Honolulu Community College
University of Hawai'i
General Education
Foundations Course Designation Proposal Form
For Fall 2014 – Summer 2018

Global & Multicultural Perspectives  Symbolic Reasoning  Written Communication

The Honolulu Community College Foundations Board will review all proposals to ensure that approved courses meet Foundations Hallmarks. If clarification is needed, a Board member will contact you. If the Foundations Board and the General Education Committee approve the proposal, all sections of the course will be designated as satisfying the requirement. The course will be reviewed every five years.

1. Course information.
   Course Alpha MATH Course Number 103
   If the course is cross listed, please provide the cross-listing: Alpha Number

   Course Title: College Algebra

2. Foundations area requested. Check one.
   Global & Multicultural Perspectives ☒  Symbolic Reasoning ☒  Written Communication ■

3. How many instructors currently teach this course? It makes a difference if there are only one or two instructors teaching this course versus ten instructors teaching this course. This question is asked to get an idea of how many instructors the department needs to communicate with to discuss this foundation course.

4. Syllabus. Submit a master syllabus. If multiple instructors teach the course and use varying texts and/or assignments, please include multiple representative syllabi for comparison. (Three is recommended.)

5. Hallmark Requirements. Provide an explanation of how each of the hallmarks for this proposed Foundation course will be satisfied. Try to completely answer how the course intends to meet each particular hallmark. Referencing assignments, tasks, and evaluations used in the course (as stated on the syllabus /syllabi being submitted) as supporting evidence would be very helpful.

6. Assessment. Provide a brief explanation of how the department will periodically review that this course has been meeting the Foundations Hallmarks including a description of what kinds of evidence will be collected to demonstrate this (Knowledge Survey results, sample of exam responses, writing samples, etc.). Also include a detailed description of how the department plans to have all instructors of this course share information with each other regarding how the hallmarks have been met. Please include a brief explanation of the assessment tools you will use to make this determination (such as Knowledge Surveys, Exams, Projects, Portfolios, etc.) and how you will use the results to make course improvements.

7. Signatures. The signatures of the initiator and the initiator's Division Chair are required. The completed proposal must be routed to the Chair of the CPC before being delivered to the chair of the Foundations Board. No action on the part of the CPC is required unless the proposal also includes a new course Curriculum Action or a course modification Curriculum Action. The "routi ng" is a courtesy to the CPC. Signatures indicate approval/acceptance.

Initiated by: Steven Mandraccia
   Initiator’s printed name Date 4/7/2016

Approved by: Michael Ferguson
   Division Chair’s printed name Date 4/12/16

Routed via: Kara Kam-Kalani
   CPC Chair’s printed name Date 4/15/16

Accepted by: Steven Mandraccia
   Foundation Board Chair’s printed name Date 4/11/2016

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Math 103 College Algebra

Official Course Description

This course is an extension of the concepts learned in elementary algebra and prepares the students for pre-calculus. Topics include units on algebraic simplification of polynomial, rational, exponential, and radical expressions, as well as solving equations in inequalities involving absolute value, polynomial, rational, exponential, and radical expressions, and the graphing of parabolas.

This course fulfills the Symbolic Reasoning requirement for the Foundation requirement for Honolulu Community College and all campuses belonging to the Multi-Campus Foundations Agreement.

Symbolic Reasoning Objectives:

Students will

- Demonstrate an understanding of the beauty, power, clarity, and precision of formal systems through guided practice in problem solving involving linear, quadratic, rational and radical equations or inequalities.
- Demonstrate through performances on assessment exams, classwork, and homework exercises the concept of proof as a chain of inferences.
- Apply formal rules of algorithms in simplifying algebraic expressions and solving linear and non-linear equations and systems of equations.
- Demonstrate correct and effective use of the symbolic rules of algebra on assessment exams, classwork, homework exercises or related projects.
- Analyze rules and theorems to find the most effective solutions to problems.
- Apply algebraic principles to solve real-world problems related to real-world problems.

Course Specific Learning Objectives:

The student will

- Solve equations and inequalities involving absolute values
- Solve systems of equations in three unknowns and nonlinear systems in two unknowns.
- Raise binomials to the nth degree using Pascal’s triangle or the Binomial Theorem
- Factor polynomials using techniques such as grouping, sum and difference of two cubes and completing the square, including problems with greater complexity than elementary algebra
- Perform operations on rational expressions and solve rational equations, including problems with greater complexity than elementary algebra
- Change from rational exponents to radicals and visa versa, including problems with greater complexity than elementary algebra.
- Perform operations on radicals and solving radical equations containing more than one radical, including problems with greater complexity than elementary algebra
- Perform arithmetic operations with complex and imaginary numbers
• Solve quadratic form and literal quadratic equations
• Use the discriminant to determine the number and nature of the solutions of a quadratic equation.
• Analyze and graph a parabola including finding its vertex by completing the square.
• Solve compound linear and quadratic inequalities
• Divide polynomials using synthetic division
• Recognize functions through graphs and equations, stating their domains and ranges
• Use function notation
• Determine the algebraic and graphical properties of a one-to-one function
• Find the inverse function of a one-to-one function
• Define and graph basic exponential and logarithmic functions
• Solve basic exponential and logarithmic equations

In general, the course is designed to provide the student with skills and knowledge necessary to handle pre-calculus courses such as Math 135, and Math 140. Upon completion, students are expected to have a clearer understanding of, and deeper insight into, algebraic and related geometric concepts, operations, and techniques.

**Foundations Hallmarks – Symbolic Reasoning**

1. *Students will be exposed to the beauty, power, clarity, and precision of formal systems. How will the course meet this hallmark?*

When a student simplifies a math expression, it must be transformed into an equivalent object with fewer symbols and smaller numbers. Simplifying occurs through the entire course. This requires a process using various definition laws and theorems to obtain an equivalent expression with fewer symbols and smaller numbers.

This is a powerful process where, for example, expressions of 27 characters can be reduced to 15 characters. This requires the use of more than 20 applicable definitions, laws, theorems, and formulas that are done in a chain of inferences. The beauty is evident when a complicated expression can be elegantly expressed in a few symbols.

In addition, the simplified expression or equation can often be used as a powerful tool to model or analyze other relationships. For example, from Physics we have the formula, $E = mc^2$. These 5 symbols show the relationship between mass and energy (created by Einstein to resolve a major physics problem in his era.)

The precision and clarity of using these formal systems can be clearly seen when one problem can be solved in a variety of ways. For example: $a^n - b^m$ can be factored in two different ways with the same result: $(a - b)(a + b)(a^2 + ab - b^2)(a^2 - ab + b^2)$. 
2. *Instructors will help students understand the concept of proof as a chain of inferences. How will instructors help students understand this concept?*

The instructor will demonstrate the development of the tools and formulas used in algebra, which in each case requires a proof process.

**Example:** The derivation of quadratic formula requires a chain of inferences, using completion of squares and basic axioms of equality.

Starting with the quadratic equation in standard form: \[ ax^2 + bx + c = 0 \]

**Completing the squares** to achieve the form desired:

\[
a \left[ x^2 + \frac{b}{a}x + \left( \frac{b}{2a} \right)^2 \right] = -c + a \left( \frac{b}{2a} \right)^2
\]

Creating the “perfect square trinomial”

\[
\left[ x + \frac{b}{2a} \right]^2 = -\frac{4ac + b^2}{4a^2}
\]

Using basic axioms of equality.

\[
x + \frac{b}{2a} = \pm \sqrt{\frac{b^2 - 4ac}{4a^2}}
\]

Using basic axioms of equality.

Including square root of both sides.

Finally,

\[
x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}
\]

Using basic axioms of equality and simplifying the algebraic expression.

The student is expected to understand and reproduce these steps in the proof with numbers in place of literal coefficients. The student will be tested on this method, specifically, on homework and written exams; steps and procedure are considered as important as final answers.

**Example:** The Properties of Logarithms are presented with proof, as well. The first Law, for example, with \( a > 0, \ a \neq 1, \ A > 0, \ B > 0 \) is \( \log_a (AB) = \log_a A + \log_a B \)

**Proof:** Let \( \log_a A = u \), Let \( \log_a B = v \)

\[
A = a^u \quad \text{and} \quad B = a^v \quad \text{by definition of the logarithmic function}
\]

\[
AB = a^u a^v = a^{u+v} \quad \text{by rules of exponents}
\]

\[
\therefore \log_a AB = u + v = \log_a A + \log_a B
\]

Expanding on the proofs of these Properties, the student will demonstrate his understanding by proving the equivalence of different representations of a logarithmic expression, using the appropriate Properties in homework problems and tests. A sample question is to verify using the properties of logarithms that

\[
\log_a \sqrt{x^2 - xy} = \frac{1}{2} \log_a x + \frac{1}{2} \log_a (x - y).
\]
Also, as previously mentioned, the reduction of large valid collection of algebraic symbols into a smaller equivalent collection (simplified) is accomplished by a chain of mathematical theorems, definitions, laws, and rules of simplification. The instructor will explain and demonstrate several representative problems in class on the usage of the appropriate mathematical theorems, laws, and properties for simplification.

3. **Instructors will teach students how to apply formal rules or algorithms.** How will instructors meet this hallmark?

Every step in simplifying an expression or solving an equation requires application of a formal rule or algorithm. Recognizing when to apply the appropriate algorithm is a skill that must be developed in this course. Not only will the instructor demonstrate these algorithm applications in simple as well as complex examples, the student will be required to do the same in his homework and assessments. Answers alone will not be sufficient. Although the student may not be required to state the algorithm or reason for each transformation, he will definitely need to show his logical steps.

Example: Solving the following equation for $x$: \[
\left(\frac{x}{x-2}\right)^2 + \left(\frac{x}{x-2}\right) = 2
\]

1. \[u = \frac{x}{x-2}\] Recognizing the quadratic form of the equation, use the substitution.

2. \[u^2 + u = 2\] Re-write the equation in transformed state.

3. \[u^2 + u - 2 = 0\] Re-write equation into standard form, using the equality axiom \[(a = b, \text{ then } a - c = b - c)\]

4. \[(u + 2)(u - 1) = 0\] Using factoring as a tool, transform the expression. (Here, he may choose to use the quadratic formula, unless otherwise directed.)

5. \[
\begin{align*}
u + 2 &= 0 \Rightarrow u &= -2 \\
u - 1 &= 0 \Rightarrow u &= 1
\end{align*}
\] Zero Product Rule

6. \[2 = \frac{x}{x-2}\] or \[1 = \frac{x}{x-2}\] Substitution for further solution

(remainder of solution left out)

Continuing in the same manner, the student is expected to show a logical sequence of equivalent equations and actions based on formal rules and algorithms to finally result in the solution, which should be checked for validity.

4. **Students will be required to use appropriate symbolic techniques in the context of problem solving, and in the presentation and critical evaluation of evidence.** What symbolic techniques will be required and in what contexts? How will presentations and evaluations of evidence be incorporated into the course?
The constant use of symbolic techniques is required in this course, in setting up the problem, simplifying expressions and solving the equation or inequality. The student learning outcomes listed above cover the multitude of symbolic techniques used in this course.

Example 1: At a power station, the difference between two sources of power, x and y, is constantly monitored. If the difference exceeds 5 volts, a warning light turns on. Express this inequality (when the light turns on) using absolute-value notation. Answer: \(|x - y| > 5|

Checking: If the difference is larger than \(+5\) the absolute value is larger than \(+5\) and the light will turn on.

Example 2: The student will learn that the radical sign and the rational exponent are alternate ways of expressing the same thing and must able to work with them easily in more complex expressions than in elementary algebra. Every step of the following solution requires use of symbolic techniques.

Solve for \(x\): 
\[
\sqrt[3]{x^2} \cdot \sqrt[3]{x} = 1
\]

\[
(x^2)^{\frac{1}{3}} \cdot (x)^{\frac{1}{3}} = 1
\]

\[
x \cdot x^{\frac{1}{3}} = 1
\]

\[
x^{\frac{4}{3}} = 1
\]

\[
x = 1^{\frac{3}{4}}
\]

\[
x = 1
\]

Check for valid solution:

\[
\sqrt[3]{x^2} \cdot \sqrt[3]{x} \geq 1
\]

\[
\sqrt[3]{1^2} \cdot \sqrt[3]{1} \geq 1
\]

\[
1 = 1 \quad \text{True}
\]

The instructor will incorporate demonstrations and examples ranging from the simple to more complex problems as example 2. Evidence of the correctness of their solutions will be their check.

5. Include computational and/or quantitative skills. What reasoning skills will be taught in the course? What computational and/or quantitative skills will be taught in the course? How will you assess this and provide evidence that students are meeting this hallmark?

Although computational skills are necessary for efficient and basic numeric manipulation, reasoning and algebraic skills are the primary focus in this course. The use of calculators is allowed, especially for more complex computations.

Reasoning skills are essential to this course. There are various methods and processes to solve different kinds of problems. Some of the methods and processes are similar and can be used in the wrong situation. So the student must reason on how to solve most problems by using the correct algebraic law, property, theorem, or formula in order to get to the correct answer.

For example, suppose a student determines that the graph of a given parabola \(y = ax^2 + bx + c\) does not intersect the x-axis. However, by using the quadratic formula, he is able to find two real zeroes for the same parabola when \(y=0\), i.e. \(0 = ax^2 + bx + c\). Using his reasoning skills, he must conclude that these two results are contradictory and seek to find the correct solution.
6. **Instructors will build a bridge from theory to practice and show students how to traverse this bridge. How will instructors help students make connections between theory and practice?**

Many real world applications of algebra will be studied throughout the course. General examples are:

1) Linear functions to compare different pricing plans.
2) Absolute value problems to show tolerance ranges.
3) Quadratic functions to show maximum and minimum problems in surface areas.
4) Exponential functions to study bacterial growth or compound interest.

A specific application using rational expressions is the resistance formula in electronics. The total resistance \( R_T = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n} \). The student must be able to solve for \( R_T \), given \( n \) is a small number, such as \( n = 3 \).

Most of the contents of the lectures, homework and tests are practiced in solving various algebra problems to bridge the theory to correct practice.

**Assessment**

Any faculty member assigned to teach Math 103 must become familiar with both the course content and the FS hallmarks. The learning outcomes and FS hallmarks will be assessed by the use of embedded questions on exams. It is the responsibility of the math department liaison to meet with the instructor(s) and ensure that the course learning outcomes and the FS hallmarks are being satisfied. Math 103 faculty will meet, beginning with the spring 2011 semester to correlate the learning outcomes with the appropriate hallmark and to specify which questions to embed and determine whether the FS hallmarks are being addressed via the specific questions chosen. After the initial assessment, the Math 103 faculty will meet each year for a two year period to determine whether the FS hallmarks are being addressed. After the initial assessment, the Math Faculty will meet every three years for a review of the process.
Math 103  
College Algebra

COURSE DESCRIPTION: The course is a brief review of elementary algebra, introduction to functions, including linear and quadratic functions, fractional exponents, logarithms and other selected topics. (3 credits)

PREREQUISITES: “C” or higher in MATH 25 or placement in MATH 103.

This course fulfills the Symbolic Reasoning requirement for the Foundation requirement for Honolulu Community College and all campuses belonging to the Multi-Campus Foundations Agreement.

SYMBOLIC REASONING OBJECTIVES:

Students will

- Demonstrate an understanding of the beauty, power, clarity, and precision of formal systems through guided practice in problem solving involving linear, quadratic, rational and radical equations or inequalities.
- Demonstrate through performances on assessment exams, classwork, and homework exercises the concept of proof as a chain of inferences.
- Apply formal rules of algorithms in simplifying algebraic expressions and solving linear and non-linear equations and systems of equations.
- Demonstrate correct and effective use of the symbolic rules of algebra on assessment exams, classwork, homework exercises or related projects.
- Apply algebraic principles to solve real-world problems related to real-world problems.

COURSE OBJECTIVES AND OUTCOMES: Using instructor selected evaluation tools, the student will

- Solve equations and inequalities involving absolute values
- Solve systems of equations in three unknowns and nonlinear systems in two unknowns.
- Raise binomials to the nth degree using Pascal’s triangle or the Binomial Theorem
- Factor polynomials using techniques such as grouping, sum and difference of two cubes and completing the square, including problems with greater complexity than elementary algebra
- Perform arithmetic operations on rational expressions and solve ration equations, including problems with greater complexity than elementary algebra
- Change from rational exponents to radicals and visa versa, including problems with greater complexity than elementary algebra.
- Perform operations on radicals and solving radical equations containing more than one radical, including problems with greater complexity than elementary algebra
- Perform arithmetic operations with complex and imaginary numbers
- Solve quadratic form and literal quadratic equations
- Use the discriminant to determine the type of roots of an equation
- Graph quadratic functions including finding its vertex by completing the square
- Solve compound linear and quadratic inequalities
- Divide polynomials using synthetic division
- Recognize functions through graphs and equations, stating their domains and ranges
• Use function notation
• Determine the algebraic and graphical properties of a one-to-one function
• Find the inverse function of a one-to-one function
• Define and graph basic exponential and logarithmic functions
• Solve basic exponential and logarithmic equations

In general, the course is designed to provide the student with skills and knowledge necessary to handle pre-calculus courses such as Math 135, Math 140 and QM 121. Upon completion, students are expected to have a clearer understanding of, and deeper insight into, algebraic and related geometric concepts, operations, and techniques.

**TEXT AND REFERENCES:** *Algebra for College Students* by Allen R Angel. There is a single copy of this textbook that can be checked out from the library for two hours.

**EQUIPMENT AND MATERIALS:** The student will be required to purchase and know how to use, a scientific calculator. A calculator may be used on all homework and all tests, but you must show appropriate work on your paper for grading.

**METHODS OF INSTRUCTION:** This course will be taught in an informal lecture/interactive format. Regular attendance is expected and attendance is taken. Regular homework will be assigned and students are expected to do all homework problems before the next class. Group work is encouraged, but test scores are based on individual performance.

**METHODS OF EVALUATION:**

**Homework:** All homework assignments are collected, graded and returned. The cumulative homework grade has the same weight as a one test. Test problems will be very similar to your homework problems, so if you know how to do the homework, you should do well on the test. A list of assigned problems will be given out in advance, with the due date for each assignment. Late homework will be penalized, but may be turned in early for no penalty. Check your answers in the back of the book for the odd problems.

**Tests/Grade:** The test dates will be given in advance and you are expected to take each test as scheduled. You may NOT take a test over, so you must prepare for each test. If you miss a test due to sickness or an emergency or are going to miss a test, let me know (you or someone) by email, phone message or in person, so I can put a make-up test in the Testing Center (building 7, third floor) for you. Let me know when you have taken the make-up, so I know when to pick it up from the testing center. You are allowed ONE make-up test, to be taken before the next class, without penalty. Another make-up test or one taken after the next class day, may be assessed a penalty.

The final exam covers the entire course, including the last lecture. There is no make up for the final exam.

Tests have a raw grade of more than 100 points, but scaled to 100 points by calculating the percent. Your course grade is the numerical average of the four tests, the homework and the final test. When each test is returned, it has your test grade, current homework and current course grade. Here is the percent to letter grade conversion:
The last day to drop/withdraw from a course with a W grade is Friday, March 17.

If you decide to stop coming to this class, please contact me first before doing so. I am open to reasonable ways to help you through this course. Otherwise, please officially withdraw from this class. A “W” grade is better than an “F” grade.