 6; **S-ID** 1; **S-MD** 1, 6;
NGSS: SEP 1, 2, 3, 4, 5, 6, 7, 8; **ESS** 3-6; **PS** 2-1, 2, 3, 4, 5, 6; 3-2; 4-1,3,4,5

Key Assignments	CTE Anchor Standards	CTE Pathway Standards
✓ **Key Assignments:** Algorithm Comparison Study: Students compare multiple machine learning algorithms using identical datasets to evaluate performance, strengths, and limitations. Students use real data to explore how different algorithms (k-NN, Decision Tree, Naive Bayes, Logistic Regression) classify objects based on features. **Assessment:** rubric, observation	1.0, 4.0, 5.0, 10.0	C 4.6, C 4.7, C 4.9, C 7.5

✓ **Key Assignments**: Evidence-Based Evaluation: Students evaluate which algorithm best represents the system being studied, justifying their conclusions using quantitative evidence, prediction accuracy, and model behavior. **Assessment***:* rubric, observation ✓ **Key Assignments**: Scientific Presentation: Students present their findings using data visualizations and quantitative evidence to communicate algorithm performance and scientific conclusions. **Assessment***:* presentation rubric, peer and self-assessment		
✓ **Lab-Algorithm Olympics:** Students design and conduct controlled experiments testing algorithm performance under varied conditions. Students will participate in an "Algorithm Olympics," where each small team represents an algorithm (k-NN, Decision Tree, Logistic Regression, Naive Bayes). Instead of individually testing algorithms, students become experts on one algorithm and then compete as they run the same dataset. Topics to include: ● Explain how mathematical models represent relationships between variables ● Compare how different regression types (linear, polynomial, logistic) fit a given dataset ● Describe how prediction accuracy is measured using statistical tools (RMSE, error residuals, R^2) ● Discuss how model structure influences the accuracy, bias, and generalization of predictions ● Use evidence from data to support conclusions about which model best represents the system being studied **Assessment:** rubric,observation, peer and self assessment, presentation		

Unit 8: Neural Networks & Computer Vision as Scientific Models — 6.6 weeks (99 hours)

Students will explore how neural networks are designed to recognize patterns and make predictions similar to the human brain and investigate neural networks as scientific models that simulate pattern recognition, with emphasis on testing, refinement, and evaluation.

- Understand the structure of a neural network, including input, hidden, and output layers.
- Learn how neurons, weights, and activation functions work together to detect patterns in data.
- Experiment with simple examples of image classification to understand how computers "see" and interpret pixels.
- Use Python and image libraries (such as TensorFlow, Keras, or Teachable Machine exports) to classify images into categories.
- Visualize how neural networks adjust weights through training and backpropagation and analyze how parameter changes affect model performance.
- Identify common challenges such as overfitting, underfitting, and data bias and sources of error in neural network models.
- Evaluate accuracy, precision, and recall to scientifically assess model performance
- Explore real-world applications, including facial recognition, self-driving cars, and medical imaging.

- Reflect on ethical considerations and the importance of fairness and privacy in visual AI systems.

Standards Alignments:
CCSS: A-REI 1, 2; F-IF 4; F-LE 6; C 5; G-GPE 4, 5, 6; G-MG 1, 3; N-Q 1, 2, 3, N-CN 4, 5, 6; S-ID 1, S-MD 1, 6
NGSS: SEP 1, 2, 3, 4, 5, 6, 7, 8; ESS 3-6; PS 2-1, 2, 3, 4, 5, 6; 3-2; 4-1,3,4,5

Key Assignments	CTE Anchor Standards	CTE Pathway Standards
✓ **Key Assignments:** Students will fine-tune or use a pre-trained model to classify 2–3 image categories (e.g., school supplies). They will produce report accuracy, precision, and recall. **Assessment:** rubric, observation, peer feedback ✓ **Key Assignments:** Computer Vision Experiment: Students conduct experiments classifying images using computer vision models and analyze performance metrics to evaluate strengths, limitations, and sources of error.	2.2, 4.0, 5.0, 10.0	B1.3, B2.1, B2.2, B3.1
✓ **Key Assignments:** Students will collect real driving data from their robot to train or improve an existing AI driving model. ✓ **Key Assignments:** Scientific Reflection: Students explain limitations, sources of error, and model constraints in neural network systems and reflect on ethical considerations such as bias, fairness, and privacy in visual AI applications. **Assessment:** observation, demonstration	2.2, 4.0, 5.0, 10.0	B1.3, B2.1, B2.2, B3.1
✓ **Key Assignments:** Students will apply principles of artificial intelligence, computer vision, and robotics to program a self-driving car. **Assessment:** rubric, observation, demonstration	2.2, 4.0, 5.0, 10.0	B1.3, B2.1, B2.2, B3.1

Unit 9: Natural Language Processing and Scientific Interpretation — 7 weeks (45 hours)

Students will explore how computers understand and generate human language using Natural Language Processing (NLP) techniques and examine NLP as a scientific approach to modeling language patterns through experimentation, evaluation, and interpretation.

- Understand how text data is represented numerically through tokenization, word embeddings, and vectorization.
- Learn how algorithms analyze language to perform tasks such as text classification, sentiment analysis, and keyword extraction.
- Experiment with Python libraries such as NLTK, spaCy, or Hugging Face Transformers to process and analyze real-world text.
- Build small projects that demonstrate how AI can summarize articles, predict sentiment, or identify topics in large datasets.
- Analyze model effectiveness by comparing classification results, accuracy, and error rates.
- Examine ethical considerations, including bias in language models, misinformation, and responsible use of generative AI.
- Reflect on how NLP powers technologies like chatbots, translation, and voice assistants, and its impact on modern communication.
- Interpret results scientifically and discuss model limitations and sources of error.

Standards Alignments:
CCSS: AD 12.8.2, 12.8.3; **WH** 10.11

Key Assignments	CTE Anchor Standards	CTE Pathway Standards
✓ **Key Assignments:** Students will write a Python program that cleans and tokenizes text and numerically represent text using tools such as NLTK or spaCy. They analyze how text features (tokens, TF-IDF, embeddings) affect model performance and evaluate effectiveness using evidence from results. **Assessment:** rubric, observation	2.2, 4.0, 5.0, 10.0	B1.3, B2.1, B2.2, B3.1
✓ **Key Assignments:** Students will train a simple Naive Bayes or Logistic Regression classifier to categorize text (e.g., news topics or spam detection). They compare classification outcomes, analyze accuracy and error rates, and justify conclusions using quantitative evidence. **Assessment:** rubric, observation	2.2, 4.0, 5.0, 10.0	B1.3, B2.1, B2.2, B3.1
✓ **Key Assignments:** Students will explore natural language processing, learning how computers interpret text and experimenting with algorithms for sentiment analysis, text classification, and language generation. Students interpret NLP classification results, explain limitations and sources of error in language models, and discuss ethical considerations such as bias, sensitive content handling, and responsible AI use. Topics to include: • Text preprocessing (tokenization, stop-word removal, stemming/lemmatization)		

• Feature extraction from text (bag-of-words, TF-IDF, embeddings) • Simple NLP algorithms (Naive Bayes, Logistic Regression, or neural embeddings) • Ethical considerations in NLP (bias in text data, sensitive content handling) **Assessment:** rubric, observation Laboratory Investigation ✓ **Lab:** NLP Classification Lab: Students design and conduct an experiment classifying text using NLP algorithms. They preprocess data, select features, evaluate outcomes using accuracy metrics, and use scientific reasoning to explain results and limitations.		

Instructional Materials

Textbooks:

The Fundamentals of Artificial Intelligence
Dr. Nisha Talagala | Dr. Sindhu Ghanta
ISBN: 9-79879-577759-4

Standards Assessed in this Course

CTE Anchor Standards

1.0 Academics: Academics standards are aligned to pathways; see below.
2.0 Communications: Acquire and use accurate sector terminology and protocols at the career and college readiness level for communicating effectively in oral, written, and multimedia formats.
3.0 Career Planning and Management: Integrate multiple sources of career information from diverse formats to make informed career decisions, solve problems, and manage personal career plans.

4.0	Technology: Use existing and emerging technology, to investigate, research, and produce products and services, including new information, as required in the sector workplace environment.
5.0	Problem Solving and Critical Thinking: Conduct short, as well as more sustained, research to create alternative solutions to answer a question or solve a problem unique to the sector using critical and creative thinking, logical reasoning, analysis, inquiry, and problem-solving techniques.
6.0	Health and Safety: Demonstrate health and safety procedures, regulations, and personal health practices and determine the meaning of symbols, key terms, and domain-specific words and phrases as related to the sector workplace environment.
7.0	Responsibility and Flexibility: Initiate, and participate in, a range of collaborations demonstrating behaviors that reflect personal and professional responsibility, flexibility, and respect in the sector workplace environment and community settings.
8.0	Ethics and Legal Responsibilities: Practice professional, ethical, and legal behavior, responding thoughtfully to diverse perspectives and resolving contradictions when possible, consistent with applicable laws, regulations, and organizational norms.
9.0	Leadership and Teamwork: Work with peers to promote divergent and creative perspectives, effective leadership, group dynamics, team and individual decision making, benefits of workforce diversity, and conflict resolution.
10.0	Technical Knowledge and Skills: Apply essential technical knowledge and skills common to all pathways in the sector following procedures when carrying out experiments or performing technical tasks.

Information and Communication Technologies Sector — Software and Systems Development Pathway Standards

C1.0	**Identify and apply the systems development process.**
C1.1	Identify the phases of the systems development life cycle, including analysis, design, programming, testing, implementation, maintenance, and improvement.
C1.2	Identify and describe models of systems development, systems development life cycle (SDLC), and agile computing.
C1.3	Identify and describe how specifications and requirements are developed for new and existing software applications.
C1.4	Work as a member of, and within the scope and boundaries of a development project team.
C1.5	Track development project milestones using the concept of versions.
C1.6	Diagram processes using flowcharts and the Unified Modeling Language.
C2.0	**Define and analyze systems and software requirements.**
C2.1	Describe the major purposes and benefits of development, including automation, improving productivity, modeling and analysis, and entertainment.
C2.2	Recognize and prevent unintended consequences of development work: programming errors, security issues, health and environmental risks, and privacy concerns.
C2.3	Develop strategies that target the specific needs and desires of the customer.
C2.4	Analyze customers' needs for development.
C2.5	Determine and document the requirements and alternative solutions to fulfill the customers' needs.

C3.0 Create effective interfaces between humans and technology.

C3.1 Describe and apply the basic process of input, processing, and output
C3.2 Design effective and intuitive interfaces using knowledge of cognitive, physical, and social interactions.
C3.3 Support methods of accessibility for all potential users, including users with disabilities and non-English-speaking users.

C4.0 Develop software using programming languages.

C4.1 Identify and describe the abstraction level of programming languages from low-level, hardware-based languages to high-level, interpreted, Web-based languages.
C4.2 Describe the interaction and integration of programming languages and protocols such as how client-side programming can work with server-side programming to use a query language to access a database.
C4.3 Identify and use different authoring tools and integrated development environments (IDEs).
C4.4 Identify and apply data types and encoding.
C4.5 Demonstrate awareness of various programming paradigms, including procedural, object oriented, event-driven, and multithreaded programming.
C4.6 Use proper programming language syntax.
C4.7 Use various data structures, arrays, objects, files, and databases.
C4.8 Use object oriented programming concepts, properties, methods, and inheritance.
C4.9 Create programs using control structures, procedures, functions, parameters, variables, error recovery, and recursion.
C4.10 Create and know the comparative advantages of various queue, sorting, and searching algorithms.
C4.11 Document development work for various audiences, such as comments for other programmers, and manuals for users.

C5.0 Test, debug, and improve software development work.

C5.1 Identify the characteristics of reliable, effective, and efficient products.
C5.2 Describe the ways in which specification changes and technological advances can require the modification of programs.
C5.3 Use strategies to optimize code for improved performance.
C5.4 Test software and projects.
C5.5 Evaluate results against initial requirements.
C5.6 Debug software as part of the quality assurance process.

C6.0 Integrate a variety of media into development projects.

C6.1 Identify the basic design elements necessary to produce effective print, video, audio, and interactive media.
C6.2 Describe the various encoding methods of media and trade-offs: vector graphics vs. bitmaps, and bit depth.
C6.3 Use media design and editing software: keyframe animation, drawing software, image editors, and three-dimensional design.
C6.4 Develop a presentation or other multimedia project: video, game, or interactive Web sites, from storyboard to production.
C6.5 Analyze the use of media to determine the appropriate file format and level of compression.
C6.6 Integrate media into a full project using appropriate tools.
C6.7 Create and/or capture professional-quality media, images, documents, audio, and video clips.

C7.0	**Develop Web and online projects.**
C7.1	Identify the hardware (server) and software required for Web hosting and other services.
C7.2	Describe the full process of online content delivery, registering domain names, setting up hosting, and setting up e-mail addresses.
C7.3	Attract Web-site visitors through search engine optimization using various strategies like keywords and meta-tags.
C7.4	Enable e-commerce capabilities to sell products, create a shopping cart, and handle credit card transactions.
C7.5	Create an online project, Web-based business, and e-portfolio.
C7.6	Optimize fast delivery and retrieval of online content such as Web pages.
C8.0	**Develop databases.**
C8.1	Describe the critical function of databases in modern organizations.
C8.2	Identify and use the basic structures of databases, fields, records, tables, and views.
C8.3	Identify and explain the types of relationships between tables (one-to-one, one-to-many, many-to-many) and use methods to establish these relationships, including primary keys, foreign keys, and indexes.
C8.4	Use data modeling techniques to create databases based upon business needs.
C8.5	Use queries to extract and manipulate data (select queries, action queries).
C8.6	Develop databases that are properly normalized using appropriate schemas.
C8.7	Export and import data to and from other applications and a database recognizing the limitations and challenges inherent in the process.
C8.8	Analyze and display data to assist with decision making using methods like cross tabulations, graphs, and charts.
C9.0	**Develop software for a variety of devices, including robotics.**
C9.1	Demonstrate awareness of the applications of device development work, including personalized computing, robotics, and smart appliances.
C9.2	Install equipment, assemble hardware, and perform tests using appropriate tools and technology.
C9.3	Use hardware to gain input, process information, and take action.
C9.4	Apply the concepts of embedded programming, including digital logic, machine-level representation of data, and memory-system organization.
C9.5	Program a microcontroller for a device or robot.
C10.0	**Develop intelligent computing.**
C10.1	Describe models of intelligent behavior and what distinguishes humans from machines.
C10.2	Describe the major areas of intelligent computing, including perception, proximity, processing, and control.
C10.3	Know artificial intelligence methods such as neural networks, Bayesian inferences, fuzzy logic, and finite state machines.
C10.4	Implement artificial intelligent behavior through various methods: mathematical modeling, reinforcement learning, and probabilistic analysis.

Common Core State Standards

Language Standards – LS – (Standard Area, Grade Level, Standard #)

LS 11-12.1: Demonstrate command of the 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.

LS 11-12.3: Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.

LS 11-12.6: Acquire and accurately use general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Reading Standards for Informational Text – RSIT – (Standard Area, Grade Level, Standard #)

RSIT 11-12.1: Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.

Writing Standards – WS – (Standard Area, Grade Level, Standard #)

WS 11-12.3: Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

WS 11-12.4: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WS 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.

WS 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.

Speaking & Listening Standards – SLS – (Standard Area, Grade Level, Standard #)

SLS 11-12.1: Initiate and participate effectively in a range of collaborative discussions (one-on- one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

SLS 11-12.1A: Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.

SLS 11-12.1B: Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed.

SLS 11-12.1C: Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives.

SLS 11-12.1D: Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task.

SLS 11-12.2: Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

SLS 11-12.3: Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used.

SLS 11-12.4: Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.

SLS 11-12.5: Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

SLS 11-12.6: Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate.

Algebra – A-REI – Reasoning with Equations and Inequalities – (Standard Area, Grade Level, Standard #)

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.

A-REI-2: Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

Functions – F-IF – Interpreting Functions – (Standard Area, Grade Level, Standard #)

F-IF-4: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.

Functions – F-LE – Linear, Quadratic, and Exponential Models – (Standard Area, Grade Level, Standard #)

F-LE-6: Apply quadratic equations to physical problems, such as the motion of an object under the force of gravity.

Geometry – C – Circles

C-5: Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.

Geometry – G-GPE – Expressing Geometric Properties with Equations – (Standard Area, Grade Level, Standard #)

G-GPE-4: Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point (1, Ã3) lies on the circle centered at the Origin and containing the point (0, 2).

G-GPE-5: Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g, find the equation of a line parallel or perpendicular to a given line that passes through a given point.

G-GPE-6: Find the point on a directed line segment between two given points that partitions the segment in a given ratio.

Geometry – G-MG – Modeling with Geometry – (Standard Area, Grade Level, Standard #)

G-MG-1: Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder.

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 – G-CO – Congruence – (Standard Area, Grade Level, Standard #)

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.

Geometry – G-GMD – Geometric Measurement and Dimensions – (Standard Area, Grade Level, Standard #)

G-GMD-5: Determine how changes in dimensions affect the perimeter, area, and volume of common geometric figures and solids.

Numbers and Quantities – N-Q – Quantities – (Standard Area, Grade Level, Standard #)

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.

Numbers and Quantities – N-CN – Complex Number System – (Standard Area, Grade Level, Standard #)

N-CN-4: Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number.

N-CN-5: Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. For example, (-1 + -Ã3 i) = 8 because (-1 + -Ã3 i) has modulus 2 and argument 120°.

N-CN-6: Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.

Statistics and Probability – S-ID – Interpreting Categorical and Quantitative Data – (Standard Area, Grade Level, Standard #) S-ID-1: Represent data with plots on the real number line (dot plots, histograms, and box plots).

Statistics and Probability – S-MD – Using Probability to Make Decisions – (Standard Area, Grade Level, Standard #)

S-MD-1: Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.

S-MD-6: Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).

California State History - Social Science Standards

American Democracy – AD – (Standard Area, Grade Level, Standard #)

AD 12.8.2: Describe the roles of broadcast, print, and electronic media, including the Internet, as means of communication in American politics.

AD 12.8.3: Explain how public officials use the media to communicate with the citizenry and to shape public opinion.

World History – WH – (Standard Area, Grade Level, Standard #)

WH 10.11: Students analyze the integration of countries into the world economy and the information, technological, and communications revolutions (e.g., television, satellites, computers).

Next Generation Science Standards:

Scientific and Engineering Practices

Disciplinary Core Ideas

- 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

Disciplinary Core Ideas

- PS2-1: Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship
- PS2-2: Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.
- PS2-3: Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.
- PS2-4: Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
- PS3-2: Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles either by a wave model or a particle model, and that for some situations one model is more useful than the other.
- PS4-4: Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of Electromagnetic radiation is absorbed by matter.
- PS4-5: Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.
- ESS3-6: Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.