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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 objectives (indicated by an asterisk), contains a lesser focus on supporting objectives, 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.)

1. *Evaluate a function at numeric and symbolic inputs (CO 1, 2)
2. *Interpret the input and output of a function within an applied context (CO 3)
3. *Identify the largest possible domain of a function containing division or radicals (CO 1, 2)
4. *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)
5. *Model a linear function from a written context (CO 3, 4)
6. *Construct the equation of a line given two points or a point and a slope (CO 2, 4)
7. *Find the vertex of a parabola and interpret its value as an extremum (CO 1, 4)
8. *Identify characteristics of a higher-order polynomial function (CO 4)
9. *Model a rational function as a ratio of polynomials within an applied context (CO 1, 3)
10. *Use the principle of ratios of small and large numbers to infer long-term behavior of basic rational functions (CO 4)
11. *Use long-term behavior of polynomials to infer long-term behavior of non-basic rational functions (CO 4)
12. *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)
13. *Determine an exponential function’s constant growth factor and relative growth rate (CO 4)
14. *Use the definition of the logarithm to solve exponential and logarithmic equations (CO 1, 4)
15. *Model a logarithmic function which is fit to two data points (CO 1, 3)
16. *Model a power function which is fit to two data points (CO 1, 3)
17. *Compute the composition of two functions at a point given formulas, table, and/or graphs of the functions (CO 2, 5)
18. *Write a simplified composition of two functions defined by formula (CO 2, 5)
19. *Determine if a function is one-to-one (CO 5)
20. *Find a function’s inverse given its formula, graph, table, or written description (CO 5)
21. Find the input(s) of a function, given an output, by solving linear and quadratic equations (CO 1, 2)
22. Find the domain and image of a function defined by table or graph (CO 1, 4)
23. Draw the graph of a function on a suitable domain (CO 2)
24. Determine the practical domain of a function described in a non-mathematical context (CO 1, 3)
25. Evaluate and solve equations involving piecewise-defined functions (CO 1, 2)
26. Identify a function as increasing, decreasing, or constant on an interval (from the function’s graph)
27. Interpret the slope of a line in an applied context (CO 3)
28. Construct piecewise-linear functions from graph or written description (CO 3, 4)
29. Use general, root, and/or vertex forms of a quadratic to fit a function to data (CO 3, 4)
30. Classify the long-term behavior of a polynomial function (CO 4)
31. Model a rational function with unknown parameters which is fit to data (CO 1, 3)
32. Use inverse proportionality to write a function with a negative exponent (CO 4)
33. Identify whether or not a function is rational (CO 4)
34. Compute percent change in a function over an interval (CO 2)
35. Model an exponential function using its proportionality characteristic (CO 1, 3, 4)
36. Identify a function or phenomenon as exponential growth or decay (CO 4)
37. Determine the long-term behavior of an exponential function (CO 4)
38. Identify the domain and image of an exponential function (CO 4)
39. Compute, by hand, logarithms with rational number results (CO 1, 4)
40. Apply properties of logarithms to solve a logarithmic equation (CO 1, 4)
41. Identify whether or not a function is a power function (CO 4)
42. Combine functions using arithmetic operations (CO 1, 5)
43. Interpret arithmetic operations and composition of functions in a non-mathematical context (CO 3, 5)
44. Find the domain of arithmetic combinations, and composition, of two functions (CO 1, 4, 5)
45. Interpret the value of an inverse in an applied context (CO 3, 5)
Prerequisite Objectives – Prerequisite skills to be incorporated into the course learning objectives are as follows.

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

Additional Objectives – All additional objectives together should represent 0 – 5% of the points on an each assessment.

1. Identify whether or not a relationship between two variables defines a function (CO 2)
2. Determine if a set of three or more points is collinear (CO 4)
3. Identify a relation having constant second differences as quadratic (CO 4)
4. Compute and interpret the percentage change in a function over a specified interval (CO 4)
5. Use the defining characteristics of quadratic, polynomial, rational, power and logarithmic functions to identify which functions are of which type(s) (CO 4)
6. Identify extraneous solutions of a logarithmic equation (CO 1, 4)
7. Use properties of logarithms to simplify expressions (CO 1, 4)
8. Identify the domain of composite or inverse functions (CO 4, 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.

<table>
<thead>
<tr>
<th>Week</th>
<th>Sections to Cover</th>
<th>Notes</th>
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<tbody>
<tr>
<td>1</td>
<td>Review, 1</td>
<td>Section 1: 4 – 5 hrs</td>
</tr>
<tr>
<td>2</td>
<td>1, 2</td>
<td>Section 2: 3 – 4 hrs</td>
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<tr>
<td>3</td>
<td>2, 3</td>
<td>Section 3: 3 – 4 hrs</td>
</tr>
<tr>
<td>4</td>
<td>3, Review</td>
<td><strong>Exam 1</strong> (approximately sections 1 – 3) — I typically get through quadratics, but not polynomials to test on.</td>
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<tr>
<td>5</td>
<td>4</td>
<td>Section 4: 2 – 3 hrs</td>
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<tr>
<td>6</td>
<td>5</td>
<td>Section 5: 2 – 3 hrs</td>
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<tr>
<td>7</td>
<td>6, Review</td>
<td><strong>Exam 2</strong> (approximately Sections 3 – 5) — I typically go from polynomials through rationals.</td>
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<td>8</td>
<td>6</td>
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<td>9</td>
<td>7</td>
<td>Section 7: 3 – 4 hrs</td>
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<tr>
<td>10</td>
<td>8, Catch-up and Review</td>
<td>Section 8: 2 – 3 hrs</td>
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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.

Technology: If you require a graphing calculator, use it and recommend a TI-84, TI-83 Plus or TI-83. If you do not allow the use of a calculator, be prepared to a) not use one yourself (lest ye be accused of hypocrisy) and b) write exams so that the simplification of arithmetically complex problems does not overshadow the actual concept they are being tested on. If you’re open to it, free and/or browser-based programs like Wolfram|Alpha can be of tremendous use to you and to students.

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)