

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

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SECTION A. BASIC COURSE INFORMATION

Course Title: Integrated Mathematics I w/ Computing & Robotics (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:

The course guides students through topics in Integrated Mathematics 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, statistical data analysis and visualization, arithmetic and geometric sequences, and geometric transformations, including translations, rotations, and reflections, and geometric constructions. Robotics activities allow students to reenact physically derived mathematical problems through robotics technologies, such as RoboBlockly and RoboSim via C-STEM Studio, to visualize situations, associate linear and exponential graphs with physical phenomenon, predict and identify key features of the graphs with robotic systems, and solve robotics problems through mathematical modeling and programming.

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 and Robotics/Operations with Real Numbers and Expressions

This unit introduces students 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 and practice order of operations in a Ch Command Shell. Students write 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. 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 with robotics 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 and students apply their knowledge and understanding of basic programming syntax and number sense, expressions and equations to create mathematical models.

For example, students create a program that successfully makes a robot move along a number line by evaluating positive and negative integers as it relates to measurement of distance. In this task, students are introduced to the functions in Ch by declaring and initializing variables and the basic programming syntax. In order for the robot to move along the number line, students must create a number line with a scale of 1 unit integer = 1 inch. Students then create another conversion for converting distance measurements in inches to robot joint angles. The program should allow input and output functions of passing distance and displaying questions and distance traveled by the robot. The robots move along the number line using the member functions **robot.driveDistance()**, **robot.driveAngle()**, and **robot.driveTime()**.

Unit Two: Using Functions and Robotics for Math Application

In Unit Two, students learn function notations and develop the concepts of domain and range. Students explore four types of functions (arithmetic sequence, geometric sequence, linear, and exponential) and interpret them graphically, numerically, symbolically, and verbally. Comparing and contrasting linear and exponential functions, students interpret arithmetic sequences and geometric sequences as the linear functions and exponential functions. Students work as a development project team to construct programs in Ch that define a function, call the function using correct syntax, and debug it. Constructing graphs of functions using **plot.func2D()** and **plot.expr()** with arguments specific to the graphed function, students graph linear an exponential function with transformations. This includes diagramming processes using flowcharts. For each task in unit two, students integrate a variety of media into development projects, develop web and online projects, and develop programs that control the motions of robotics using **robot.driveDistance()** and **robot.drivexyToFunc()**. In addition, there are many opportunities for students to practice and improve their writing, reading, listening, and language skills.

For example, interpreting functions numerically, symbolically, and verbally, students write a program that directs a robot's motions to be based on distance, time, and different speeds. Students create a table of inputs and outputs for the distance equals speed multiplied by time function with different speeds. Next, students write a program that uses the function **robot.drivexyToFunc()** to direct the robot's motions with different speeds used and prints a list of distances traveled by the robot.

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

In this unit, students work on multiple tasks integrating on concepts of mathematics, software development, and robotics. Students connect two dimensional lines and systems of linear equations as well as inequalities algebraically and graphically using robots and programming. The robot simulation environment RoboBlockly and RoboSim with virtual robots are used to show students that the graph of a linear function is the set of all ordered pair of solutions plotted on a plane as well as the meaning of the solution to a system of two linear equations. Robots are used to deepen the students' understanding what a line means and the meaning of two crossing lines in terms of real-life situations. This is reinforced by graphical output of the two programs *recorddistance.ch* and *recorddistanceoffset.ch*. Students learn to plot all solutions to any equation in two variables, graph the equations while displaying its data, and run the code to explore what happens when one changes the speed or distance that a robot travels. The unit's tasks also focus on Standards of Mathematical Practice by providing multiple opportunities to have students make sense of problems and persevere in solving them, reason abstractly and quantitatively, and attending to precision.

An object moving at a constant rate is a good example of a linear equation in two variables. Students working in pairs of two run the code *recorddistance.ch*. Students explore what happens when one changes the speed or distance that the robot travels. Then, they record the distance as the robot moves with a time interval of 0.1 second. Once the students have a strong grasp of how the speed and distance affect its graph, students summarize what they learned by writing a short essay.

Unit Four: **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. 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.

For one task, students plot points with the x- and y- values given on a chart to determine the relationship between the points and to form a linear equation. Additionally, students need to be in groups of 2-4 with 2 robots per group. Students will create a 4 by 4 grid and place the two robots at teacher-defined (x,y) coordinates. The goal of this activity is to have the robots be aligned in a straight line with a slope of 1 when they finish moving. Students apply their understanding of linear relationships by moving the robots in a straight line.

Unit Five: **Congruency and Geometric Transformation**

In Unit Five, students apply previously gained knowledge of software development and robots to the mathematical concepts of congruence, similarity and the four primary geometric transformations of translation, rotation, and reflection by programming a pair of unconnected robots to be simultaneously moved with identical movements, except the second robot is affected by a type of transformation. In this way, students learn how geometric transformations are applied to the movement of objects in a plane through rules that define that motion. When writing their computer programs in Ch, students apply RoboSim with the x and y coordinate system. Students expand their computer programs with plotting that visually demonstrate and reinforce the different types of primary geometric transformations and coordinate geometry. After the introduction of the concept of congruency, students develop understanding of rigid motions and similarity as it applies to polygons and transformation. The first four tasks and the culminating task require the student to use best programming practices and apply mathematical concepts precisely. Students practice using appropriate tools strategically and attend to precision.

To enhance students understanding of a geometric translation, they create a computer program in Ch to make a robot move in the geometric shape of a rectangle. Students test their program first using RoboSim with the x and y coordinate system and visible tracking to illustrate a correct geometric shape. Once students have a correctly working simulation, students then take the original coordinates and apply specific shifts to a second robot. By adjusting the second robot to the translated coordinates, and re-executing the program, students observe both robots creating the exact same rectangle shape, one at the original location, and one at a different location.

Unit Six: **Coordinate Geometry and Geometric Construction**

Students build depth of knowledge upon their prior understanding of geometry with a Cartesian coordinate system to verify geometric relationships, including properties of special triangles, quadrilaterals, circles, and slopes of parallel and perpendicular lines, as well as areas and perimeters of polygons. Introducing congruence and geometric transformations by noting the robot is pre-imaged and applying the unit shifts from the translated coordinates, students design computer programs for other geometric shapes including triangles and other polygons. Continually, building one task after another, students expand their programming capacity by adding a control and loop structure in programming. This extends into designing three additional computer programs for a triangle with reflection transformations under three circumstances. Eventually, students design additional computer programs for other geometric shapes, while taking the original coordinates for the first robot and applying different scale factors to the second robot. Expressing geometric properties with equations, students use coordinates to prove simple geometric theorems algebraically; this includes the slope formula. Throughout units, students communicate their reasoning, demonstrate conceptual and procedural fluency, find examples of connecting Algebra and Geometry through coordinates in real life contexts by applying the elements of mathematical modeling, and become efficient problem solvers. In addition, students use a compass, straightedge, and protractor to copy a line segment, copy an angle, bisect a segment, construct a perpendicular line, bisect an angle, construct a line parallel to a given line through a point, construct a regular hexagon inscribed in a circle, construct an equilateral triangle, and construct a square.

For example, a group of four students create an island on which there are many geometrically shaped buildings blocking a straight path from one end of the island to the opposite end in RoboSim. Teams in the class will design a path that is the shortest route to get from one end of the island to the other opposite end. Then, they write a program in Ch which will control a robot to complete the route they designed. Upon completion of this task, they time how long it takes the robot to complete the course. With this benchmark time, other students in the class will compete in designing a path that beats the best time needed to complete the route by a robot.

(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 Integrated Math 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: Ch Professional Edition

Developer: SoftIntegration, Inc.

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

Software: C-STEM Studio

Developer: UC Davis C-STEM Center

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

Software: Linkbot Labs

Developer: Barobo, Inc.

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

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.

Title: Learning Robot Programming with Linkbot for the Absolute Beginner

Edition: 6th

Publication Date: May 2016

Publisher: UC Davis C-STEM Center

Author(s): Harry H. Cheng

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

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
- _____ Algebra 1
- x _____ 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