# Chino Valley Unified School District
# High School Course Description #5U01

| CONTACTS | |
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| **1. School Information:** | **School:** Chino Valley Unified School District<br>**Street Address:** 5130 Riverside Dr., Chino, CA 91710<br>**Mailing Address:** 5130 Riverside Dr., Chino, CA 91710<br>**Phone:** (909) 628-1201<br>**Web Site:** http://www.chino.k12.ca.us |
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| **A. COVER PAGE - COURSE ID** | |
| **1. Course Title:** | Constructing Algebra 2 (UCCI) |
| **2. Transcript Title/Abbreviation:** | Constructing Algebra 2 |
| **3. Transcript Course Code/Number:** | 5U01 |
| **4. Seeking Honors Distinction:** | No |
| **5. Subject Area/Category:** | (c) Mathematics or (g) Elective |
| **6. Grade level(s):** | 10-12 |
| **7. Unit Value:** | 5 credits per semester/10 total credits |
| **8. Was this course previously approved by UC?** | Yes |
| **9. Is this course classified as a Career Technical Education course:** | Yes |
| **10. Is this course modeled after an UC-approved course?** | Yes |

**11. Brief Course Description:**

Advanced Algebra 2 standards are combined with the Building Trades and Construction Industry Sector concepts into an integrated secondary course that meets both Algebra 2 course requirements and CTE standards. The course follows a contextualized model, where "a - g" mathematics determines and drives occupational (CTE) curriculum. Mathematics is the gatekeeper for hands-on projects that result in construction of a scale model or an actual residential home. Seven thematic units encompass rigorous algebraic calculations that facilitate student construction tasks, resulting in the completion of a residential or commercial structure and its surrounding landscape features.

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| **12. Prerequisites:** | Teacher Recommendation |

**13. Context for Course:**

This is an integrated course utilizing Algebra 2 concepts in a building trades and construction environment. The course is designed to prepare students for the natural progression to higher math courses, through a course rich in connections to construction projects that generate interest in the math and increase students' likelihood of success. The applications throughout the course allow students to see the connection between mathematical concepts and the construction of a scale or full-size dwelling. Also, this course could be part of Building Trades and Construction Academy as an intermediate course in a sequence of construction and mathematical courses.

**14. History of Course Development:**

This course was developed at the Spring 2012 University of California Curriculum Integration (UCCI) Institute focusing on subject area "c" - mathematics and the Career Technical Education (CTE) industry sector Building Trades and Construction. It has been challenging for educators to find and develop linkages with certain disciplines, including English, history/social sciences, and mathematics. To address these challenges, the University of California (UC) created the UCCI Institute to focus on subject areas that have proven to be difficult to develop integrated curriculum.

**B. COURSE CONTENT**

**Course Purpose:**

This course provides secondary mathematics students with an answer to the question: Why do we need to learn this? In this integrated UC mathematics and construction class, students learn advanced algebraic and trigonometry concepts and apply them to building a house. Throughout the building process, students learn the skills that are essential for 21st century college and careers: critical thinking and problem solving, collaboration, communication, application and adaptability. These learning activities require students to think and work in order to apply mathematics through all stages of the construction process, from the early planning stages and site work through foundations, framing, electrical, and finishing work. Major construction phases are divided into seven instructional units; each incorporating unique aspects of algebra and trigonometry, building the knowledge and skills students need to be successful during the construction process.

Initial planning begins with the introduction of scale and proportion as students design a three-dimensional Computer-Aided Design (CAD) building with a corresponding lot. The second unit transitions to site work where right triangle trigonometry is used to calculate the slope of the lot and elevation of the building. The third unit incorporates sonic sections and linear equations during the excavation process and initial preparation of the foundation. In unit four, students apply algebra and trigonometry to calculate, measure, and place the floor, walls, and roofing system. As students transition into unit five, passive solar concepts are introduced using R-values and inverse variations, which are later applied to the building's exterior enclosure. During unit six's rough-in stage, students explore basic plumbing concepts using quadratics and regression and study sequences by creating electrical circuits based on Ohm's Law. The construction process culminates in unit seven with students calculating roots of polynomials and studying complex numbers as it applies to electrical grids and finish work.

The final product, a residential structure, can be utilized on a school site, donated to a housing provider, such as Habitat for Humanity, or sold to generate funding for building the next house. For schools that do not have the facility for full size construction, scale models and virtual construction can be viable substitutes.

**Course Outline:**

Unit 1: Planning - Introduction to Functions

The process of planning and designing a structure is introduced first. Students experience each step of the development process and outline appropriate sequencing of events as it applies to project scheduling. The process of creating a floor plan allows the students to investigate math modeling and a variety of functions in practical applications. In addition, students justify their decisions by explaining their design choices in writing assignments.

Unit 2: Site Work - Linear Functions/Linear Systems

The physical transformation of the site begins in preparation for building. During site work, the building process moves from two and three-dimensional plans to three dimensional structures. Students prepare the site through surveying, leveling, and grading for the building foundation and other necessary site improvements. This process allows students to begin investigating piecewise functions. The connection between systems of two equations and systems of three equations is illustrated throughout the site work process, both in the work done on the plot of land and using the software program to create the 3-D plan. An essential part of this unit requires students to apply measurements from scale drawings to blueprint specifications.

Unit 3: Foundation Systems - Quadratic Functions/Conic Sections

Every structure needs to have a solid foundation. In this phase, first students survey the site, excavate soil for the foundation, build wall forms, pour footings and stem walls, and install rebar for structural strength. Students prepare a plan with estimates for the foundation work. Students use direct variation to calculate exactly how much dirt will need

to be moved from the site. In addition, students continue to work with the site and floor plans, rewriting the plan as a series of piecewise functions on the Cartesian Plane. Continuing their work with the drawings from the previous chapters, and their investigations of conic sections, students begin to see the connection between the equations of conic sections to the construction drawings created in Units 1 and 2, allowing the abstract idea of translating between equations and graphs to become much more concrete.

Unit 4: Framing Systems - Polynomial Functions/Rational Functions

Working with framing, students transform conceptual ideas and construction drawings into a real structure for the first time. The structure itself comes together during the framing process, starting with material selection, flooring, walls and roofing construction, tasks necessitating a review of trigonometric concepts. By the end of this unit, students will have constructed the entire framing for their structure. Students solve rational equations in their work using the scale model. Mathematical concepts require students to work with surface area, continuing their investigation of conic sections.

Unit 5: Exterior Enclosure - Radical Functions and Inverses

During this unit of study, the physical structure takes on aesthetic qualities. The exterior enclosure unit encompasses finishing the roof, building wrap, exterior wall finish material, and installing windows and doors on the structure. The mathematical components in this unit include precise measurements and working with scale from floor plans. As students calculate R-values for insulation, inverse variation is explored. Students continue the work they started in Unit 1 with maximizing and minimizing areas of more complex plots of land by integrating the idea of inverses with polynomials and radicals.

Unit 6: Rough In - Exponential & Logarithmic Functions/Sequences and Series

In this unit, elements are added to make the building fully functional. All mechanical systems, including plumbing, electrical, and HVAC, are installed in the structure prior to completing exterior weatherproofing of the walls. The next step in this process is insulation, which encompasses thermal, moisture, and sound control. As students calculate the R-value for the insulation, to ensure compliance with Title 24, they gain experience calculating with inverse variation as well as an appreciation of the many mathematical concepts that must come together in the building of a structure. Students continue to investigate the idea of mathematical modeling, specifically quadratics, as they design a water fountain or other landscape feature. The electrical component of this unit provides students the opportunity to work with sequences and series as well as complicated rational functions. Energy efficient HVAC systems are analyzed for cost/benefit analysis, a task lending itself to the study of exponential decay and requiring students to solve exponential and logarithmic equations.

Unit 7: Finish Work - Complex Numbers

The project comes alive with the colors and textures that give it a unique personality and marketability. This unit represents the culmination of the work the students have completed throughout the course. The structure itself comes together in this unit, starting with material selection, flooring, walls and roofing construction. The project goal at the end of this unit is to have a completed structure and surrounding terrain. The students complete their investigation into the practical application of higher mathematics with an introduction into complex numbers and how they apply to electricity.

**Key Assignments:**

Unit 1: Planning - Introduction To Functions

Written Proposal for Site Plan: This assignment introduces the planning segment and should take roughly one day to complete.

- Read a site plan to determine the best location of a structure.
- Write a proposal of approximately one typed page justifying the location.

- Orientation of the structure on the site.

Maximum Space Calculations Diagram: This assignment introduces students to linear, quadratic, and higher degree polynomial functions and takes between two and four days to complete.

- Determine the most suitable location on the site selecting from parabolic or trapezoidal lots of different sizes provided by the instructor.
- Assess maximum and minimum values of functions based on maximizing rectangular spaces inside of the lots.
- Create a table.
- Draw the maximized space on their lot.
- Lots are implified structures to accommodate Algebra 2 skill sets.

2D Draft Plans Part I: This assignment serves as an introduction to conic sections. It takes between two and three days to complete.

- Use required multiple Algebra 2-level shapes, including conic sections to draw plan.
- Draw functions in the draft plan as represented in CAD.
- Begin providing domain/range of each function. Solve simple problems for conic sections on a worksheet.
- Utilize proportions to represent scale in the draft 2-D plan in preparation for the introduction of rational equations.

<u>Unit 2: Site Work - Linear Functions/Linear Systems</u>

Topographical Map of Site: This assignment is an introduction to three-dimensional coordinates and matrices. It takes between 2 to 3 days to complete.

- Find and plot the elevation of the land both on site and on a map. (Students are introduced to three dimensional Cartesian coordinates based upon their results.)
- Plot land elevation using stakes at land site
- Plot 3-D elevation using classroom software, such as Sketchup or similar software, as well as on a map of their own design
- Use matrices from the points found to find the area of the space plotted
- Provide directions to grade the lot for slope/drainage, calculating slop, and using inverse trig functions to find the angle of depression
- Map the footprint, roof line, and orientation of the structure

2D Draft Plans Part 2: This assignment expands upon knowledge about conic sections and introduces piecewise functions/relations from the 2D draft plans in Unit 1. It takes between one to two days to complete.

- Using the floor plan, state the domain and range for each of the functions that comprise the floor plan of the structure.
- Number each function and organize it on the page as part of a piecewise relation.

Drainage Diagram and Grading Summary: This assignment builds upon linear piecewise functions. It takes one to two days to complete.

- Create a report on how lot grading is accomplished on a particular site.
- Create a piecewise function to represent the difference between slopes used to build on compared with the slope used for drainage on the site.

Passive Solar Building Model: This assignment emphasizes slope, angles of elevation and depression, and basic trigonometry. It takes between one to two days to complete.

- Create a model for passive solar building on a site.
- Observe the angle of the sun using various tools outdoors
- Plot a graph determining proper building orientation.
- Demonstrate use of trigonometry to find the angle of orientation.

**Instructional Methods and/or Strategies:**

Unit 1: Planning

- Lecture/demonstration/guided discussion to scaffold what steps are needed in the planning process and how to draw a floor plan.
- Lecture/guided discussion of math concepts combined with pair sharing of practice problems to increase student ability to justify their work verbally to others.
- Peer editing and review of drafting plans so that students can justify their work in front of others and learn from each other's mistakes.
- Use computer aided design for visual learning.

Unit 2: Site Work

- Use Google Sketch-Up or equivalent to illustrate how 3-Dimensional coordinates work on a CAD-like system.
- Lecture/demonstration on grading the site.
- Team work for building-each student is assigned a specific task.
- Tasks must be completed in a timely manner or the entire job is affected, which teaches students responsibility.
- In addition, students practice communicating clearly, utilizing appropriate academic vocabulary.

Unit 3: Foundation Systems

- Lecture/demonstration is be used to show students how to complete their foundation system. (Note that there are several videos available which can be shown that give excellent coverage to these areas.)
- Lecture/guided discussion of math concepts.
- Team work for building-each student is assigned a specific task, which must be completed in a timely manner or the entire job is affected, which teaches students responsibility.
- Students' practice communicating clearly, utilizing appropriate academic vocabulary.

Unit 4: Framing Systems

- Use tools, such as Graphmatica, Mathematica, or equivalents that allow students to investigate domain and range, as well as allowing students to limit the domain and range of the functions.
- Team work for building-each student is assigned a specific task, which must be completed in a timely manner or the entire job is affected, which teaches students responsibility.
- In addition, students practice communicating clearly, utilizing appropriate academic vocabulary.

Unit 5: Exterior Enclosure

- Lecture/demonstration is used to show students how to complete their roof and all exterior finish work (Note that there are several videos available on YouTube which can be shown that give excellent coverage to these areas.)
- Lecture/guided discussion of math concepts.
- Small group discussion regarding maximizing lot usage, allowing students to practice sharing mathematical ideas verbally, using both appropriate math and CTE vocabulary.
- Team work for building-each student is assigned a specific task, which must be completed in a timely manner or the entire job is affected, which teaches students responsibility.
- In addition, students practice communicating clearly, utilizing appropriate academic vocabulary.

Unit 6: Rough In

- Lecture/demonstration/discussion is used to show students how to complete their plumbing and electrical assignments, and Heating, Ventilation, and Air Conditioning (HVAC). Demonstrations are combined with YouTube videos so students can review steps multiple times before attempting project themselves.
- Lecture/guided discussion of math concepts.
- Team work for building-each student is assigned a specific task, which must be completed in a timely manner or the entire job is affected, which teaches students responsibility. In addition, students practice communicating clearly, utilizing appropriate academic language.

Unit 7: Finish Work

- Team work for building-each student is assigned a specific task, which must be completed in a timely manner or the entire job is affected, which teaches students responsibility.
- In addition, students practice communicating clearly, utilizing appropriate academic vocabulary.

**Assessment Including Methods and/or Tools:**

**Unit 1: Planning**

Key Assignments

- Maximum Space Calculation Diagram.
- Check linear, quadratic, and polynomial equations for completion and understanding.
- Check graphs and minimum/maximum values for understanding.
- 2D Draft Plans.
- Ensure all shapes are present (conic sections and linear.)
- Check domain and range of each function.

CTE Assessments

Written Proposal for Site Plan: The site plan specifies the exact location of the structure relative to physical reference points, such as lot size, other buildings, fence lines, etc. Student's site plans are evaluated to within 1/16" on plan, (3" in physical world to ¼ inches to one foot scale).

- Bi-weekly Algebra 2 quizzes.
- Basic proportion and simple rational equations.
- Identifying maximums, minimums, asymptotes, y-intercepts, domain, range and zeros of functions given a graph.
- Writing simple equations of conic sections without any transformations.
- Basic function graphing (root functions without major transformations).

**Unit 2: Site Work**

Key Assignments

Topographical Map

- Verify student work on Sketchup or equivalent CAD program for mathematical accuracy
- Assess the plot plan for accuracy (Was space usage efficient? Does it meet the CTE criteria for a plot plan, such as back sets, etc.).
- 2D Plans.
- Assess plans for both measurement and symbol accuracy (check whether scale correct; check to see whether symbols for the roof, walls, and floor are accurate).
- Ensure all shapes are numbered.
- Recheck domain and range laid out on a piecewise function.
- Drainage diagram and grading summary.
- Grade piecewise function for accuracy.
- Passive solar model.
- Verify that trigonometric calculations are correct.
- Check model for orientation accuracy.
- Material mineralization.
- Verify that the data matrix has the correct values in it.
- Check minimization function calculations for accuracy.
- Verify minimization graph that the students used to find the minimum value for surface area.

CTE Assessments

- Log sheets recording elevations are verified -- 90% accuracy within 1/4" required for passing.
- Student groups present and explain their 3D site plan to class and instructor; graded according to presentation strength, and the accuracy of topographic map.
- Teacher checks individual site plan drawings from Unit 1 for accuracy of scale (1/4" to 1 foot), sides of equal length (for rectangular structure), and all 4 corners are 90 degrees.
- Bi-weekly Algebra 2 quizzes
- Plotting points in three dimensional spaces.
- Solving linear systems with three variables.
- Solving linear systems with matrices.
- Basic matrix operations.
- Using the discriminant.
- Trigonometry for right triangles.
- Graphing polynomial functions, and identifying zeros, y-intercepts, maximums, minimums, domain, and range.
- Word problems on minimizing material usage and maximizing area.
- Finding equations of lines given two points, parallel lines, perpendicular lines, and graphs of lines.

**Unit 3: Foundation Systems**

Key Assignments

- Dealing with dirt.
- Check plot and linear equations for accuracy.
- Grade graphs and comparisons of the number of trucks needed based on the expansion of dirt.
- Scale models.
- Grade worksheet on conic sections and quadratics (in preparation for work done in 2D draft plans in Unit 4).
- Foundation model.
- During class, verify physical accuracy of slump tests.
- Grade linear equation calculations and function accuracy for slump test estimates.
- Check foundation for proper grade (slope).

CTE assessments

Students present preliminary scale models to teams, for peer review and comment. Teacher evaluates the work of the team according to the following and provides feedback.

- Progress: in a typical 90 minute class, student teams will complete twelve inches of wall framing, (including one bottom plate and two top plates) and studs installed according to assigned scale. Accuracy must be within 1/16 inch on plan.
- Scale: model must be to scale in all dimensions - height, width, spacing of studs, (to 1/16 inch).
- Craftsmanship: in construction, craftsmanship is somewhat subjective but is assessed by measuring (with a Tri-Square) all right angle joints to be 90 degrees with zero tolerance; if joints are not 90 degrees, they must be done over. Distances between studs must all be equal at bottom and top of wall.
- Teacher evaluates each student's computations for amount of concrete required for footing and stem walls; final answer is 5% above estimated concrete calculation. The 5% is calculated for material waste factor.
- Teacher evaluates scale of model (1 ½ inch to 1 foot) mirroring the drafting assignment of Unit 1.
- Bi-weekly Algebra 2 quizzes.
- Direct and joint linear variation.
- Finding best-fitting functions given a set of data.
- Describing function transformations for linear and polynomial functions, and conic equations.

- Transforming functions for linear and polynomial functions, and conic equations.
- Graphing conic sections in graphing form (doesn't use completing the square)
- Graphing basic rational functions, and stating domain, range, zeros, y-intercepts, asymptotes, minimum, and maximum values.
- Solving basic rational equations
- Writing and graphing basic piecewise functions

**Unit 4: Framing Systems**

Key Assignments

- 2D draft plans.
- Grade draft plan symbols for electrical outlets, switches, voltage, light fixtures, outlets, and electrical panels.
- Verify accuracy of plans in mathematical software used by the student or graded manually.
- Floor system.
- Verify the physical floor system is measured correctly, angles are at 90 degrees, and that the system is level.
- Grade rational equation worksheet.
- Frame walls.
- Check floor drawings for future floor framing for accuracy (angles, scale, etc.).
- Verify walls have been properly constructed.
- Grade rational equation worksheet.
- Calculating building area.
- Grade conic section worksheet.
- Diagram roof slope.
- Verify that the slopes and trigonometric equations are accurate.
- Stairs.
- Verify stairs are level and accurate (do they meet code for angles, depth, railing, etc.).
- Check inverse trig calculations and linear equation representing the stairs and railing.

CTE Assessments

- Benchmark test: framing systems – flooring, walls and roofing. Assessment is done by checking accuracy, layout, and craftsmanship.
- Using an architect's scale, measure length and width of floor within 1/16" on scale model.
- Floor joists are placed every 16 inch on a real house; model must show correct spacing of floor joists to within 1/16 inch.
- From scale model and plans, students create a materials list. Based on price lists for typical materials purchased from suppliers, students develop a corresponding cost breakdown.
- By referencing drawings, layout location for structural within 1/16 inch to scale and verified by tape measure.
- Calculating size of framing by tape measure to within 1/16 inch.
- Installing materials to allowable tolerances.
- Calculating roof rafter length using three layout methods.
- Step off: using a framing square, roof rafter length is calculated within 1/16 inch
- Rafter table: students learn to read the rafter table (the math is done by the table); assessment is by written or oral exam.
- Trigonometric table: students fill out a basic trigonometric table using angles from special triangles (30, 45, 60, 90 degrees) exact answers with square roots are required.
- Written framing terminology and vocabulary exam.
- Research project and oral presentation. Projects and presentations scored by rubric, and judged by peers,

teacher and industry experts, for completeness, accuracy and cost effectiveness.
- Bi-weekly Algebra 2 quizzes.
- Writing conic sections in graphing form given standard form, and graphing conic sections given standard form (requires completing the square).
- Graphing general rational equations. Stating domain, range, zeros, y-intercepts, and asymptotes, local minimum and maximum values.
- Solving general rational equations.
- Describing function transformations for rational, polynomial, and linear functions, as well as conic sections.
- Writing and graphing piecewise functions involving a variety of functions and relations covered thus far.

**Unit 5: Exterior Enclosure**

Key Assignments

- Maximizing space/passive solar orientation.
- Grade worksheets on inverse functions, and their domain/range.
- Inverses/radicals worksheet.
- Grade worksheet.
- Title 24 evaluation.
- Verify that handicapped access meets local codes.
- Check inverse variation calculation.

CTE Assessments

- Benchmark test: install weatherproof shell, roof, exterior wall covering, doors and windows.
- Relating to Green Construction.
- Passive Solar Systems require correct orientation of the building to maximize solar effect on heating and minimize solar effect for cooling. Sun angle, orientation of the building, roof slope is measured by site glass, referencing tables and performing calculations; accuracy within 1 degree required; assessment by written quiz or exam.
- Insulation selection includes cost/benefit analyses; assessed by exam, 5% tolerance allowed.
- Wall and roof covering includes cost/benefit analyses; assessed by exam, 5% tolerance allowed.
- Students' oral, written, and graphical presentations of the historical roof project evaluated by a rubric assessing appropriate academic language and technical terminology.
- Bi-weekly Algebra 2 quizzes.
- Linear, quadratic, and polynomial word problems (problems involving gravity and fluid dynamics).
- Finding, graphing, and proving inverse functions.
- Graphing radical functions. State domain, range, zero(s), y-intercepts, local minimum and maximum values.
- Solving radical equations.
- Summative quiz for finding equations of all types covered so far based on their graphs or data from their graphs (rational, radical, polynomial, and linear functions, as well as all conic sections)
- Summative graphing quiz for all types of functions covered so far(rational, radical, polynomial, and linear, as well as all conic sections)

**Unit 6: Rough In**

Key Assignments

- Circuitry project.
- Verify that physical circuits created by students work.
- Grade worksheet on rational functions / sequences and series.
- HVAC data graphs.

- Verify exponential decay graphs for student understanding.
- Water fountain.
- Check student calculations for fountain against the physical product.
- Grade accompanying word problem worksheet.

CTE Assessments

- Daily check of students' progress completing key assignments; students are required to make some progress each period; somewhat subjective based on the student's capabilities. Observation, record keeping and frequent one on one discussion with student.
- Grades for each key assignment completed.
- Bi-weekly Algebra 2 quizzes.
- Finding general sequences and series.
- Arithmetic sequences and series.
- Geometric sequences and series.
- Direct, joint, and inverse variation.
- Laws of exponents.
- Solving exponential equations
- Graphing exponential and logarithmic functions. Identifying exponential functions as either growth or decay. State domain, range, asymptotes, zero(s), and y-intercepts.
- Solving logarithmic equations.
- Logarithmic word problems.
- Proving logarithm properties.

**Unit 7: Finish Work**

Key Assignments

- Drywall installation.
- Verify drywall is installed to code, and that the craftsmanship is done in a workmanlike manor.
- Finish carpentry.
- Verify doors, windows, cabinets, trim, and baseboards work correctly, meet at the correct angles, have correct gaps, and are visually sound.
- Surface finishes.
- Verify final flooring is installed properly.
- Complex numbers and circuits worksheet.
- Grade worksheet.
- Long division worksheet grade worksheet.

CTE Assessments

- Benchmark: Aesthetics and Marketability.
- Daily check of students' progress completing key assignments.
- Grades for each key assignment completed.
- Grade the final finished structure.
- Test on the various mathematical concepts presented in class.
- Oral presentation of the final structure.
- Bi-weekly Algebra 2 quizzes.
- Summative transformation quiz on all topics covered so far(rational, radical, polynomial, linear, exponential, and logarithmic functions, as well as all conic sections).
- Complex numbers

- Long division of polynomials
- Summative quiz for finding equations of all types covered so far based on their graphs or data from their graphs (rational, radical, polynomial, linear, exponential, and logarithmic functions, as well as all conic sections)
- Linear, quadratic, and polynomial word problems (problems involving gravity and fluid dynamics).
- Summative graphing quiz for all types of functions covered so far (rational, radical, polynomial, linear, exponential, and logarithmic functions, as well as all conic sections).