CSU GE BREADTH SUBAREA B4 and IGETC AREA 2

Mathematics/Quantitative Reasoning, Mathematical Concepts and Quantitative Reasoning

Mathematics/Quantitative Reasoning   **CSU General Education Breadth Requirements**

Through courses in Subarea B4 students shall demonstrate the abilities to reason quantitatively, practice computational skills, and explain and apply mathematical or quantitative reasoning concepts to solve problems. Courses in this Subarea shall include a prerequisite reflective only of skills and knowledge required in the course. In addition to traditional mathematics, courses in Subarea B4 may include computer science, personal finance, statistics or discipline-based mathematics or quantitative reasoning courses, for example.

Mathematical Concepts and Quantitative Reasoning   **IGETC Standards 2.3**

Area 2A Mathematical concepts and Quantitative Reasoning may be met by a baccalaureate course in Mathematics, Statistics, or other Quantitative Reasoning Course. Courses outside the discipline of math using the application of statistics may be used to fulfill this requirement. Historically, the prerequisite for 2A courses was intermediate algebra or equivalent.* Currently, some courses use intermediate algebra as a prerequisite but others include co-requisite content or build the prerequisite skill development into the course itself.

In addition, courses should have their primary purpose and content focused on appropriate mathematics/quantitative reasoning. An appropriate course in statistics must emphasize the mathematical basis of statistics, probability theory and estimation, application and interpretation, uses and misuses, and the analysis and criticism of statistical arguments in public discourse.

As knowledge relevant to public and private decision making is expressed frequently in quantitative terms; we are routinely confronted with information requiring quantitative analysis, calculation, and the ability to use and criticize quantitative arguments. In addition, many disciplines require a sound foundation in mathematical concepts. The requirement in Mathematical Concepts and Quantitative Reasoning is designed to help prepare students to respond effectively to these challenges.

Courses approved to fulfill this requirement must focus on quantitative analysis and the ability to use and criticize quantitative arguments. Symbolic Logic, Computer Programming, Mathematics for Teachers and survey courses such as Math in Society, were deemed unacceptable to fulfill the Mathematical Concepts

and Quantitative Reasoning requirement; math survey courses may fulfill this requirement if the focus is on mathematical concepts and quantitative analysis.

"Stretch" Mathematics or Statistics courses (i.e., blended courses that include both transferable content and remedial content) may be approved only if both/all courses in the "stretch" course sequence are successfully completed with "C" grade or higher or the equivalent* (2.0 on a 4.0 scale) and the transferable course content is otherwise comparable to a 'standard' Mathematics or Statistics course.

*The equivalent should cover the content and mathematical practices of the Common Core State Standards for Mathematics, or CCSSM. Statistics course prerequisites/co-requisites should be consistent with CCSSM math standards and teach the skills and knowledge without which the student is highly unlikely to succeed in college-level statistics. For details see the UCTCA Guidelines for Mathematics and Statistics: https://www.ucop.edu/transfer-articulation/transferable-course-agreements/tca-policy/regulations-by-subject-area.html

CSU GE Breadth Area B	IGETC Area 2
B4 Mathematics/Quantitative Reasoning • courses shall include a prerequisite reflective only of skills and knowledge required in the course • courses must have as their primary purpose for students to demonstrate the abilities to reason quantitatively, practice computational skills, and explain and apply mathematical or quantitative reasoning concepts to solve problems • may include computer science, personal finance, statistics or discipline-based mathematics or quantitative reasoning courses	**2A Mathematical Concepts and Quantitative Reasoning** • fulfilled by completion of a Mathematics, Statistics, or other Quantitative Reasoning course • prerequisite for 2A was intermediate algebra or equivalent.* Currently, some courses use intermediate algebra as a prerequisite or co-requisite content or build the prerequisite skill development into the course • courses should have their primary purpose and content focused on appropriate mathematics/quantitative reasoning • courses outside the discipline of math using the application of statistics may be used to fulfill this requirement • appropriate course in statistics must emphasize the mathematical basis of statistics, probability theory and estimation, application and interpretation, uses and misuses, and the analysis and criticism of statistical arguments in public discourse

	• courses approved to fulfill this requirement must focus on quantitative analysis and the ability to use and criticize quantitative arguments

Given the ubiquity of quantitative and statistical information that the public encounters, successful completion of a mathematics/quantitative reasoning course is an important driver of equitable outcomes and social mobility. The requirement in Mathematical Concepts and Quantitative Reasoning is designed to support students in their pursuit of these goals. Courses approved to fulfill this requirement must have as their primary purposes the development of a general understanding of how practitioners and scholars build mathematical models and solve problems using quantitative methods, and the development of quantitative skills leading to a proficient and fluent ability to reason quantitatively in their subsequent courses and after graduation in the various contexts defined by personal, civic, and professional responsibilities.

CSU GE Breadth Subarea B4 Mathematics/Quantitative Reasoning (QR) Guidelines and Principles[1]

Courses submitted for CSU GE Breadth Subarea B4 approval shall ask students to:
- interpret and communicate quantitative information and mathematical and statistical concepts using language appropriate to the context and intended audience;
- make sense of problems, develop strategies to find solutions, and persevere in solving them;
- reason, model, draw conclusions, and make decisions with quantitative information about problems arising in everyday life, society, and the workplace;
- construct, critique, and evaluate quantitative arguments that utilize mathematical, statistical, and quantitative information;
- use appropriate tools strategically.[2]

Statistics courses, in particular, shall ask students to:
- produce and interpret graphical displays and numerical summaries;
- recognize questions for which the investigative process of statistics is useful and answer questions using that process
- have a conceptual and computational understanding of descriptive and basic inferential statistical methods;
- recognize and explain the roles of variability in statistics and randomness in designing studies and drawing conclusions;

---

[1] These guidelines and principles align with the CSU Math Council, CSU GE Area B4 Mathematics/Quantitative Reasoning Course Guidelines and Principles, approved 4/10/2020.
[2] Drawn from Dana Center QR Learning Outcomes, Common Core Standards for Mathematical Practice, Committee on the Undergraduate Program in Mathematics Curriculum Guide 2004

- demonstrate an understanding of concepts useful in building statistical literacy such as correlation is not causation and the difference between statistical significance and practical importance.[3]

Courses that do not make significant use of quantitative reasoning are excluded from Subarea B4. These include:
- courses in the history of mathematics
- computer programming courses
- symbolic logic courses

Computer Science courses that go beyond programming concepts, methodologies, and fundamental techniques to meaningfully address quantitative information may be acceptable.

Personal Finance courses require a mathematics prerequisite reflective only of skills and knowledge required in the course and/or appropriate mathematics skills advisory.

Quantitative Reasoning courses (beginning with the fall 2018 semester) without a stated prerequisite of intermediate algebra or equivalent may be approved for CSU GE Breadth but may not qualify for IGETC.

Survey courses are excluded from IGETC but are acceptable for CSU GE Breadth if they meet the expectations outlined in this document for CSU GE B4 courses.

For general QR courses such as Math for Liberal Arts, Mathematics for Practical Purposes, Introduction to Mathematical Modelling, and more targeted introductory courses such as Personal Finance, students should be proficient in a broad set of skills and knowledge from 8th grade mathematics, geometry, and Algebra I (or equivalent).

Students enrolling in these courses should be able to:[4]
- demonstrate procedural fluency with real number arithmetic operations and using those operations to represent real-world scenarios and to solve stated problems;
- evaluate with the use of technology expressions that involve arithmetic with signed numbers, square roots, squaring, exponents, factorials, and summation notation;
- demonstrate number sense, including dimensional analysis and conversions between fractions, decimals, and percentages;
- represent numbers, intervals, and inequalities on the number line;
- make estimates and predications, understand when approximations are appropriate and when exact calculations are necessary;

---

[3] Drawn from UC transfer regulations for courses in specific subject areas, Guidelines for Assessment and Instruction in Statistics Education (GAISE) College Report 2016, CID Descriptor for Math 110
[4] Drawn from Dana Center Quantitative Reasoning Course, Statement on Competencies in Mathematics Expected of Entering College Students, California Common Core State Standards: Mathematics

- evaluate, and apply linear, quadratic, and absolute value expressions and formulas;
- use information about functions and features of graphs to model relationships between quantities (positive, negative, increasing, decreasing, etc.);
- solve, graph, and interpret linear equations and inequalities; solve problems modeled by linear equations;
- demonstrate an understanding of displays of data such as tables, bar charts, histograms, pie charts, and line graphs;
- use data to calculate and interpret median, and mean;
- solve application problems applying measurement and geometry topics such as distance, area, perimeter, and volume

Courses in **elementary statistics** may be offered by multiple departments, including business, economics, mathematics, social science, and science. Students should be proficient in a broad set of skills and knowledge from 8th grade mathematics, geometry, and Algebra I (or equivalent). Students enrolling in these courses should be able to:[5]

- work with numerical information:
  - ordering decimals, order of operations, operations with fractions and percentages,
  - converting fractions to decimals and percentages,
  - representing numbers, intervals, and inequalities on the number line.
- evaluate expressions with the use of technology that involve arithmetic with signed numbers, square roots, squaring, exponents, factorials, and summation notation;
- solve simple linear equations in one variable;
- model linear models;
  - interpreting slope and intercept;
  - graphing a line and points;
  - making predictions;
  - calculating vertical deviation of a point from the line;
- approximate areas of specified regions given the area under a curve or histogram;
  - extracting information from graphs and tables;
- understanding set notation and diagrams;
  - finding the complement of a set;
  - finding the union and intersection of two sets.

For courses that require stronger algebra skills, such as finite math, college algebra, or precalculus, the prerequisite skills and knowledge will also include topics from

---

[5] Drawn from UC Requirements for Transferable Courses and Dana Center Math Prerequisites for Success in Introductory Statistics

Algebra II. In addition to the topics listed for general QR courses, students enrolling in these courses should be able to:[6]

- Evaluate and apply polynomial, rational, exponential, power, rational, and trigonometric expressions and formulas;
- solve, graph, and interpret quadratic equations; solve two linear equations in two unknowns; solve problems modeled by quadratic equations;
- perform arithmetic operations on polynomials and rational expressions; apply factoring techniques to simplify expressions and locate roots;
- understand the relationship between the multiple representations (variable, graph, data, words) of various functions (quadratic, power, exponential, rational, trigonometric functions);
- find inverse functions;
- create and interpret mathematical models, by building functions that describe a given situation;
- use the concepts of congruence, similarity, and symmetry to demonstrate relationships in geometric figures such as lines, triangles, circles, quadrilaterals, and other polygons;
- use trigonometric ratios to solve problems involving right triangles;
- understand the graphs and properties of trigonometric functions;
- analyze data to calculate center (mean and median), and measures of spread (standard deviation and interquartile range);
- describing data, interpreting summaries of data, and making predictions based on the data;
- demonstrate a basic understanding of inductive and deductive reasoning, hypotheses and conclusions.

Across all CCC courses that are approved for CSU GE Breadth (including Subarea B4), the course content and outcomes must be baccalaureate level, requiring as prerequisite the skills and knowledge developed in high school that are needed for the given course.

Note: With the issuance of CSU EO 1110 Revised, CSU students will no longer be required to complete remedial courses but will enroll in courses with support as indicated by multiple measures. Similarly, we leave it to the individual CCC to determine how students who have not completed the prerequisites to Subarea B4 courses will be supported to succeed (e.g., traditional remedial courses, co-requisite, stretch, or pathways models).

CSU GE Breadth: Math courses developed specifically for students preparing to teach elementary school are ***excluded from IGETC but acceptable in CSU GE Breadth.*** CSU math faculty have asked reviewers to check for inclusion of specific elements of math instruction before granting approval. (For Subarea B4 requirements, see Approving Math Courses for Elementary School Teachers on page 31.)

---

[6] Drawn from Statement on Competencies in Mathematics Expected of Entering College Students, California Common Core State Standards: Mathematics, DCMP Reasoning with Functions II

Approving Math Courses for Elementary School Teachers (CSU GE Breadth pattern only)

Math courses designed as part of a teacher preparation or liberal studies curriculum must meet specific criteria to qualify for Subarea B4 of CSU GE Breadth. Faculty have asked that such courses include *all* of these elements listed in the March 2013 posting of the C-ID Math 120, "Mathematical Concepts for Elementary School Teachers - Number Systems."

Course Topics: In conformity with ESM standards, topics must include, but are not limited to:

1. Numeration systems: history, Hindu-Arabic numeration system, and place value systems;
2. Integers: structure and basic properties, computational algorithms;
3. Basic number theory: divisibility, prime and composite numbers, prime factorization, fundamental theorem of arithmetic, least common multiple and greatest common divisor;
4. Rational numbers: structure and properties, ratio and proportion;
5. Real numbers: structure and basic properties, arithmetic operations, rational and irrational numbers, decimal representation, number line representation;
6. Patterns, problem solving, communication, connections, modeling, reasoning, and representation; and
7. National and state curriculum standards for elementary school math including Common Core State Standards.

Student Learning Outcomes: In conformity with ESM standards, course outcomes must include, but are not limited to:

1. Perform calculations with place value systems;
2. Evaluate the equivalence of numeric algorithms and explain the advantages and disadvantages of equivalent algorithms in different circumstances;
3. Apply algorithms from number theory to determine divisibility in a variety of settings;
4. Analyze least common multiples and greatest common divisors and their role in standard algorithms;
5. Explain the concept of rational numbers, using both ratio and decimal representations; analyze the arithmetic algorithms for these two representations; and justify their equivalence;
6. Analyze the structure and properties of whole, rational, and real number systems; define the concept of rational and irrational numbers, including their decimal representation; and illustrate the use of a number line representation;
7. Develop and reinforce conceptual understanding of mathematical topics through the use of patterns, problem solving, communication, connections, modeling, reasoning, and representation*;* and
8. Develop activities implementing curriculum standards.