

Text: “Modern Precalculus”, AY2021-22 edition, by Mike Price

Coordinator: Mike Price (mprice@uoregon.edu, 6-0991)

Course Materials: There is no universal calculator policy for Math 111. However, some calculator use may be worthwhile for students, and you may need to consider available functions. Calculators like the TI-89, TI-92 and some Casio calculators (e.g. Casio FX-115ES and FX-991ES) can do differentiation and integration. The Casio calculators are not “graphing calculators”, so simply banning any calculators that graph is insufficient. You may need to be *very specific* about your calculator policy if you want to limit this kind of assistance on exams.

Course Objectives: The course-level objectives for a student completing the class are the following.

(CO 1): Manipulate algebraic equations and expressions fluently

(CO 2): Use functions to express a relationship between two variables

(CO 3): Translate bidirectionally between English descriptions and mathematics models

(CO 4): Determine the characteristics of linear, quadratic, polynomial, rational, exponential, logarithmic, and power functions

(CO 5): Build new functions using arithmetic, composition, and inversion of provided functions

Learning Objectives: A successful student should be able to succeed at an exam which focuses on the essential learning objectives (indicated by “ELO”), contains a lesser focus on supporting objectives (indicated by “LO”), and may or may not contain content on the additional objectives. Remember that a single task can incorporate multiple learning objectives. (Linked Course Objectives appear in parentheses following each learning objective.)

ELO 1.1: Evaluate a function at numeric and symbolic inputs (CO 1, 2)

ELO 1.2: Interpret the input and output of a function within an applied context (CO 3)

ELO 1.3: Identify the largest possible domain of a function containing division or radicals (CO 1, 2)

LO 1.4: Find the input(s) of a function, given an output, by solving linear and quadratic equations (CO 1, 2)

LO 1.5: Find the domain and image of a function defined by table or graph (CO 1, 4)

LO 1.6: Draw the graph of a function on a suitable domain (CO 2)

LO 1.7: Determine the practical domain of a function described in a non-mathematical context (CO 1, 3)

LO 1.8: Evaluate and solve equations involving piecewise-defined functions (CO 1, 2)

ELO 2.1: Compute the average rate of change in functions on an interval – including an interval of arbitrary constants, e.g. the difference quotient (CO 1, 2)

ELO 2.2: Model a linear function from a written context (CO 3, 4)

ELO 2.3: Construct the equation of a line given two points or a point and a slope (CO 2, 4)

LO 2.4: Identify a function as increasing, decreasing, or constant on an interval (from the function’s graph) (CO 2)

- LO 2.5: Interpret the slope of a line in an applied context (CO 3)
- LO 2.6: Construct piecewise-linear functions from graph or written description (CO 3, 4)
- ELO 3.1: Write a quadratic in root form, using three data points or a product of linear functions (CO 3, 4)
- ELO 3.2: Write a quadratic in vertex form, using the vertex and another data point (CO 3, 4)
- ELO 3.3: Find the vertex of a parabola and interpret its value as an extremum (CO 1, 4)
- ELO 3.4: Classify the long-term behavior of a polynomial function (CO 4)
- LO 3.5: Identify a function as quadratic from its formula or table (CO 4)
- LO 3.6: Identify an expression as being a polynomial or not (CO 4)
- ELO 4.1: Model a rational function as a ratio of polynomials within an applied context (CO 1, 3)
- ELO 4.2: Use the principle of ratios of small and large numbers to infer long-term behavior of basic rational functions (CO 4)
- ELO 4.3: Use long-term behavior of polynomials to infer long-term behavior of non-basic rational functions (CO 4)
- LO 4.4: Model a rational function with unknown parameters which is fit to data (CO 1, 3)
- LO 4.5: Use inverse proportionality to write a function with a negative exponent (CO 4)
- LO 4.6: Identify whether or not a function is rational (CO 4)
- ELO 5.1: Determine an exponential function's constant growth factor and relative growth rate (CO 4)
- ELO 5.2: Model an exponential function of the form $a(1+r)^t$ or $a \cdot b^t$ which is fit to two data points (CO 1, 3)
- LO 5.3: Compute percentage change in a function over an interval (CO 1)
- LO 5.4: Identify a function or phenomenon as exponential growth or decay (CO 4)
- LO 5.5: Sketch the graph of an exponential function (CO 4)
- LO 5.6: Determine the long-term behavior of an exponential function (CO 4)
- LO 5.7: Identify the domain and image of an exponential function (CO 4)
- LO 5.8: Apply characteristics of exponential functions to applications in finance (CO 4)
- ELO 6.1: Use the definition of the logarithm to solve exponential and logarithmic equations (CO 1, 4)
- ELO 6.2: Model a logarithmic function which is fit to two data points (CO 1, 3)
- ELO 6.3: Model a power function which is fit to two data points (CO 1, 3)
- LO 6.4: Compute, by hand, logarithms with rational number results (CO 1, 4)
- LO 6.5: Apply properties of logarithms to solve a logarithmic equation (CO 1, 4)
- LO 6.6: Identify whether or not a function is a logarithmic function (CO 4)
- LO 6.7: Identify whether or not a function is a power function (CO 4)
- ELO 7.1: Compute the composition of two functions at a point given formulas, table, and/or graphs of the functions (CO 2, 5)
- ELO 7.2: Write a simplified composition of two functions defined by formula (CO 2, 5)

- LO 7.3: Combine functions using arithmetic operations (CO 1, 5)
- LO 7.4: Interpret arithmetic operations and composition of functions in a non-mathematical context (CO 3, 5)
- ELO 8.1: *Determine if a function is one-to-one (CO 5)
- ELO 8.2: *Compute the inverse of a function at a point (CO 5)
- ELO 8.3: *Find a formula for a function's inverse (CO 2, 5)
- LO 8.4: Interpret the value of an inverse function in an applied context (CO 3, 5)

Prerequisite Objectives – Prerequisite learning objectives (PLO) that are incorporated into the course learning objectives are as follows.

- PLO 1 Express a relationship between two variables related by proportionality
- PLO 2 Write a mathematical expression defined in words by a sum, difference, product, or quotient
- PLO 3 Solve linear and quadratic equations
- PLO 4 Simplify expressions requiring combination of like terms or rules for exponents
- PLO 5 Sketch a graph of a relationship between two variables defined by formula, table, or words
- PLO 6 Identify horizontal axis and vertical axis intercepts of a graph
- PLO 7 Solve systems of equations using substitution

Additional Objectives – All additional learning objectives (ALO) together should represent no more than 5% of the points on an each assessment.

- ALO 1.1 Identify whether or not a relationship between two variables defines a function (CO 2)
- ALO 2.1 Determine if a set of three or more points is collinear (CO 4)
- ALO 3.1 Identify a relation having constant second differences as quadratic (CO 4)
- ALO 3.2 Identify zeros of polynomials algebraically and graphically
- ALO 5.1 Model an exponential function using its proportionality characteristic (CO 1, 3, 4)
- ALO 6.1 Use the defining characteristics of quadratic, polynomial, rational, power and logarithmic functions to identify which functions are of which type(s) (CO 4)
- ALO 6.2 Identify extraneous solutions of a logarithmic equation (CO 1, 4)
- ALO 6.3 Use properties of logarithms to simplify expressions (CO 1, 4)
- ALO 6.4 Identify graphs of logarithmic functions
- ALO 7.1 Find the domain of an arithmetic combination of two functions (CO 4, 5)
- ALO 7.2 Find the domain of a composite function (CO 4, 5)
- ALO 8.1 Find the domain of an inverse function (CO 4, 5)
- ALO 8.2 Sketch the graph of an inverse function (CO 5)
- ALO 8.3 Use the composition property of inverses to evaluate an expression (CO 2, 5)

A Rough Schedule of Content: This should be viewed as a tentative schedule for discussing content. With about 25 hours of lecture contact time but 15 hours of total discussion time, there should be time to do primarily new content in lecture (ideally with some student engagement) and then homework questions, assessments (e.g. quizzes, exams), review, and in-class student work in discussions.

Week	Sections to Cover	Notes
1	Review, 1	Section 1: 4 – 5 hrs Appendix Sections 10 – 13 in text are review Section 1 covers a lot of basics of functions, priority is getting them familiar with notation, solving equations/evaluating expressions with functions, and interpreting results
2	1, 2	Section 2: 3 – 4 hrs In Section 2, make sure students can interpret “such-and-such increases/decreases at a constant rate” as a linear phenomenon
3	2, 3	Section 3: 3 – 4 hrs In Section 3, second differences are an interesting (and calculus-adjacent) way to discuss quadratics, but aren’t strictly necessary Completing the square is unsupported as a solving strategy, so if you want to use it, provide all necessary resources
4	3, Review	Exam 1 (approximately sections 1 – 3) – I typically get through quadratics, but not polynomials to test on
5	4	Section 4: 2 – 3 hrs In Section 4, try to limit discussion of end behavior to comparisons of degree, true limiting behavior and notation can wait until calculus
6	5	Section 5: 2 – 3 hrs In Section 5, revisit linear relationships to compare with the constant <i>relative</i> change in exponential relationships; percentage change moved here
7	6, Review	Section 6: 5 – 6 hrs In Section 6, try to resist doing too much “write this expression as the logarithm of a single quantity”, more useful is using logarithmic properties for some additional goal (e.g. solving an equation, rewriting an expression to see that it is actually a formula for a power function) Exam 2 (approximately Sections 3 – 5) – I typically go from polynomials through rationals
8	6	
9	7	Section 7: 3 – 4 hrs In Section 7 don’t forget composition in context; also, it is fun to do composition with “mixed media” (e.g. $f(x)$ defined by formula while $g(t)$ is defined by table)
10	8, Catch-up and Review	Section 8: 2 – 3 hrs In Section 8, finding inverses is another excuse to reinforce good algebra skills; try to resist the temptation to “swap the x’s and y’s” at the beginning of the process, like many students are familiar with: variables in context have meaning which is eradicated by this practice

			Section 9 is intended to be a review section, although it isn't really labeled as such. Please take the time to at least assign exercises for practice from this set, or additionally have students work on it in class or do additional examples of this ilk. Students need practice figuring out which processes are valid when they see some random problem, and they only get that practice when they don't know what section the exercise is from
11	Final Exam	Finals exam week	No classes; Final exam at scheduled time http://registrar.uoregon.edu/calendars/final_exam?schedule=2021-2022

Additional Notes:

- If you are covering content outside of the learning objectives, it is likely because you aren't doing justice to the listed course topics. Probably it is only if you can honestly state "my students have already mastered all of the content on the course objectives" that it would be time to incorporate more material. Otherwise, consider incorporating more interesting conceptual examples (in particular if additional applications seem onerous or not your style) to reinforce the existing content rather than expanding to additional subjects like formal limits, polynomial division, or the rational roots test.
- It is extremely important that the students know that Math 111 is a pre-calculus course. It is designed for students who have a basic arithmetic and algebraic understanding that is to be built upon in order to prepare them for calculus. Not all students fit this description, but nevertheless it is the assumption.
- The content of this class may be different than you've experienced in a precalculus course (either taking one or if you've taught it elsewhere). There are fewer topics than in many other college algebra curricula, with the goal of the topics being covered in depth and with lots of varying applications. Keep in mind that probably less than 5% of the students will go on to degrees in mathematics, and that the majority enrolled are better served by a solid conceptual understanding of the topics in a social science or "hard" science context.
- Common areas of difficulty: Basic algebra (factoring, simplifying and operations on fractions), completing the square (although not explicitly required), applications of any sort and modeling in particular. Be conscious of these facts when you approach each topic and combat student resistance with detailed examples and ample opportunities for practice. Basic algebra review is most effective when integrated into new concepts, so do it on an as-needed basis. Students tend to not relate well to abstract problems and yet also have trouble with word problems because they're hard and/or contrived. It's a difficult situation to win, but a responsible math class for predominantly non-majors involves both "raw" mathematics and applications.
- Word problems should be a key feature of the course. Consider introducing new topics in a non-mathematical context (there is lots of evidence that this not only helps students learn the material to begin with, but also to retain it longer). E.g. Describing a function from the perspective of a machine like a wood-chipper or microwave oven; exponential functions from the notion of the thickness of paper after n foldings, and so on.

- Only section 9 listed as optional – and only that one in the sense that you don't have to cover the review section explicitly, but review is important. All other sections are required content for measuring student proficiency. To further that end, please use the course outcomes at the beginning of this syllabus when preparing your class lecture schedule. Ask if you have questions!
- Mike has lecture guides (or in-class worksheets, if you aren't lecturing), quizzes, exams, practice packets, and word problems available upon request. These include some great lecture guides written by Leanne Merrill (note: these are written for a different book, so the section numbers don't match, but the content has a lot in common with the current text).
- Research in instruction is clear: small, regular assessments that count (a very small amount) toward the course grade encourage learning and help students more accurately determine their standing in the course prior to a large assessment like a midterm exam. Even if you plan to primarily lecture in class, please consider including 5 – 10 minutes of regular student work time in lecture to answer quick computational or conceptual questions during class. Examples include
 - Think-pair-share questions in which students report out results in class (either verbally or by Canvas chat)
 - Quick questions given on board (or by handout), to be written up and collected at the end of each class for tiny participation-only credit
 - iClickers to answer multiple-choice questions during class (CMET in room 19 of Knight Library can get you set up)