

Program Course Description Template

(Required information needed for course submission)

Program Information

Program Name: UC Davis Center for Integrated Computing and STEM Education (C-STEM)

Contact Person

First Name: Harry

Last Name: Cheng

Position/Title: Professor/ C-STEM Center Director

Phone Number: (530) 752 – 9082

E-mail: info@c-stem.ucdavis.edu

SECTION A. BASIC COURSE INFORMATION

Course Title: Algebra 1 w/ Computing (C-STEM)

Transcript Abbreviation(s) / Course Code(s): _____

NOTE: Schools are responsible for providing the above information.

Length of Course:

- Half Year (1 semester; 2 trimesters; 2 quarters)
- Full Year (2 semesters; 3 trimesters; 4 quarters)
- Two Years (4 semesters; 6 trimesters; 8 quarters)

Subject Area / Discipline:

NOTE: See attached [Appendix A] for all subject areas and disciplines.

Subject Area: Mathematics

Discipline: Algebra 1

UC Honors Designation:

Is this course being submitted for [UC honors](#) consideration?

NOTE: 9th grade courses are not eligible for UC Honors consideration.

- Yes No

Grade Level:

NOTE: Grade level pertains to which grades the course has been designed.

- 9 10 11 12

Course Learning Environment:

Is this course, or any separate section of this course, taught in an online learning environment?*

- Yes No

If “Yes,” has your institution conducted a self-assessment of the online course against the [iNACOL Standards for Quality Online Courses](#)?

- Yes No

If “Yes,” does the course fulfill all 15 UC-identified power standards from the iNACOL Standards for Quality Online Courses?

Yes No

If “Yes,” how many of the remaining 37 standards from the iNACOL Standards for Quality Online Courses the course satisfy? _ _____

*Please ensure to attach a copy of your completed [Online Course Self-Assessment Form](#).

Is this course an integrated course?

NOTE: UC encourages the development of integrated courses that combine and skills of traditional academics with contextualized learning in [career technical education](#).

Yes No

If “Yes,” please indicate the Industry Sector and Career Pathway below:

NOTE: See attached [Appendix B] for all industry sectors and career pathways.

Industry Sector: Information and Communication Technologies (ICT)

Career Pathway: Software and Systems Development

SECTION B: COURSE DESCRIPTION

Course Overview:

Briefly (in a short paragraph) provide a brief summary/snapshot of the course’s content:

This course guides students through topics in Algebra 1 in Common Core State Standards for Mathematics while simultaneously teaching students programming and computational thinking. Students use programming in C/C++ interpreter Ch to reinforce and extend their knowledge of mathematical concepts by analyzing real life situations, identifying given information, formulating steps that a computer program could calculate to find a solution, analyzing the results for accuracy, and revising/modifying the programming solutions as necessary. Topics covered include solving one-variable equations with multiple steps, solving and plotting absolute value equations and inequalities, linear equations, systems of linear equations and inequalities, polynomial functions, exponential functions, and step and piecewise functions, evaluating, multiplying, and factoring polynomial functions, solving quadratic equations with applications, probability, statistical data analysis and visualization, and arithmetic and geometric sequences. Group computing projects allow students to collaborate on critical thinking activities based on algebraic topics while developing their teamwork and communication skills.

Pre-Requisites: _____ Required _____ Recommended _____

NOTE: Laboratory science and Advanced VPA courses require a pre-requisite. Some courses require appropriate pre-requisites. Please refer to the “A-G” Guide for more information.

Co-Requisites: _____ Required _____ Recommended _____

Course Content:

For each unit of the course, provide:

- 1) A brief description (5-10 sentences) of topics to be addressed that demonstrates the critical thinking, depth and progression of content covered.
- 2) A brief summary (2-4 sentences) of at least one assignment that explains what a student produces, how the student completes the assignment and what the student learns.

Unit One: Introduction to Computing/Operations with Real Numbers

This unit introduces the students to how a computer works and the importance of computing in the 21st century. Students learn the basics of programming and programming language syntax in C/C++ using the C/C++ interpreter Ch. Students evaluate expressions, practice order of operations, and examine properties of rational numbers in a Ch Command Shell. Students write programs with proper programming language syntax to review and practice basic operations with real numbers, order of operations, and manipulating and evaluating variables in simple algebraic equations. Students also solve one-variable equations with multiple steps. Students demonstrate their understanding of properties of rational and irrational numbers through utility programs.

To meet the challenges of this unit, students persevere in solving specific problems with attention to precision, construct variable arguments and critique the reasoning of others, and model with mathematics. Throughout this unit, students understand problems that arise in real life context of programming and find solutions of multi-step problems, choose and interpret the problems with formulas and conceptual understanding, and choose and interpret the scale of measurement. These skills are demonstrated in multi-tiered tasks throughout the unit. Students apply their knowledge and understanding of basic programming syntax, number sense, expressions and equations to create mathematical models.

For example, students demonstrate their level of understanding on properties of rational and irrational numbers through a utility program in Ch where the user determines if the sum or product of two random numbers is rational or irrational. After running the program 10 times, students write a 5-paragraph essay explaining why the sum or product of two rational numbers is rational, the sum of a rational number and an irrational number is irrational, and the product of a nonzero rational number and an irrational number is irrational.

Unit Two: Using Functions for Math Application

In Unit Two, students learn function notation and develop the concepts of domain and range in terms of a given context. Students explore four types of functions (arithmetic sequence, linear, polynomial, and exponential) and interpret them graphically, numerically, symbolically, and verbally. Comparing and contrasting all 4 types of functions, students interpret arithmetic sequences and geometric sequences as linear functions and exponential functions, respectively. Through real-world applications, students master the concept of function transformations and the effects of each transformation in terms of the context. Students work as a development project team to construct programs in Ch that define a function, call a function using correct syntax, and debug it. Students construct graphs of functions using **plot.func2D()** and **plot.expr()** and scatter plots using **plot.point()** and **plot.scatter()**. In addition, there are many opportunities for students to practice and improve their writing, reading, listening, and language skills.

For this unit, students have to make sense of the problem, construct a program in Ch, debug the program,

refine their program, and generalize their findings regarding relationships between functions. Also, students make conclusions and critique the reasoning of others about relationships between different types of function based on the product for each task. Students are assessed on their mastery of function notations, operations on functions, graphical, numerical, symbolic, and verbal representations of linear, polynomial, and exponential functions and their sequences, transformations of functions and function declaration in Ch.

Unit Three: **Linear Models and Solving Linear Equations and Inequalities**

In this unit, students work on multiple tasks integrating concepts of mathematics and software development. Students connect two-dimensional lines and systems of equations algebraically and graphically using programming. Animation is used to show students that the graph of a linear function is the set of all ordered solutions plotted on a plane. Students use a powerful graphing program to get a deeper understanding of the solution to a system of two linear equations. Tasks allow students to explore real life problems that require them to solve a system of two linear equations. Students focus on systems of equations and systems of inequalities. Students learn to solve an introductory Linear Programming problem to summarize everything that was learned in this unit. This unit's tasks also focus on Standards of Mathematical Practice by providing multiple opportunities to instill understanding by having students make sense of problems and persevere in solving them, reason abstractly and quantitatively, and attend to precision.

This unit employs a variety of formative assessments and a summative, culminating assessment to ensure students' understanding so that they can apply their mastery of both the mathematics and Information and Communication Technologies (ICT) standards. For example, students use the relationship between Celsius and Fahrenheit to connect lines to real world quantities. With this, the students play with animation to discover that a line is the set of all its ordered pairs plotted on a Cartesian coordinate system. The use of real-life models allows students to draw conclusions about two-dimensional lines and systems.

Unit Four: **Quadratic Equations - Playing with Quads**

In this unit, students apply previously learned concepts about solving equations, functions, and computer programming to construct knowledge about solving quadratic functions and real life applications of these functions. The key tasks direct students through the concepts of multiplying binomials, understanding quadratic functions as the product of two linear factors, evaluating quadratics, methods of solving quadratic equations, graphing quadratic equations and applications of quadratic equations to solve problems involving projectiles. When working on math concepts for each task, students use Ch command window to evaluate quadratic expressions and calculate the coordinates of the vertex and the solutions (x-intercepts) of a quadratic function. Also, students run a utility program in Ch to factor multiple quadratic equations and to modify an existing program to calculate the vertex and solutions of a new equation. At the end of the unit, students use their knowledge to construct equations, and apply and synthesize their knowledge of programming with quadratic functions. In this process, students apply Standards of Mathematical Practice by looking for and making use of programming and mathematical structure while expressing regularity in repeated reasoning.

In this unit, students write a program in Ch to demonstrate their knowledge of multiplying binomials. Students will also evaluate quadratics and write a program in Ch to evaluate quadratics. Taking their skills one step farther, students use programming to graph quadratics and quadratic transformations. Finally, students construct quadratic equations based on specified criteria consisting of points through which the

parabola must pass.

Unit Five: **Special Functions: Piecewise and Absolute-Value**

In this unit, students are introduced to three new types of functions: piecewise, step, and absolute-value functions. Students build upon their knowledge of lines, functions, and programming to develop a deeper understanding of the new types of functions. Throughout the tasks in this unit, students are actively engaged in using computing to learn about piecewise, step, and absolute-value functions. Students model real-life situations with these types of functions, write programs in Ch to generate graphs and tables, and analyze and generalize the steps to completing each task. Students create a piecewise function to outline the shapes of icicles given on a photograph. In addition, students use an absolute-value function to model the rate at which a rainstorm rains and analyze and interpret components of the graph in terms of the context. Students develop a deeper understanding of transformations on functions through modeling different rainstorms with absolute-value functions. Students model cell phone data plans using a step function and analyze and interpret components of the graph in terms of the context. In summation, students are given a printout of a program that generates the graph of a composite function made up of an absolute-value function and a step function. Based on the graph generated by the codes, students make sense of the function and understand all the components of the function. Students compare and contrast the characteristics of these functions.

This unit emphasizes modeling real-life scenarios with piecewise and absolute value functions. Students write a program to generate the graph of a piecewise function to outline icicles on a photograph. Students make a poster to show their understanding of piecewise functions and how can it be interpreted in terms of real-life situations. Students deepen their understanding of transformations on absolute-value functions and the real-world meaning of each transformation.

Unit Six: **Probability and Statistical Data Analysis**

In this unit students learn to reason abstractly and quantitatively to create plots with a title, labels, and specific points using member functions **plot.title()**, **plot.label()**, and **plot.point()**, respectively. Students make use of copying, pasting, and printing the displayed plot. Additionally, students informally fit a straight line to a scatter plot and find the trend line for the data. Students build upon probability concepts learned in the middle school to compute and analyze real-world applications through computer programming. Predicting the probability of an event occurring by observing the relative frequency of the event occurring over many trials, students develop a model from those observations using a while-loop. Also, using single variable statistical measures like mode, mean, median, and standard deviation, students summarize, represent and interpret data. Additionally, students use simple linear regression and residuals to analyze two-variable data. The data can also be interpreted using statistical models like scatter plots, dot plots, bar graphs, histograms, and Box-and-Whisker plots.

Students integrate basic programming with the fundamentals of data modeling in order to analyze sample data. Building upon prior knowledge, students expand their knowledge and relate to real-world applications of using a scatter plot to find the most cost-effective Disneyland ticket package. Students print out their scatter plot and paste it on poster board to be presented to the class. Students continue to reinforce scatter plots and trend lines concepts in mathematics while informally analyzing residuals to assess the fit of a trend line.

(Please feel free to add as many unit fields as necessary.)

SECTION C: COURSE MATERIALS

Primary Textbook:

NOTE: Include list of primary and secondary course materials. Course materials help UC understand what materials are used to support student learning and the delivery of the course.

Title: Learning Common Core Mathematics with C/C++ Interpreter Ch for Algebra 1

Edition:

Publication Date: June 2016

Publisher: UC Davis C-STEM Center

Author(s): Harry H. Cheng

URL Resource(s): <http://c-stem.ucdavis.edu>

Usage: x _____ Primary Text x _____ Read in entirety or near entirety

Software: C-STEM Studio

Developer: UC Davis C-STEM Center

Website: <http://c-stem.ucdavis.edu/downloads/>

Software: Ch Professional Edition

Developer: SoftIntegration, Inc.

Website: <http://www.softintegration.com/download/>

Supplemental / Secondary Instructional Materials:

NOTE: Please list any other course materials here. These may include but are not limited to: literary texts, manuals, periodicals, articles, websites, primary documents, multimedia, etc.

[APPENDIX A] — SUBJECT AREAS / DISCIPLINES

NOTE: For detailed information on all subject requirements, please visit the [A-G Guide](#).

_____ (“a”) – History / Social Science

_____ U.S. History

_____ American Government / Civics

_____ World History / Geography / Cultures

_____ (“b”) – English

_____ English

_____ English as a Second Language (ESL)/ English Language Development (ELD)

x _____ (“c”) – Mathematics

_____ Algebra 1; Yr 1 of 2

_____ Algebra 1; Yr 2 of 2

x _____ Algebra 1

_____ Mathematics I

_____ Geometry; Yr 1 of 2

_____ Geometry; Yr 2 of 2

_____ Geometry

_____ Mathematics II

_____ Algebra 2; Yr 1 of 2

_____ Algebra 2; Yr 2 of 2

_____ Algebra 2

_____ Mathematics 3

_____ Algebra 2 / Trigonometry

_____ Advanced Mathematics

_____ Statistics

_____ Computer Science

_____ (“d”) – Laboratory Science

_____ Biology

_____ Chemistry

_____ Physics

_____ Earth and/or Space

_____ Integrated Science

NOTE: Students that enroll in an integrated-science program (ISP) are strongly advised to complete the entire three-year sequence. In most cases, the first year of an integrated-science sequence fulfills only the "g" elective requirement; the second and third years of the sequence then fulfill the two-year "d" laboratory science requirement. Accordingly, if only ISP I is successfully completed, then two courses from the categories of Biology, Chemistry, or Physics in the "d" subject area must be completed. If ISP I and only one of ISP II or ISP III are completed, then one additional course from the categories of Biology, Chemistry, or Physics from the "d" subject area must be taken to fulfill the "d" requirement.

_____ Interdisciplinary Science

NOTE: This category demonstrates that the course is cross-disciplinary and is often used for advanced science courses such as AP Environmental Science or Biochemistry.

_____ (“e”) – Language Other than English

_____ LOTE Year 1

_____ LOTE Year 2

_____ LOTE Year 3

_____ LOTE Year 4+

Language:

_____ American Sign Language (ASL)

- _____ Arabic
- _____ Chinese
- _____ French
- _____ German
- _____ Hebrew
- _____ Italian
- _____ Japanese
- _____ Latin
- _____ Other
- _____ Russian
- _____ Spanish

_____ (“f”) – Visual & Performing Arts

- _____ Dance
- _____ Music
- _____ Theater Arts
- _____ Visual Arts
- _____ Interdisciplinary Arts

_____ (“g”) – College-Preparatory Elective

- _____ History / Social Science
- _____ English
- _____ Mathematics / Computer Science
- _____ Laboratory Science—Biology / Life Science
- _____ Laboratory Science—Physical Science
- _____ Laboratory Science—Earth / Space Science
- _____ Laboratory Science—Interdisciplinary Science
- _____ Laboratory Science—Integrated Science
- _____ Language Other than English
- _____ Visual & Performing Arts
- _____ Interdisciplinary

[APPENDIX B] — INDUSTRY SECTORS / CAREER PATHWAYS

NOTE: This applies to integrated courses only.

_____ **Agriculture and Natural Resources**

- _____ Agricultural Business
- _____ Agricultural Mechanics
- _____ Agriscience
- _____ Animal Science
- _____ Forestry and Natural Resources
- _____ Ornamental Horticulture

- _____ Plant and Soil Science
- _____ **Arts, Media, and Entertainment**
 - _____ Media and Design Arts
 - _____ Performing Arts
 - _____ Production and Managerial Arts
- _____ **Building and Construction**
 - _____ Cabinetmaking and Wood Products
 - _____ Engineering and Heavy Construction
 - _____ Mechanical Construction
 - _____ Residential and Commercial Construction
- _____ **Education, Child Development and Family Services**
 - _____ Child Development
 - _____ Consumer Services
 - _____ Education
 - _____ Family and Human Services
- _____ **Energy and Utilities**
 - _____ Electromechanical Installation and Maintenance
 - _____ Energy and Environmental Technology
 - _____ Public Utilities
 - _____ Residential and Commercial Energy and Utilities
- _____ **Engineering and Design**
 - _____ Architectural and Structural Engineering
 - _____ Computer Hardware, Electrical, and Networking Engineering
 - _____ Engineering Design
 - _____ Engineering Technology
 - _____ Environment and Natural Science Engineering
- _____ **Fashion and Interior Design**
 - _____ Fashion Design, Manufacturing, and Merchandising
 - _____ Interior Design, Furnishings, and Maintenance
- _____ **Finance and Business**
 - _____ Accounting Services
 - _____ Banking and Related Services
 - _____ Business Financial Management
- _____ **Health Science and Medical Technology**
 - _____ Biotechnology Research and Development
 - _____ Diagnostic Services
 - _____ Health Information

- Support Services
- Therapeutic Services

Hospitality, Tourism, and Recreation

- Food Service and Hospitality
- Food, Science, Dietetics, and Nutrition
- Hospitality, Tourism, and Recreation

x **Information Technology**

- Information Support and Services
- Media Support and Services
- Network Communications
- x Programming and Systems Development

Manufacturing and Product Development

- Graphic Arts Technology
- Integrated Graphics Technology
- Machine and Forming Technology
- Welding Technology

Marketing, Sales, and Service

- E-Commerce
- Entrepreneurship
- International Trade
- Professional Sales and Marketing

Public Services

- Human Services
- Legal and Government Services
- Protective Services

Transportation

- Aviation and Aerospace Transportation Services
- Collision Repair and Refinishing
- Vehicle Maintenance, Service, and Repair