Finite Mathematics and Calculus with Applications 11th edition Lial Solutions Manual

SKU: 9780135904602-SOLUTIONS

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PREFACE

This book provides several resources for instructors using *Finite Mathematics and Calculus with Applications*, Eleventh Edition, by Margaret L. Lial, Raymond N. Greenwell, and Nathan P. Ritchey, with Katherine Ritchey, Sarah Ritchey Patterson, and Blain Patterson.

- Hints for teaching *Finite Mathematics and Calculus with Applications* are provided as a resource for faculty.
- One open-response form and one multiple-choice form of a pretest are provided. These tests are an aid to instructors in identifying students who may need assistance.
- One open-response form and one multiple-choice form of a final examination are provided.
- Solutions for nearly all of the exercises in the textbook are included. Solutions are usually not provided for exercises with open-response answers.

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HINTS FOR TEACHING FINITE MATHEMATICS AND CALCULUS WITH APPLICATIONS

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HINTS FOR TEACHING FINITE MATHEMATICS AND CALCULUS WITH APPLICATIONS

Algebra Reference

This chapter is not as important for finite mathematics as it is for calculus. Nevertheless, we have included it in both books for those instructors who wish to cover this material. Some instructors get best results by going through this chapter carefully at the beginning of the semester. Others find it better to refer to it as needed throughout the course. Use whichever method works best for your students. We refer to the chapter as a "Reference" rather than a "Review," and the regular page numbers don't begin until Chapter 1. We hope this will make your students less anxious if you don't cover this material.

Section 1.1

This section and the next may seem fairly basic to students who covered linear functions in high school. Some students have difficulty finding the equation of a line from two points. Emphasize that there is no point-point form.

Perpendicular lines are not used in future chapters and could be skipped if you're in a hurry.

Section 1.2

Linear functions are the only functions students learn about in this section, giving them a gentle introduction to functions. Review graphing lines using intercepts, especially lines through the origin.

Supply and demand provides the students' first experience with a mathematical model. Spend time developing both the economics and the mathematics involved.

Stress that for cost, revenue, and profit functions, x represents the number of units. For supply and demand functions, we use the economists' notation of q to represent the number of units.

Emphasize the difference between the profit earned on 100 units sold as opposed to the number of units that must be sold to produce a profit of $100.

Section 1.3

The statistical functions on a calculator can greatly simplify these calculations, allowing more time for discussion and further examples. As in previous editions, we use "parallel presentation" to allow instructor choice on the extent technology is used. This section may be skipped if you are in a hurry, but your students can benefit from the realistic models and the additional work with equations of lines.

Chapter 2

The echelon method and the Gauss-Jordan method presented in the text are improved variations of the traditional methods. The "leading ones" are postponed until the last step, so as to avoid fractions and decimals. You may want to practice a few examples before presenting this method in class. We also present the traditional Gauss-Jordan method but only recommend it for use with a graphing calculator, for which keeping track of the fractions presents no difficulty.

Section 2.1

We have found it useful to spend less time on the echelon method and save the larger examples for the Gauss-Jordan method in the next section. Consequently, most of the exercises in this section involve only two equations. Use this section to introduce the concept of solving a system of linear equations and to show how a system can have one solution, no solutions, or an infinite number of solutions. Also use this section to show students how to solve applied exercises. Notice the application exercises in which a dependent system only has a finite number of solutions because the solution is restricted to nonnegative integers.

Emphasize the row notation as a way to keep track of and to check the problem solving process.

Stress the guidelines, found before Example 4, for solving an application problem.

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Section 2.2

In this edition we present the traditional Gauss-Jordan method as Method 1 in Example 1, and the improved version as Method 2. Our experience is that students are much more successful in carrying out the improved version, so we present it as the first method in Example 2 and the only method in later examples. As we suggest in Example 2, the traditional method is appropriate when technology is available.

Shown below is a comparison between the improved version and the traditional Gauss-Jordan method. Note the absence of tedious fractions in the improved version.

Solve:

$$\begin{aligned} 4x - 2y - 3z &= -23 \\ -4x + 3y + z &= 11 \\ 8x - 5y + 4z &= 6 \end{aligned}$$

New Method

$$\left[\begin{array}{rrr|r} 4 & -2 & -3 & -23 \\ -4 & 3 & 1 & 11 \\ 8 & -5 & 4 & 6 \end{array}\right]$$

$$\begin{array}{r} \\ R_1 + R_2 \to R_2 \\ -2R_1 + R_3 \to R_3 \end{array} \left[\begin{array}{rrr|r} 4 & -2 & -3 & -23 \\ 0 & 1 & -2 & -12 \\ 0 & -1 & 10 & 52 \end{array}\right]$$

$$\begin{array}{r} R_1 + 2R_2 \to R_1 \\ \\ R_2 + R_3 \to R_3 \end{array} \left[\begin{array}{rrr|r} 4 & 0 & -7 & -47 \\ 0 & 1 & -2 & -12 \\ 0 & 0 & 8 & 40 \end{array}\right]$$

$$\begin{array}{r} 7R_3 + 8R_1 \to R_1 \\ R_3 + 4R_2 \to R_2 \\ \\ \end{array} \left[\begin{array}{rrr|r} 32 & 0 & 0 & -96 \\ 0 & 4 & 0 & -8 \\ 0 & 0 & 8 & 40 \end{array}\right]$$

$$\begin{array}{r} \frac{1}{32}R_1 \to R_1 \\ \frac{1}{4}R_2 \to R_2 \\ \frac{1}{8}R_3 \to R_3 \end{array} \left[\begin{array}{rrr|r} 1 & 0 & 0 & -3 \\ 0 & 1 & 0 & -2 \\ 0 & 0 & 1 & 5 \end{array}\right]$$

$(-3, -2, 5)$ is the solution.

Traditional Method

$$\left[\begin{array}{rrr|r} 4 & -2 & -3 & -23 \\ -4 & 3 & 1 & 11 \\ 8 & -5 & 4 & 6 \end{array}\right]$$

$$\frac{1}{4}R_1 \to R_1 \left[\begin{array}{rrr|r} 1 & -\frac{1}{2} & -\frac{3}{4} & -\frac{23}{4} \\ -4 & 3 & 1 & 11 \\ 8 & -5 & 4 & 6 \end{array}\right]$$

$$\begin{array}{r} \\ 4R_1 + R_2 \to R_2 \\ -8R_1 + R_3 \to R_3 \end{array} \left[\begin{array}{rrr|r} 1 & -\frac{1}{2} & -\frac{3}{4} & -\frac{23}{4} \\ 0 & 1 & -2 & -12 \\ 0 & -1 & 10 & 52 \end{array}\right]$$

$$\begin{array}{r} \frac{1}{2}R_2 + R_1 \to R_1 \\ \\ R_2 + R_3 \to R_3 \end{array} \left[\begin{array}{rrr|r} 1 & 0 & -\frac{7}{4} & -\frac{47}{4} \\ 0 & 1 & -2 & -12 \\ 0 & 0 & 1 & 5 \end{array}\right]$$

$$\frac{1}{8}R_3 \to R_3 \left[\begin{array}{rrr|r} 1 & 0 & -\frac{7}{4} & -\frac{47}{7} \\ 0 & 1 & -2 & -12 \\ 0 & 0 & 8 & 40 \end{array}\right]$$

$$\begin{array}{r} \frac{7}{4}R_3 + R_1 \to R_1 \\ 2R_3 + R_2 \to R_2 \\ \\ \end{array} \left[\begin{array}{rrr|r} 1 & 0 & 0 & -3 \\ 0 & 1 & 0 & -2 \\ 0 & 0 & 1 & 5 \end{array}\right]$$

$(-3, -2, 5)$ is the solution.

By reworking a problem from Section 2.1 using the Gauss-Jordan method, students will see how closely this method parallels the echelon method given there.

Remind students to operate on the entire row. A common error is to forget the entry to the right of the vertical bar.

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Section 2.3

Mention that, as in algebra, only like things can be added or subtracted. In this case, the like things are matrices having the same dimensions.

Section 2.4

Using the visual approach to matrix multiplication given in Examples 2 and 3, students will have no trouble multiplying matrices. Most will eventually no longer need this tool.

Section 2.5

Explain that the technique used in finding the multiplicative inverse of a matrix is still the Gauss-Jordan method, now with more than one entry per row to the right of the vertical bar.

Students may be resistant to learning another method for solving a system of equations. Stress the advantage of using the inverse method to solve systems having the same matrix of coefficients. See Example 5. Point out that these systems can be found in many different fields of application. See Exercise 64.

Section 2.6

Discuss how the entries of A, the input-output matrix, could be determined. Stress the economic significance of the matrices A, D, X, and AX.

Section 3.1

Emphasize that the test point can be *any* point *not* on the boundary. Choose several points on either side of the boundary and on the boundary itself to illustrate this concept.

Students may fall into the habit of always choosing (0, 0) as the test point. Do a couple of problems where (0, 0) is not available for use as a test point.

Using a different color to shade each half plane for a system of inequalities will make their overlap easier to recognize.

Section 3.2

Use diagrams like Figures 13 and 14 to convince students of the believability of the corner point theorem. Emphasize that a corner point must be a point in the feasible region. Also, stress that not all corner points can be found by inspection. Some require solving a system of two linear equations. Have students note the equation of the boundary line next to its graph, so they will know which equations to solve as a system.

Section 3.3

Review the guidelines for setting up an applied problem (Section 2.1) to determine the objective function and all necessary constraints.

Students find those constraints comparing two unknown quantities the most difficult. See Exercise 18 for an example of this type of constraint.

Section 4.1

The simplex method in this chapter is modified from the traditional method along the lines of the Gauss-Jordan method in Chapter 2, eliminating tedious fractions until the last step. The notation of s instead of x for slack and surplus variables will help students remember which variables are the originals and which are slack or surplus variables.

Note the horizontal line in the simplex tableau to separate the constraints from the objective function.

Students may need several examples to be able to pick out the basic variables and to find the basic feasible solution from a matrix.

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Section 4.2

Vocabulary is extremely important in this section. An understanding of the terms basic variables, basic feasible solution, indicators, and pivots is a necessity.

Remind students that the simplex method stated before Example 1 works only for problems in standard maximum form.

Example 1 is extremely important because it connects the two methods of solving a linear programming problem. You may want to do a similar example in class. Emphasize the advantages of the simplex method, especially for larger problems.

Section 4.3

If you are in a hurry, either Section 4.3 or 4.4 can be skipped. Notice in Exercises 25 and 26 that for maximization problems, shadow costs become shadow profits.

Provide numerous examples for reading the optimal solution from the last row of the final tableau of the dual problem.

Section 4.4

The usual method for solving nonstandard problems (those with mixed constraints) is the two-phase method, which is somewhat complicated for students at this level. We use a modification of this method which students should find simpler.

Stress that slack variables are used for $\leq$ constraints, while surplus variables are used for $\geq$ constraints. Artificial variables only need to be covered if you want to solve constraints with an $=$. Even then, they can be avoided by replacing each $=$ constraint with two inequalities, one with $\leq$ and one with $\geq$.

Emphasize that to use the simplex method to find the optimal feasible solution, one must start with a feasible solution.

In Step 5 of the box "Solving a Nonstandard Problem," our choice of the positive entry that is farthest to the left is arbitrary. If your students choose a different column, they may still come up with the correct answer, and it might even require fewer steps.

Remind students to convert from z to w as the last step in solving a minimization problem.

Chapter 5

The chapter on mathematics of finance does not depend on earlier chapters and may be covered at any time.

Students may feel overwhelmed by the number of formulas presented in Chapter 5. Guidelines for choosing the appropriate formula can be found at the end of the chapter. This summary may be referred to throughout Chapter 5.

Chapter 5 requires numerous financial calculations. Make sure students are familiar with their calculators. The financial features of the TI-83/84 Plus make calculations easy.

Section 5.1

Interest is the key concept in Chapter 5. It is important that students understand that interest is the cost of borrowing money (or the reward for lending money). Both simple and compound interest are covered in the first section.

Point out that as the frequency of compounding increases, so does the amount of interest earned. Also note, however, that this increase in interest gets smaller and smaller as the interest is compounded more frequently. See Exercises 59 and 60.

The effective rate of interest is a topic that students find most useful and interesting. Bring in advertisements for loans that hide the effective rate (the APR) in the fine print.

Chapter 5 is full of symbols and formulas. It is imperative that students become familiar with the notation and know which formula is appropriate for a given problem. A summarization of the formulas in Section 5.1 is found at the end of the section.

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Section 5.2

This section starts with an introduction to geometric sequences, which lays the groundwork for developing the future value formula as the sum of a geometric sequence.

Section 5.3

Make sure students understand that the present value formula presented here is for an ordinary annuity only.

Many students have had experience with amortization. Illustrate this topic using examples with present day interest rates. Students may bring in personal examples that may be used in class.

Chapter 6

This chapter leads students toward the construction of proofs in Section 5, with quantifiers briefly introduced in Section 6. Proofs are more difficult than truth tables, but they are also far more important. Throughout the chapter we use meaningful variables, such as d for "Django is a good dog," rather than generic variables such as p and q. We find (and our students do too) that this makes it easier to keep track of which variables stands for each statement.

This is a nice chapter to cover before sets (Chapter 7), because many of the same ideas appear in both contexts. You should point out the parallels to the students whenever possible.

Section 6.1

The chapter starts with fairly easy material, but the statement "Neither p nor q" can cause trouble. Notice that we introduce the basic truth tables, except for the conditional and biconditional. Material on the quantifiers "For all" and "There exists" appears in Section 6.

Section 6.2

Students usually find truth tables fun. The alternative method presented in Example 5 helps alleviate any tedium.

Sections 6.3 and 6.4

The conditional is probably the most challenging logical operator, perhaps because its usage in mathematical language is just different enough from that of common language to cause confusion. We have found that even after students have studied logic, they still give erroneous answers to tests of reason such as those in Exercises 57 and 58 of Section 6.4. The common translations of $p \rightarrow q$ given before Example 1 of Section 6.4 are particularly troublesome. Don't assume your students have mastered this material until you have firm evidence.

Section 6.5

This section is the culmination of the first four sections. The two most important skills are showing an argument is invalid by counterexample, and showing an argument is valid by proof. Look carefully at Examples 1 through 8. This is the most difficult material in the chapter, so students need a lot of practice to master these ideas. The payoff is worth it when students learn to create a proof. The puzzles by Lewis Carroll in Example 6 and Exercises 43–48 are fun.

Section 6.6

Some students won't believe Euler is pronounced "oiler." The material on quantifiers appears here. This is just an introduction; we do not try to teach proofs using quantifiers except by Euler diagrams.

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Chapter 7

The material on probability is arranged so that if you are in a hurry to get to Markov chains, you can skip Section 7.6 and all of Chapters 8 and 9.

Section 7.1

Manipulatives are quite useful in this chapter, especially a deck of cards. Further, set brackets may be modeled as a box and the elements of the set as objects inside the box.

Stress the key word for each set operation: "not" for complement, "and" for intersection, "or" for union.

Section 7.2

Mention the order of set operations: If parentheses are present, simplify within them in the following order:

(1) Take all complements.

(2) Take the unions or intersections in the order they occur from left to right.

If no parentheses are present, start with (1).

To solve a survey problem, students must first be able to identify what type of object belongs to a certain region before they can determine how many objects belong to that region.

Have students explore the union rule for sets by determining the number of cards that are red or a king in their decks. Compare this problem with the problem of determining how many cards are fives or sevens (disjoint sets).

Section 7.3

Students need to be able to identify the experiment, the number of trials, the sample space, and the event in each probability problem.

Illustrate the basic probability principle using numerous examples utilizing the manipulatives.

Section 7.4

Redo the examples used to explore the union rule for sets to explore the related union rule for probability.

The complement rule is most useful for problems that contain statements of the form greater than, less than, etc.

Section 7.5

Sometimes independent events can be thought of as events that have the same sample space. For example, when two cards are drawn one at a time with replacement, both draws have a sample space consisting of all 52 cards. If these cards are drawn, instead, without replacement, the sample space for the second card has been reduced to 51 cards. Emphasize that the notation $P(A|B)$ reminds us how the sample space was reduced.

Section 7.6

Point out that trying to calculate $P(F|E)$ directly is sometimes impossible, too expensive, or too inconvenient. Thus, there is a need for Bayes' theorem which allows for the indirect calculation of $P(F|E)$ using $P(F|E)$. If a tree diagram is employed, then Bayes' theorem can be stated as

$$P(F|E) = \frac{\text{the probability of the branch through } F \text{ and } E}{\text{the sum of the probabilities of all branches ending in } E}$$

Point out that the branch in the numerator will also be one of the branches in the denominator.

Section 8.1

To use the multiplication principle, break down the problem (the task) into parts. Draw a blank for each part. Fill in each blank with the number of ways that part of the task can be completed. Finally, multiply these numbers to obtain the solution.

Permutations are a special case of the multiplication principle that does not allow for repetition.

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Section 8.2

An additional way to determine whether to use combinations or permutations is as follows:

(1) Give a label to each of the n objects.

(2) Pick r objects from the n objects.

(3) Rearrange the r objects.

(4) If this rearrangement can be considered the same as the original arrangement, use combinations. If it is different, use permutations.

Section 8.3

This section combines the counting techniques of the previous two sections with the basic probability principle. Notice in Example 4 (d) that we have provided an alternative method for solving probabilities with poker hands.

Section 8.4

Students often have difficulty dealing with the phrases "at least," "at most," "no more than," etc. Have the students work numerous examples that include these phrases.

Section 8.5

In this section, we complete the discussion of binomial probability from the previous section by giving the formula $E(x) = np$ for the expected value in binomial probability. Having students work out expected value in a binomial probability exercise by the definition and by this formula will increase their confidence in both.

Section 9.1

Warn students that the term "average" is ambiguous. Illustrate this concept using the average salary example in Example 6. Have students find the modal salary. Discuss the problems this ambiguity may cause.

Section 9.2

The square of the standard deviation is the variance, while the square root of the variance is the standard deviation. Students often get these confused.

Section 9.3

Note that the standard normal table used in this text is different from the table that is found in many statistics books. Call this to the attention of students. Some may be familiar with the other table.

Students may find it helpful to draw the nonstandard normal curve with x-values first, then convert to z-scores and draw the standard normal curve.

If your students have graphing calculators that give normal probability, they will have no need for the standard normal table in the back of the book. Their answers to exercises and examples, however, may be slightly different from ours, which were found using the table.

Section 9.4

When using the normal approximation to the binomial, students often have difficulty choosing the appropriate x-value(s) on the normal curve. Provide numerous examples to practice this technique.

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Section 10.1

After learning about linear functions, students now learn about functions in general. This concept is critical for success in calculus. Unless sufficient time is devoted to this section, the results will become apparent later when students don't understand the derivative. One device that helps students distinguish $f(x + h)$ from $f(x) + h$ is to use a box in place of the letter x, as we do in this section after Example 6.

Section 10.2

This section combines the topics of quadratic functions and translation and reflection, with a minimal amount of material on completing the square. Our experience is that students graph quadratics most easily by first finding the y-intercept, then finding the x-intercepts when they exist (using factoring or the quadratic formula), and finding the vertex last by locating the point midway between the x-intercepts or, if the quadratic formula was used, by letting $x = -b/(2a)$.

Quadratics are among a small group of functions that can be analyzed completely with ease, so they are used throughout the text. On the other hand, the advent of graphing calculators has made ease of graphing less important, so we rely on quadratics less than in previous editions.

Some instructors pressed for time may choose to skip translations and reflections. But we have found that students who understand that the graph of $f(x) = 5 - \sqrt{4 - x}$ is essentially the same as the graph of $f(x) = \sqrt{x}$, just shifted and reflected, will have an easier time when using the derivative to graph functions. Since students are familiar with very few classes of functions at this point, it helps to work with functions defined solely by their graphs, such as Exercises 35–38.

Exercises 43–50 cover stretching and shrinking of graphs in the vertical and horizontal directions. Covering these exercises carefully will not only give students a better grasp of functions, but will help them later to interpret the chain rule.

Section 10.3

Graphing calculators have made point plotting of functions less important than before. Plotting points by hand should not be entirely neglected, however, because a small amount is helpful when using the derivative to graph functions.

The two main goals of this section are to have an understanding of what an n-th degree polynomial looks like, and to be able to find the asymptotes of a rational function. Students who master these ideas will be better prepared for the chapter on curve sketching.

Exercise 57 is the first of several in this chapter asking students to find what type of function best fits a set of data. (See also Section 10.4, Exercises 57, 58 and 59, and Review Exercise 115.) The class can easily get bogged down in these exercises, particularly if you decide to explore the regression features in a calculator such as the TI-84 Plus C. But there is a powerful payoff in terms of mastery of functions for the student who succeeds at these exercises.

Section 10.4

Some instructors may prefer at this point to continue with Chapter 11 and to postpone discussion of the exponential and logarithmic functions until later. The overwhelming preference of instructors we surveyed, however, was to cover exponential and logarithmic functions early and then to use these functions throughout the rest of the course. Instructors who wish to postpone this material will also need to omit for now those examples and exercises in Sections 11.1–12.3 that refer to exponential and logarithmic functions.

Students typically have no problem with $f(x) = 2^x$, but the number e often remains a mystery. Like π, the number e is a transcendental number, but students have had years of schooling to get used to π. Have your students approximate e with a calculator, as the textbook does before the definition of e. Notice how we use compound interest to help students get a handle on this number.

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Section 10.5

Logarithms are a very difficult topic for many students. It's easy to say that a logarithm is just an exponent, but the fact that it is the exponent to which one must raise the base to get the number whose logarithm we are calculating is a rather obtuse concept. Therefore, spend lots of time going over examples that can be done without a calculator, such as $\log_2 8$. Students will also tend to come up with many incorrect pseudoproperties of logarithms, similar in form to the properties of logarithms given in this section. Take as much time and patience as necessary in gently correcting the many errors students inevitably will make at first.

Even after receiving a thorough treatment of logarithms, some students will still be stumped when solving a problem such as Example 8. Some of these students can get the correct answer using trial-and-error. The instructor should take consolation in the fact that at least such a student understands exponentials better than the one who uses logarithms incorrectly to solve Example 8 and comes up with the nonsensical answer $t = -7.51$ without questioning whether this makes sense. Be sure to teach your students to question the reasonableness of their answers; this will help them catch their errors.

Section 10.6

This section gives students much needed practice with exponentials and logarithms, and the applications keep students interested and motivated. Instructors should keep this in mind and not worry about having students memorize formulas. We have removed the formulas for present value in this edition, having decided that it's better for students to just solve the compound amount formula for P. This reduces by two the number of formulas that students need to remember.

There is a summary of graphs of basic functions in the end-of-chapter review.

Section 11.1

This is the first section on calculus, and perhaps the most important, since limits are what really distinguish calculus from algebra. Students will have the best understanding of limits if they have studied them graphically (as in Exercises 9–16), numerically (as in Exercises 19–24), and analytically (as in Exercises 35–56). The graphing calculator is a powerful tool for studying limits. Notice in Example 12 (c) and (d) that we have modified the method of finding limits at infinity by dividing by the highest power of x in the denominator, which avoid the problem of division by 0.

Section 11.2

The section on continuity should be straightforward if students have mastered limits from the previous section.

Section 11.3

This section introduces the derivative, even though that term doesn't appear until the next section. In a class full of business and social science majors, an instructor may wish to place less emphasis on velocity, an approach more suited to physics majors. But we have found velocity to be the manifestation of the derivative that is most intuitive to all students, regardless of their major.

Instructors in a hurry can skip the material on estimating the instantaneous rate of change from a set of data, but it helps solidify students' understanding of the derivative by giving them one more point of view.

Section 11.4

Students who have learned differentiation formulas in high school usually want (and deserve) some explanation of why they need to learn to take derivatives using the definition. You might try explaining to your students that getting the right formula is not the only goal; graphing calculators can give derivatives numerically. The most important thing for students to learn is the concept of the derivative, which they don't learn if they only memorize differentiation formulas.

Zooming in on a function with a graphing calculator until the graph appears to be a straight line gives students a very concrete image of what the derivative means.

After students have learned the differentiation formulas, they may forget about the definition of derivative. We have found that if we want them to use the definition on a test, it is important to say so clearly and emphatically, or they will simply use the shortcut formulas.

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Section 11.5

One way to get students to focus on the concept of the derivative, rather than the mechanics, is to emphasize graphical differentiation. We have therefore devoted an entire section to this topic. Graphical differentiation is difficult for many students because there are no formulas to rely on. One must thoroughly understand what's going on to do anything. On the other hand, we have seen students who are weak in algebra but who possess a good intuitive grasp of geometry find this topic quite simple.

Section 12.1

Students tend to learn these differentiation formulas fairly quickly. These and the formulas in the next few sections are included in a summary at the end of the chapter.

Section 12.2

The product and quotient rules are more difficult for students to keep straight than those of the previous section. People seem to remember these rules better if they use an incantation such as "The first times the derivative of the second, plus the second times the derivative of the first." Some instructors have argued that this formulation of the product rule doesn't generalize well to products of three or more functions, but that's not important at this level. Some instructors allow their students to bring cards with formulas to the tests. This does not eliminate the need for students to understand the use of the formulas, but it does eliminate the anxiety students may have about forgetting a key formula under the pressure of an exam.

Section 12.3

No matter how many times an instructor cries out to his or her students, "Remember the chain rule!", many will still forget this rule at some time later in the course. But if a few more students remember the rule because the instructor reminds them so often, such reminders are worthwhile.

Section 12.4 and 12.5

In going through these sections, you may need to frequently refer to the rules of differentiation in the previous sections. You may also need to review the last three sections of Chapter 10.

Section 13.1 and 13.2

If students have understood Chapter 11, then the connection between the derivative, increasing and decreasing functions, and relative extrema should be obvious, and these sections should go quickly and smoothly.

Section 13.3

Students often confuse concave downward and upward with increasing and decreasing; carefully go over Figure 31 or the equivalent with your class.

Section 13.4

Graphing calculators have made curve sketching techniques less essential, but curve sketching is still one of the best ways to unify the various concepts introduced in this and the previous two chapters. Students should use graphing calculators to check their work.

Because this section is the culmination of many ideas, students often find it difficult and start to forget things they previously knew. For example, a student might state that a function is increasing on an interval and then draw it decreasing. The best solution seems to be lots of practice with immediate help and feedback from the instructor.

Students sometimes stumble over this topic because they use the rules for differentiation incorrectly, or because they make mistakes in algebra when simplifying. Exercises such as 33–38 are excellent for testing whether students really grasp the concepts.

Section 14.1

This section should not be conceptually difficult, but students need constant reminders to check the endpoints of an interval when finding the absolute maxima and minima.

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Section 14.2

This section is one of the high points of the course. Some of the best applications of calculus involve maxima and minima. Notice that some exercises have a maximum or minimum at the endpoint of an interval, so students cannot ignore checking endpoints.

Almost everyone finds this material difficult because most people are not skilled at word problems. Remind your students that if they ever wonder whether mathematics is of any use, this section will show them.

Why are word problems so difficult? One theory is that word problems require the use of two different modes of thinking, which students are using simultaneously for the first time. People use words in daily life without difficulty, but when they study mathematics, they often turn off that part of their brain and begin thinking in a very formal, mechanical way. In word problems, both modes of thinking must be active. If and when the NCTM Standards become widely accepted in the schools, children will get more practice at an early age in such ways of thinking. Meanwhile, the steps for solving applied problems given in this book might make the process a little more straightforward, and hence achievable by the average student.

Section 14.3

This section continues the ideas of the previous one. The point of studying economic lot size should not be to apply Equation (3), but to learn how to apply calculus to solve such problems. We therefore urge you to cover Exercises 19–22, in which we vary the assumptions, so Equation (3) does not necessarily apply. In this edition, we have changed the presentation to be consistent with that of business texts.

The material on elasticity can be skipped, but it is an important application that should interest students who have studied even a little economics.

Section 14.4

There are two main reasons for covering implicit differentiation. First, it reinforces the chain rule. Second, it is needed for doing related rate problems. If you skip related rates due to lack of time, it is not essential to cover implicit differentiation, either.

Section 14.5

Related rate applications are less important than applied extrema problems, but they use some of the same skills in setting up word problems, and for that reason are worth covering. The best application exercises are under the heading "Physical Sciences," because those are the exercises in which no formula is given to the student; the student must construct a formula from the words. The geometrical formulas needed are kept to a minimum: the Pythagorean theorem, the area of a circle, the volume of a sphere, the volume of a cone, and the volume of a cylinder with a triangular cross section. Some instructors allow their students to use a card with such formulas on the exam. These formulas are summarized in a table in the back of the book.

Section 14.6

Differentials may be skipped by instructors in a hurry; you need not fear that this omission will hamper your students in the chapter on integration. The differentials used there are not the same as those used here, and the required techniques are easily picked up when integration by substitution is covered. As in the previous edition, our presentation of differentials emphasizes linear approximation, a topic of considerable importance in mathematics.

Section 15.1

Students sometimes start to get differentiation and antidifferentiation confused when they reach this section. Some believe the antiderivative of x^{-2} is $(-1/3)x^{-3}$; after all, if n is -2, isn't $n + 1 = -3$? Carefully clarify this point.

Section 15.2

The main difficulty here is teaching students what to choose as u. The advice given before Example 3 should be helpful.

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Section 15.3

Some instructors who are pressed for time go lightly over the topic of the area as the limit of the sum of rectangular areas. This is possible, but care should be taken that students don't lose track of what the definite integral represents. Also, a light treatment here lessens the excitement of the Fundamental Theorem of Calculus.

We have continued the trend of the previous edition in covering three ways of approximating a definite integral with rectangles: the right endpoint, the left endpoint, and the midpoint. The trapezoidal rule is briefly introduced here as the average of the left sum and the right sum.

Section 15.4

The Fundamental Theorem of Calculus should be one of the high points of the course. Make a big deal about how the theorem unifies these two separate topics of area as a limit of sums and the antiderivative.

When using substitution on a definite integral, the text recommends changing the limits and the variable of integration. (See Example 4 and the Caution which follows the example.) Some instructors prefer instead to have their students solve an indefinite integral, and then to evaluate the integral using the limits on x. One advantage of this method is that students don't have to remember to change the limits. This method also has two disadvantages. The first is that it takes slightly longer, since it requires changing the integral to u and then back to x. Second, it prevents students at this stage from solving problems such as $\int_0^{1/2} x\sqrt{1-16x^4}\,dx$, which can be solved using the substitution $u = 4x^2$ and the fact that the integral $\int_0^1 \sqrt{1-u^2}\,du$ represents the area of a quarter circle. This is one section in which we deliberately did not use more than one method of presentation, because this would inevitably lead to confusion in the minds of some students.

Section 15.5

This section gives more motivation to the topic of integration. Consumers' and producers' surplus are important, realistic applications. We have downplayed sketching the curves that bound the area under consideration. Such sketches take time and are not necessary in solving these problems. But they clarify what is happening and make it possible to avoid memorizing formulas. Using a graphing calculator to sketch the curves can be helpful.

Section 15.6

The ubiquity of computers and graphing calculators has made numerical integration more important. Rather than computing a definite integral by an integration technique, one can just as easily enter the function into a calculator and press the integration key. Point out to students that this is valuable when the function to be integrated is complicated. On the other hand, using the antiderivative makes it easier to see the effect of changing the upper limit, say, from 2 to 3, or for working with the definite integral when one or both limits are parameters, such as a and b, rather than numbers.

Simpson's rule is the most accurate of the simple integration formulas. To achieve greater accuracy, a more complicated method must be used. This is why, unlike the trapezoidal rule, Simpson's rule is actually used by mathematicians and engineers.

You may wish to give your students the programs for the trapezoidal rule and Simpson's rule in *The Graphing Calculator Manual* that is available with the text.

Section 16.1

Students usually find column integration simpler than traditional integration by parts. We show both methods to give instructors a choice, and also to emphasize that the two methods are equivalent. Column integration makes organizing the details simpler, but is no more mechanical than the traditional method, as some have mistakenly claimed. At Hofstra University, students even use this method when neither the instructor nor the book discuss it. They find out about it from other students, and so it has become an underground method. Some instructors feel that students will lose any theoretical understanding of what they are doing if they use this method. Our experience is that almost no students at this level have a theoretical understanding of what integration by parts is about, but the better students can at least master the mechanics. With column integration, almost all of the students master the mechanics.

Section 16.2 and 16.3

These two sections give more applications of integration. Coverage of either section is optional.

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Section 16.4

Improper integration is not really an application of integration, but it makes further applications of integration possible.

Many mathematicians use shorthand notation such as the following: $\int_0^\infty e^{-x}dx = -e^{-x}\Big|_0^\infty = 0 - (-1) = 1.$ For students at this level, it may be best to avoid the shorthand notation.

Section 16.5

Differential equations of the form $dy/dx = f(x)$ are treated lightly in this section because they were already covered in the chapter on integration, although the terminology and notation were different then. Remind students that solving such differential equations is the same as antidifferentiation. The rest of the section is on separable differential equations. Students sometimes have trouble with this section because they have forgotten how to find an antiderivative, particularly one requiring substitution.

Section 17.1

The major difficulty students have with this section, and indeed with this entire chapter, is that they cannot visualize surfaces in 3-dimensional space, even though they live there. Fortunately, such visualization is not really necessary for doing the exercises in this chapter. A student who wants to explore what various surfaces look like can use any of the commercial or public domain computer programs available.

Section 17.2

Students who have mastered the differentiation techniques should have no difficulty with this section.

Section 17.3

This section corresponds to the section on applied extrema problems in the chapter on applications of the derivative, but with less emphasis on word problems. In Exercise 30, we revisit the topic of the least squares line, first covered in Section 1.3.

Section 17.4

Lagrange multipliers are an important application of calculus to economics. At some colleges, the business school is very insistent that the mathematics department cover this material.

Section 17.5

This section corresponds to the section on differentials in the chapter on applications of the derivative.

Section 17.6

Students who have trouble visualizing surfaces in 3-dimensional space are sometimes bothered by double integrals over variable regions. Instructors should assure such students that all they need to do is draw a good sketch of the region in the xy-plane, and not try to draw the volume in three dimensions.

Chapter 18

Probability is one of the best applications of calculus around. In fact, statistics instructors sometimes feel the temptation to start discussing the definite integral even when their students know no calculus. This chapter is just a brief introduction, but it covers some of the most important concepts, such as mean, variance, standard deviation, expected value, and probability as the area under the curve. The third section covers three of the most important continuous probability distributions: uniform, exponential, and normal.

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PRETESTS AND ANSWERS

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FINITE MATHEMATICS AND CALCULUS WITH APPLICATIONS **Name:**

Pretest, Form A

Find the value of each of the following expressions.

1. $(0.5)^3 \cdot (0.2)^2$ **1.** _____

2. $\sqrt{27\left(\frac{1}{3}\right)\left(1+\frac{1}{3}\right)}$ **2.** _____

3. $2000\left(1-\frac{1}{2}\right)^4$ **3.** _____

4. $\frac{8 \cdot 7 \cdot 6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}{4 \cdot 3 \cdot 2 \cdot 1}$ **4.** _____

5. $\frac{0.5\,(0.7)}{0.5\,(0.7)\,+\,2(0.35)}$ **5.** _____

6. Find the value of $\frac{3a(a+2b-1)}{a(a+1)}$ if $a = 6$ and $b = -2$. **6.** _____

Solve each of the following equations.

7. $18 - \frac{2}{3}y = \frac{5}{6}y$ **7.** _____

8. $3x - (4x + 8) = 25$ **8.** _____

9. $4\,(2z - 3) + 5 = -2\,(z + 6)$ **9.** _____

10. $0.03x + 0.05\,(200 - x) = 9$ **10.** _____

11. Solve the equation $q = \frac{3}{4}p - 8$ for p. **11.** _____

12. Solve the equation $4x - 5y = 8$ for y. **12.** _____

13. Find the coordinates of the point where the graph of $6x - 5y = 10$ crosses the x-axis. **13.** _____

14. Suppose $C = 35x - 250$. Find x when C is 450. **14.** _____

15. A coat that sells for \$125 is put on sale for \$80. Find the percent of markdown. **15.** _____

16. 66 is 120% of what number? **16.** _____

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17. Margaret can travel 216 miles on 9 gallons of gas. How many gallons will she need to travel 336 miles?

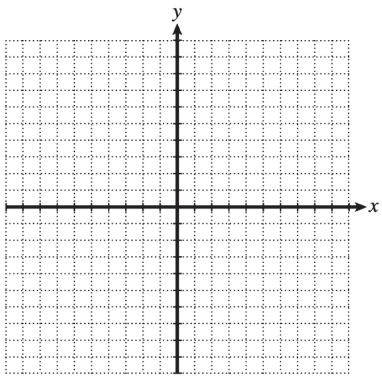
17. _____

18. Solve the inequality $3(2 - x) - 4(x + 6) < -2(x - 1)$.

18. _____

19. Graph the equation $5x - 2y = 10$.

19.



20. Find the slope of the line through the points with coordinates $(4, 7)$ and $(-3, 5)$.

20. _____

21. Write an equation in the form $ax + by = c$ for the line through the points with coordinates $(2, -3)$ and $(5, 6)$.

21. _____

22. Solve the following system of equations.

$$3x + 4y = 14$$
$$-2x + 5y = 29$$

22. _____

23. Which of the following describes the graph of the equation $x = -4$?

23. _____

(a) A line with slope -4 (b) A line with slope 4

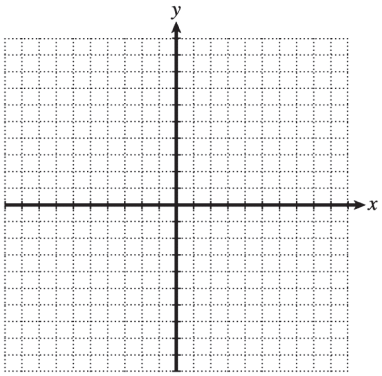
(c) A horizontal line (d) A vertical line

24. Find the slope of the line with equation $4x - 5y = 10$.

24. _____

25. Graph the inequality $3x + 5y \geq 15$.

25.



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FINITE MATHEMATICS AND CALCULUS WITH APPLICATIONS **Name:** _____

Pretest, Form B

Choose the best answer.

Find the value of each of the following expressions.

1. $(0.3)^2 \cdot (0.7)^1$ **1.** _____

(a) 2.1 (b) 0.63 (c) 0.21 (d) 0.063

2. $\sqrt{16\left(\frac{1}{2}\right)\left(1-\frac{1}{2}\right)}$ **2.** _____

(a) 8 (b) 4 (c) 2 (d) $4\sqrt{2}$

3. $4000\left(1+\frac{1}{2}\right)^3$ **3.** _____

(a) 13,500 (b) 9000 (c) 6000 (d) 3000

4. $\frac{9 \cdot 8 \cdot 7 \cdot 6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}{5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}$ **4.** _____

(a) 9876 (b) 6789 (c) 3024 (d) 120

5. $\frac{0.6\,(0.3)}{0.6\,(0.3)+0.4\,(0.9)}$ **5.** _____

(a) 2 (b) $\frac{1}{2}$ (c) $\frac{1}{3}$ (d) 0.54

6. Find the value of $\frac{2(a+1-b)}{a(a+1)}$ if $a = 10$ and $b = 5$. **6.** _____

(a) 1 (b) $\frac{6}{55}$ (c) $\frac{1}{11}$ (d) $-\frac{4}{15}$

Solve each of the following equations.

7. $12 - \frac{3}{4}r = \frac{5}{8}r + 23$ **7.** _____

(a) -8 (b) 8 (c) -1 (d) 4

8. $2x - (3x + 7) = 18$ **8.** _____

(a) 11 (b) -11 (c) 25 (d) -25

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9. $-2(k-1)+8=-2(k+3)$ **9.** _____

(a) 4 (b) 10 (c) -6 (d) No solution

10. $0.04x+0.07(900-x)=51$ **10.** _____

(a) 4000 (b) 400 (c) 317 (d) 2083

11. Solve the equation $q=-\frac{2}{7}p-3$ for p. **11.** _____

(a) $p=\frac{7}{2}q+\frac{21}{2}$ (b) $p=-\frac{7}{2}q-\frac{21}{2}$

(c) $p=\frac{7}{2}q-\frac{21}{2}$ (d) $p=7q+\frac{3}{2}$

12. Solve the equation $3x+6y=7$ for y. **12.** _____

(a) $y=-\frac{1}{2}x+7$ (b) $y=\frac{1}{2}x+\frac{7}{6}$

(c) $y=-2x+\frac{7}{3}$ (d) $y=-\frac{1}{2}x+\frac{7}{6}$

13. Find the coordinates of the point where the graph of $7x-4y=8$ crosses the y-axis. **13.** _____

(a) $(0,7)$ (b) $(0,4)$ (c) $(-2,0)$ (d) $(0,-2)$

14. Suppose $C=20x+500$. Find x when C is 650. **14.** _____

(a) 13,500 (b) 1150 (c) 7.5 (d) 3

15. A boat that sells for \$5000 is marked up to \$8000. What is the percent increase? **15.** _____

(a) 80% (b) 60% (c) 62.5% (d) 37.5%

16. 68 is 85% of what number? **16.** _____

(a) 125 (b) 80 (c) 57.8 (d) 54.4

17. Bob can travel 160 miles on 8 gallons of gas. How many gallons will he need to travel 400 miles? **17.** _____

(a) 80 (b) 30 (c) 20 (d) 16

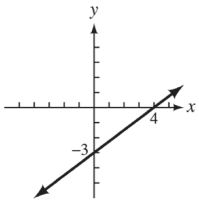
18. Solve the inequality $4(5-2x)-2(x+7)\le -2-(x-80)$. **18.** _____

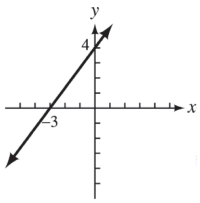
(a) $x\ge -8$ (b) $x\le -8$ (c) $x\ge 8$ (d) $x\le 8$

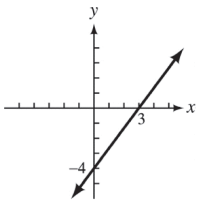
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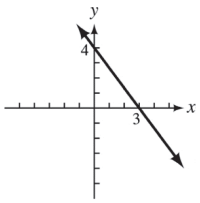
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19. Graph the equation $4x - 3y = 12$. **19.** _____

(a) 

(b) 

(c) 

(d) 

20. Find the slope of the line through the points with coordinates $(3,8)$ and $(-2,4)$. **20.** _____

(a) 6 (b) $\frac{5}{4}$ (c) $\frac{4}{5}$ (d) $-\frac{4}{5}$

21. Write an equation in the form $ax + by = c$ for the line through the point with coordinates $(5,8)$ and $(6,4)$. **21.** _____

(a) $4x - y = 12$ (b) $4x + y = 12$

(c) $x + 4y = 37$ (d) $4x + y = 28$

22. Solve the following system of equations.

$$x + 2y = 5$$
$$x - 20 = 3y$$

22. _____

(a) $(-50,25)$ (b) $(11,-3)$ (c) $(-5,5)$ (d) $(5,-5)$

23. Which of the following describes the graph of the equation $x = 7$? **23.** _____

(a) A vertical line (b) A parabola

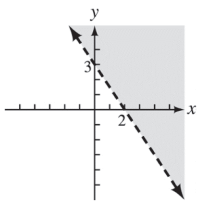
(c) A line with slope 7 (d) A horizontal line

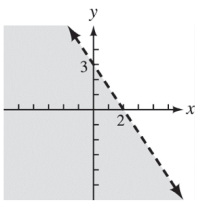
24. Which of the following lines does *not* have slope 4? **24.** _____

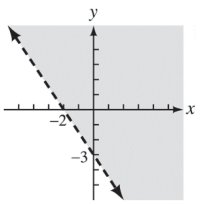
(a) $y = 4x - 8$ (b) $2y - 8x = 7$

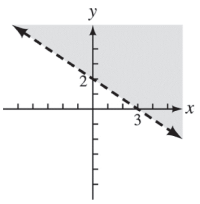
(c) $x = 4$ (d) $4x - y = 19$

25. Graph the inequality $6x + 4y > 12$. **25.** _____

(a) 

(b) 

(c) 

(d) 

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ANSWERS TO PRETESTS

PRETEST, FORM A

1. 0.005

2. $2\sqrt{3}$

3. 125

4. 1680

5. $\frac{1}{3}$

6. $-\frac{1}{2}$

7. 12

8. -33

9. $-\frac{1}{2}$

10. 50

11. $p = \frac{4}{3}q + \frac{32}{3}$

12. $y = \frac{4}{5}x - \frac{8}{5}$

13. $\left(\frac{5}{3}, 0\right)$

14. 20

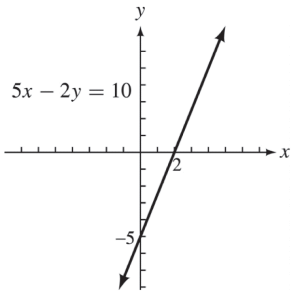
15. 36%

16. 55

17. 14

18. $x > -4$

19.



20. $\frac{2}{7}$

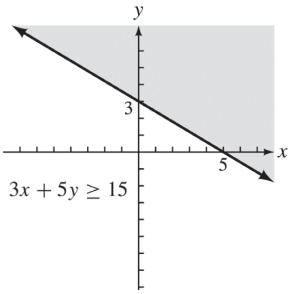
21. $3x - y = 9$

22. $(-2, 5)$

23. (d)

24. $\frac{4}{5}$

25.



PRETEST, FORM B

1. (d)	**6.** (b)	**11.** (b)	**16.** (b)	**21.** (d)
2. (c)	**7.** (a)	**12.** (d)	**17.** (c)	**22.** (b)
3. (a)	**8.** (d)	**13.** (d)	**18.** (a)	**23.** (a)
4. (c)	**9.** (d)	**14.** (c)	**19.** (c)	**24.** (c)
5. (c)	**10.** (b)	**15.** (b)	**20.** (c)	**25.** (a)

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FINAL EXAMINATIONS

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FINITE MATHEMATICS AND CALCULUS WITH APPLICATIONS **Name:**

Final Examination, Form A

1. The supply and demand functions for chocolate ice cream are given by $p = S(x) = \frac{1}{6}x$ and $p = D(x) = 9 - \frac{1}{3}x$, where p represents the price in dollars. Find the equilibrium price.

1. _____

2. Suppose that a linear cost function for an item is given by $C(x) = 50x + 300$. The items sell for \$75 each. Find the break-even quantity.

2. _____

3. If 6 items cost \$900 to produce and 13 items cost \$1600 to produce, find the linear cost function.

3. _____

4. The cost in dollars for producing x units of a particular item is given by $C(x) = 0.37x + 682$. How many units could be produced for a cost of \$978?

4. _____

5. Use the echelon method to solve the following system of equations.

$$\begin{aligned} 9x - 8y &= 12 \\ 6x + 4y &= 1 \end{aligned}$$

5. _____

6. Use the Gauss-Jordan method to solve the following system of equations.

$$\begin{aligned} 2x + y - z &= -1 \\ x - 2y + 2z &= 7 \\ 3x + y + z &= 4 \end{aligned}$$

6. _____

7. Let $A = \begin{bmatrix} 3 & 2 \\ -4 & -1 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 0 & -3 \\ 4 & -2 & 5 \end{bmatrix}$. Find the products AB and BA, if these products exist.

7. _____

8. Find the inverse of the following matrix, if the inverse exists.

$$A = \begin{bmatrix} 2 & 1 & 0 \\ 0 & 3 & 1 \\ 1 & 0 & -1 \end{bmatrix}$$

8. _____

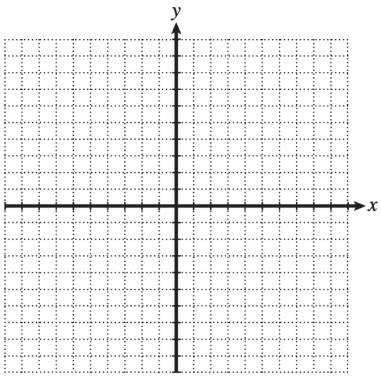
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9. Graph the feasible region for the following system of Inequalities.

$$-3 < x < 2$$
$$0 \le y \le 3$$
$$x + 2y < 6$$

9.



10. Give the coordinates of the corner points of the feasible region for the following system.

$$x \le 7$$
$$y \le x$$
$$y \ge 3$$

10. _____

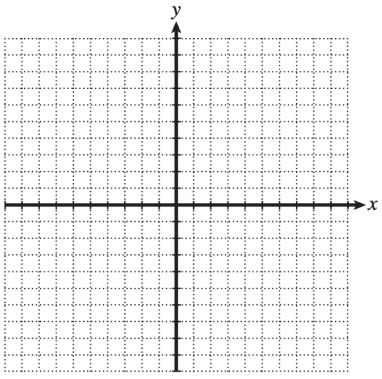
11. For the system given in Problem 10, find the maximum value of the objective function $z = 6x - 3y$.

11. _____

12. Use the graphical method to solve the following linear programming problem.

Maximize $z = 5x + 2y$
subject to: $3x + 2y \le 6$
$x + y \le 2$
$x \ge 0$
$y \ge 0.$

12. _____



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13. To pour a concrete sidewalk takes 2 hours of preparation and 3 hours of finishing. To pour a concrete patio takes 4 hours of preparation and 3 hours of finishing. There are 8 hours available for preparation and 21 hours available for finishing. ABC Concrete Company makes a profit of $450 on a sidewalk and $700 on a patio. How many sidewalks and patios should the company construct to maximize its profit?

Set up a system of inequalities for this problem, identify all variables used, and give the objective function, but do not solve.

13. _____

14. Write the initial simplex tableau for the linear programming problem given in Problem 13.

14. _____

15. Use the simplex method to solve the linear programming problem given in problem 13.

15. _____

16. Read the solution from the following simplex tableau.

$$\begin{array}{cccccc|c} x_1 & x_2 & x_3 & s_1 & s_2 & z & \\ \hline 0 & 2 & 4 & 1 & 6 & 0 & 200 \\ 1 & 3 & 6 & 0 & 9 & 0 & 350 \\ \hline 0 & -8 & 16 & 0 & 24 & 1 & 0 \end{array}$$

16. _____

17. Find the maximum value of z in Problem 16.

17. _____

18. State the dual of the following linear programming problem.

$$\begin{aligned} \text{Minimize} \quad & w = 6y_1 + 8y_2 \\ \text{subject to:} \quad & 2y_1 + 5y_2 \geq 9 \\ & 2y_1 + 3y_2 \geq 11 \\ & 7y_1 + 2y_2 \geq 5 \\ \text{with} \quad & y_1 \geq 0, y_2 \geq 0. \end{aligned}$$

18. _____

19. Find the compound amount if $750 is invested at 8% compounded quarterly for 3 years.

19. _____

20. Jerry Herst wants to have $2400 available for a vacation 2 years from now. How much must he invest today, at 6% compounded monthly, so that he will have the required amount?

20. _____

21. Find the tenth term of the geometric sequence with $a = 5$ and $r = 2$.

21. _____

22. Find the payment necessary to amortize a loan of $10,000 if the interest rate is 8% compounded quarterly and there are 20 quarterly payments.

22. _____

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23. Write the negation of

"Some pennies are made of silver."

23. _____

24. If p is false and q is true, find the truth value of

$$(q \vee \sim p) \leftrightarrow (p \rightarrow q).$$

24. _____

25. Determine the truth value of the statement

"If it is raining, then if it is not raining it is pouring."

25. _____

26. Determine whether the following argument is *valid* of *invalid:*

$$\begin{array}{l} \sim p \leftrightarrow q \\ \sim q \\ \hline p \end{array}$$

26. _____

27. Write "p is a necessary condition for q" symbolically.

27. _____

28. Let $U = \{a,b,c,d,e,f,g\}$, $M = \{b,e,f\}$, $N = \{c,f,g\}$, and $P = \{a,b,c,d\}$. List the members of each of the following sets, using set braces.

(a) $(M \cap P) \cup N$

(b) $M' \cap (N \cup P)$

28. **(a)** _____

(b) _____

29. Let A, B, and C be three sets. Draw a Venn diagram and use shading to show the set $A \cap (B' \cap C')$.

29.

30. In a survey, 28 people drank coffee with breakfast and 22 drank milk. 8 people drank both, and 5 people drank neither coffee nor milk.

Use a Venn diagram to determine how many people were surveyed.

30. _____

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31. A die is rolled and then a coin is tossed.

(a) Write the sample space for this experiment.

(b) What is the probability that an even number is rolled and a head is tossed?

31. (a) _____

(b) _____

32. A phone number consists of seven digits. How many such numbers have the prefix (first three digits) 487?

32. _____

33. A bag contains 4 red, 3 white, and 5 blue marbles. How many samples of 4 marbles can be drawn in which 2 marbles are red and 2 marbles are blue?

33. _____

34. In the experiment described in Problem 33, what is the probability that a sample of 4 marbles contains 2 red and 2 white marbles?

34. _____

35. Cass is taking a 5-question multiple-choice quiz in which each question has three choices. He guesses on all of the questions.

(a) What is the probability that Cass answers all of the questions correctly?

(b) What is the probability that he answers exactly three questions correctly?

35. (a) _____

(b) _____

36. A raffle has a first prize of $400, two second prizes of $75 each, and ten third prizes of $20 each. One thousand tickets are sold at $1 apiece. Find the expected winnings of a person buying 1 ticket.

36. _____

37. Consider the following list of test scores:

98, 70, 32, 48, 71, 80, 85, 50, 46, 71.

For this data, find each of the following. Round to the nearest tenth when necessary.

(a) The mean

(b) The median

(c) The mode

(d) The range

37. (a) _____

(b) _____

(c) _____

(d) _____

38. Find the mean for the following data. Round to the nearest hundredth.

Value	Frequency
1	5
3	8
5	10
7	3
9	4

38. _____

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39. Find the standard deviation for the following set of numbers. Round to the nearest hundredth.

$14, 5, 9, 3, 11, 12$

39. _____

40. The probability that a certain basketball team will win a given game is 0.62. If the team plays 50 games, find the expected number of wins and the standard deviation. (Round to the nearest hundredth if necessary.)

40. _____

41. Find the coordinates of the vertex of the graph of $f(x) = -2x^2 + 30x + 45$.

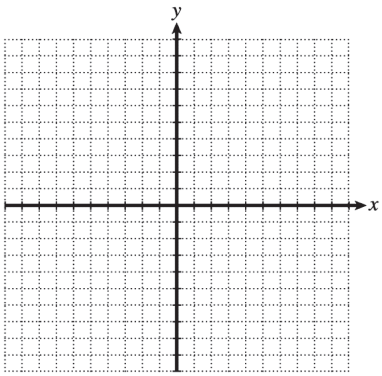
41. _____

42. Write the equation $2^a = d$ using logarithms.

42. _____

43. Graph the function $y = \log_2(x - 3) + 4$.

43.



44. Evaluate $\lim_{x \to 4} \frac{x-4}{\sqrt{x}-2}$.

44. _____

45. Find all values of x at which $g(x) = \frac{x-2}{x-5}$ is not continuous.

45. _____

46. Find the average rate of change of $y = \sqrt{2x+1}$ between $x = 4$ and $x = 12$.

46. _____

47. Find the derivative of $y = 7x^2e^{3x}$.

47. _____

48. Find the derivative of $y = \frac{\ln(3x)}{x+1}$.

48. _____

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49. Find the instantaneous rate of change of $s(t) = 3t^2 - \frac{8}{t}$ at $t = 2$. **49.** _____

50. Find an equation of the tangent line to the graph of $y = (x^2 + 3x + 3)^8$ at the point $(-1, 1)$. **50.** _____

51. Find $h'(2)$ if $h(x) = \frac{6}{\sqrt{4x+17}}$. **51.** _____

52. Find the largest open intervals where f is increasing or decreasing if $f(x) = 2x^3 - 24x^2 + 72x$. **52.** _____

53. Find the locations and values of all relative extrema of g if $g(x) = \frac{x^2 + 5x + 3}{x - 1}$. **53.** _____

54. For the function $f(x) = x^4 - 4x^3 - 5$, find

(a) all intervals where f is concave upward; **54.** (a) _____

(b) all intervals where f is concave downward; (b) _____

(c) all points of inflection. (c) _____

55. Find the fourth derivative of $h(x) = xe^x$. **55.** _____

56. Find the locations and values of all absolute extrema of $f(x) = x^3 - 6x^2$ on the interval $[-1, 2]$. **56.** _____

57. For a particular commodity, its price per unit in dollars is given by $P(x) = 120 - \frac{x^2}{10}$,
where x, measured in thousands, is the number of units sold. This function is valid on the interval $[0, 34]$.
How many units must be sold to maximize revenue? **57.** _____

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58. Find $\frac{dy}{dx}$ if $3\sqrt{x} - 5y^3 = 7xy$. **58.** _____

59. If $xy = x - 9$, find $\frac{dy}{dt}$ if $\frac{dx}{dt} = 12$, $x = -3$, and $y = 4$. **59.** _____

60. If $y = -3(2 + x^2)^3$, find dy. **60.** _____

61. Using differentials, approximate the volume of coating on a sphere of radius 5 inches, if the coating is 0.03 inch thick. **61.** _____

62. Find $\int (3x^2 - 7x + 2)\,dx$. **62.** _____

63. Find $\int \frac{8}{x+9}\,dx$. **63.** _____

64. Evaluate $\int_0^2 x\sqrt{3x^2 + 4}\,dx$. **64.** _____

65. Find the area of the region between the x-axis and the graph of $f(x) = xe^{x^2}$ on the interval $[0,2]$. **65.** _____

66. Find the area of the region enclosed by the graphs of $f(x) = x^2 - 4$ and $g(x) = 1 - x^2$. **66.** _____

67. Find $\int x^2 e^x dx$. **67.** _____

68. Evaluate $\int_1^{e^2} 3x \ln x\,dx$. **68.** _____

69. Find the average value of $f(x) = x(x^2 + 1)^3$ over the interval $[0, 2]$. **69.** _____

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70. Find the volume of the solid of revolution formed by rotating the region bounded by the graphs of $f(x) = \sqrt{x+4}$, $y = 0$, and $x = 12$ about the x-axis. **70.** _____

71. Determine whether the improper integral $\int_{-\infty}^{-1} x^{-2}\,dx$ converges or diverges. If it converges, find its value. **71.** _____

72. If $f(x,y) = 3x^2 - 4xy + y^3$, find $f_{xy}(1,-3)$. **72.** _____

73. For $f(x,y) = 2x^2 - 2xy + 2y^2 + 4x + 4y + 5$, find all of the following:

(a) relative maxima; **73.** (a) _____

(b) relative minima; (b) _____

(c) saddle points. (c) _____

74. Maximize $f(x, y) = x^2y$, subject to the constraint $y + 4x = 84$. **74.** _____

75. Find dz, given $z = 3x^2 - 4xy + y^2$, where $x = 0$, $y = 2$, $dx = 0.02$, and $dy = 0.01$. **75.** _____

76. Evaluate $\int_1^2 \int_0^3 e^{2x}\,dy\,dx$. **76.** _____

77. Find the general solution of the differential equation $\frac{dy}{dx} = \frac{1+e^x}{2y}$. **77.** _____

78. Find the particular solution of the differential equation $\frac{dy}{dx} = 3x^2 - 7x + 2$; $y = 4$ when $x = 0$. **78.** _____

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79. The probability density function of a random variable is defined by $f(x) = \frac{1}{4}$ for x in the interval $[12, 16]$.
Find $P(X \leq 14)$.

79. _____

80. For the probability density function $f(x) = 3x^{-4}$ on $[1, \infty)$, find

(a) the expected value;

80. (a) _____

(b) the variance;

(b) _____

(c) the standard deviation.

(c) _____

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FINITE MATHEMATICS AND CALULUS WITH APPLICATIONS **Name:**

Final Examination, Form B

Choose the best answer.

1. Suppose that the variable cost of producing an item is \$300 and the fixed cost is \$200. Find a linear cost function for production of this item. **1.** _____

(a) $C(x) = 200x + 300$ **(b)** $C(x) = 300x + 200$

(c) $C(x) = 500x + 200$ **(c)** $C(x) = 300x$

2. The supply and demand functions for a particular commodity are given by

$$p = S(x) = \frac{2}{7}x \text{ and } p = D(x) = 22 - \frac{1}{2}x$$

where p represents the price in dollars. Find the equilibrium price. **2.** _____

(a) \$28 **(b)** \$14 **(c)** \$8 **(d)** \$6

3. An item which sells for \$37 has a linear cost function given by $C(x) = 13x + 800$. Find the break-even quantity. **3.** _____

(a) 366 **(b)** 200 **(c)** 7400 **(d)** 300

4. The cost in dollars for producing x units of a particular item is given by $C(x) = 0.78x + 576$. How many units could be produced for a cost of \$849? **4.** _____

(a) 273 **(b)** 1088 **(c)** 350 **(d)** 1238

5. Give the solution of the system with the following augmented matrix.

$$\left[\begin{array}{cc|c} 1 & 0 & -2 \\ 0 & 6 & 18 \end{array}\right]$$

5. _____

(a) $(-2,6)$ **(b)** $(-2,3)$ **(c)** $(-2,18)$ **(d)** $(-2,9)$

6. Use the Gauss–Jordan method to solve the following system of equations. Give only the x-value of the solution.

$$\begin{aligned} -4y + y &= -12 \\ 3y + 2z &= -18 \\ 2x - 3z &= 13 \end{aligned}$$

6. _____

(a) 2 **(b)** -2 **(c)** 3 **(d)** No solution

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7. If $A = \begin{bmatrix} 6 & 3 \\ 8 & 2 \end{bmatrix}$ and $B = \begin{bmatrix} -1 \\ 2 \end{bmatrix}$, find AB. **7.** _____

(a) $\begin{bmatrix} 0 & -4 \end{bmatrix}$ **(b)** $\begin{bmatrix} 0 \\ -4 \end{bmatrix}$

(c) $\begin{bmatrix} -6 & 6 \\ -8 & 4 \end{bmatrix}$ **(d)** Product does not exist.

8. If $A = \begin{bmatrix} 2 & 4 \\ -3 & 5 \end{bmatrix}$, find A^{-1}. **8.** _____

(a) $\begin{bmatrix} -2 & -4 \\ 3 & 5 \end{bmatrix}$ **(b)** $\begin{bmatrix} -1 & -\frac{3}{4} \\ 2 & -\frac{5}{2} \end{bmatrix}$

(c) $\begin{bmatrix} \frac{5}{22} & -\frac{2}{11} \\ \frac{3}{22} & \frac{1}{11} \end{bmatrix}$ **(d)** A^{-1} does not exist.

9. Describe the graph of the inequality $2y + 4x < 8$.

(a) The region to the left of the dashed line $y = -2x + 4$

(b) The region to the right of the dashed line $y = -2x + 4$

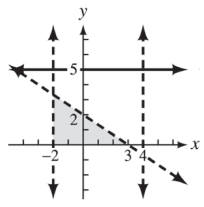
(c) The region to the left of and including the solid line $y = -2x + 4$

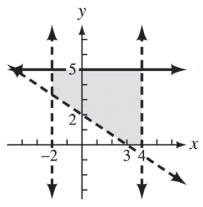
(d) The region to the right of and including the solid line $y = -2x + 4$ **9.** _____

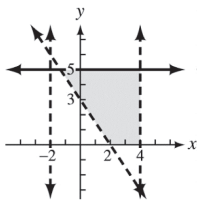
10. Graph the feasible region for the following system of inequalities.

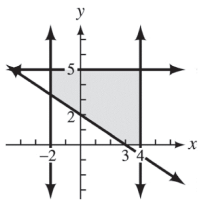
$$-2 < x < 4$$
$$0 \le y \le 5$$
$$2x + 3y > 6$$

10. _____

(a) 

(b) 

(c) 

(d) 

11. If the feasible region for a system has corner points (0, 8), (4, 3), and (5, 0), find the maximum value of the objective function $z = 6x - 3y$. **11.** _____

(a) 36 **(b)** 32 **(c)** 30 **(d)** 24

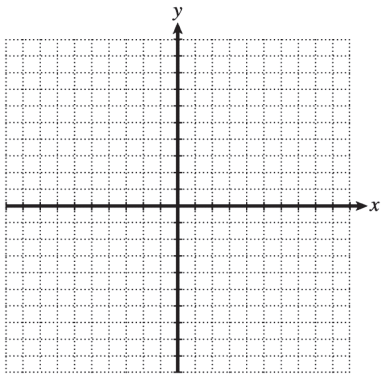
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12. Use the graphical method to solve the following linear programming problem.

Maximize $z = 2x + 3y$

subject to: $2x - 5y \le 10$
$x - y \ge 0$
$x \ge 0$
$y \ge 0.$



12. _____

(a) 10 at (5, 0) **(b)** $\frac{50}{7}$ at $\left(\frac{10}{7}, \frac{10}{7}\right)$ **(c)** 15 at (0, 5) **(d)** No maximum value

13. It takes 3 hours to build a planter box and 2 hours to paint it. It takes 4 hours to build a step-stool and 3 hours to paint it. A man has 12 painting hours and 8 building hours available. If x is the number of planter boxes and y the number of stepstools, which of the following systems of inequalities describes this problem?

13. _____

(a) $3x + 2y \le 8$
$4x + 3y \le 12$
$x \ge 0, y \ge 0$

(b) $3x + 4y \le 8$
$2x + 3y \le 12$
$x \ge 0, y \ge 0$

(c) $3x + 8y \le 4$
$2x + 12y \le 3$
$x \ge 0, y \ge 0$

(d) $3x + 4y \le 12$
$2x + 3y \le 8$
$x \ge 0, y \ge 0$

14. Read the solution from the following simplex tableau.

$$\begin{array}{c} x_1 \quad x_2 \quad s_1 \quad s_2 \quad z \\ \left[\begin{array}{ccccc|c} 3 & 0 & 3 & 1 & 0 & 17 \\ 4 & 1 & 5 & 0 & 0 & 20 \\ \hline -1 & 0 & 6 & 0 & 1 & 0 \end{array}\right] \end{array}$$

14. _____

(a) $x_1 = 3, x_2 = 0, s_1 = 3, s_2 = 1, z = 1$

(b) $x_1 = -1, x_2 = 0, s_1 = 6, s_2 = 0, z = 1$

(c) $x_1 = 0, x_2 = 20, s_1 = 0, s_2 = 17, z = 0$

(d) $x_1 = 0, x_2 = 20, s_1 = 0, s_2 = 17, z = 1$

15. To solve a linear programming problem with the following initial simplex tableau, which element would be selected as the first pivot?

$$\begin{array}{c} x_1 \quad x_2 \quad s_1 \quad s_2 \quad z \\ \left[\begin{array}{ccccc|c} 1 & 5 & 0 & 10 & 0 & 100 \\ 0 & 4 & 1 & 15 & 0 & 200 \\ \hline 0 & -6 & 0 & -10 & 1 & 0 \end{array}\right] \end{array}$$

15. _____

(a) 10 **(b)** 15 **(c)** 5 **(d)** -6

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16. Find the transpose of the following matrix.

$$\begin{bmatrix} 2 & 0 \\ 3 & -1 \\ 1 & 4 \end{bmatrix}$$

16. _____

(a) $\begin{bmatrix} 0 & 2 \\ -1 & 3 \\ 4 & 1 \end{bmatrix}$ **(b)** $\begin{bmatrix} 3 & -1 \\ 1 & 4 \\ 2 & 0 \end{bmatrix}$ **(c)** $\begin{bmatrix} 1 & 4 \\ 3 & -1 \\ 2 & 0 \end{bmatrix}$ **(d)** $\begin{bmatrix} 2 & 3 & 1 \\ 0 & -1 & 4 \end{bmatrix}$

17. Margaret Murphy opened a savings account with a deposit of $7500. The account pays 8% interest compounded quarterly. If no further deposits and no withdrawals are made, find the balance in Margaret's account at the end of 5 years.

17. _____

(a) $10,500 **(b)** $34,957.18 **(c)** $8100 **(d)** $11,144.61

18. Marc Rossoff wants to have $25,000 available 10 years from now to buy a car. How much must he invest today, at 6% compounded monthly, so that he will have the required amount?

18. _____

(a) $23,584.91 **(b)** $13,959.87 **(c)** $13,740.82 **(d)** $15,000

19. Find the sum of the first five terms of the geometric sequence with $a = 6$ and $r = -\frac{1}{2}$.

19. _____

(a) $\frac{93}{8}$ **(b)** $-\frac{93}{16}$ **(c)** $\frac{8}{33}$ **(d)** $\frac{33}{8}$

20. Find the payment necessary to amortize a loan of $20,000 if the interest rate is 10% compounded quarterly and payments are made quarterly for 10 years.

20. _____

(a) $296.72 **(b)** $796.72 **(c)** $500 **(d)** $800

21. Write the negation of "Some coins are worth one dollar."

21. _____

(a) Some coins are not worth one dollar

(b) No coins are worth one dollar.

(c) If it is a coin, it is worth one dollar.

(d) If it is not worth one dollar, it is a coin.

22. If p is true and q is false, find the true statement.

22. _____

(a) $q \wedge p$ **(b)** $\sim q \vee \sim p$ **(c)** $q \wedge \sim p$ **(d)** $\sim p$

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23. Find the valid argument. **23.** _____

(a) $p \vee q$
p
$\overline{\sim q}$

(b) $p \to q$
$q \to p$
$\overline{p \wedge q}$

(c) $(p \to q) \wedge (q \to p)$
p
$\overline{p \vee q}$

(d) $(\sim p \vee q) \wedge (\sim p \to q)$
p
$\overline{\sim q}$

24. Write "p is sufficient for q" symbolically. **24.** _____

(a) $p \to q$ **(b)** $q \to p$ **(c)** $p \leftrightarrow q$ **(d)** $\sim p \to \sim q$

25. How many subsets does the set $\{a,b,c,d,e\}$ have? **25.** _____

(a) 64 **(b)** 32 **(c)** 16 **(d)** 30

26. Which of the following statements is false? **26.** _____

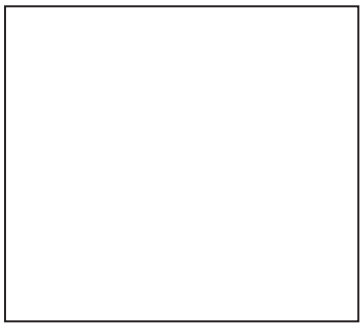
(a) $7 \in \{7, 9, 12\}$ **(b)** $\{a, b\} \subseteq \{a, b\}$

(c) $6 \notin \{5, 6, 7\}$ **(d)** $\varnothing \subseteq \{5, 6, 7\}$

27. A survey of members of a health club found that:

24 members swim;
32 members use exercise bikes;
20 members use weight machines;
8 members swim and use weight machines;
13 members use exercise bikes and weight machines;
12 members use exercise bikes only;
5 members swim, use exercise bikes, and use weight machines;
6 members do not swim and do not use either exercise bikes or weight machines

Use a Venn diagram to determine how many members were surveyed.



(a) 120 **(b)** 82
(c) 48 **(d)** 54

27. _____

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28. Suppose that a single card is drawn from a standard 52-card deck. Find the probability that the card is a black seven. **28.** _____

(a) $\frac{1}{4}$ **(b)** $\frac{3}{14}$ **(c)** $\frac{1}{13}$ **(d)** $\frac{1}{26}$

29. If $P(A) = 0.3, P(B|A) = 0.6, P(B'|A') = 0.1$, find $P(B'|A)$. **29.** _____

(a) $\frac{2}{3}$ **(b)** $\frac{7}{19}$ **(c)** $\frac{4}{25}$ **(d)** 0.9

30. Suppose that Marco has 6 shirts, 5 pairs of pants, and 3 pairs of shoes. How many outfits can he create if an outfit consists of 1 shirt, 1 pair of pants, and 1 pair of shoes? **30.** _____

(a) 150 **(b)** 30 **(c)** 90 **(d)** 14

31. Find the number of distinguishable permutations of the letters in the word *moose*. **31.** _____

(a) 120 **(b)** 60 **(c)** 30 **(d)** 5

32. From a group of 6 boys and 3 girls, an after-school reading club of 2 boys and 2 girls is selected. How many such clubs are possible? **32.** _____

(a) 126 **(b)** 720 **(c)** 18 **(d)** 45

33. Georgia is taking a 5-question multiple-choice quiz in which each question has 4 choices. She guesses on all of the questions. What is the probability that she answers exactly 2 of the questions correctly? **33.** _____

(a) $\frac{1}{16}$ **(b)** $\frac{27}{1024}$ **(c)** $\frac{135}{512}$ **(d)** $\frac{45}{512}$

34. If 3 balls are drawn from a bag containing 4 red, 3 blue, and 2 yellow balls, what is the expected number of yellow balls in the sample? **34.** _____

(a) 2 **(b)** 1 **(c)** $\frac{2}{9}$ **(d)** $\frac{2}{3}$

35. Suppose that a student has test scores of 70, 78, 80, and 94. What is the student's mean score? **35.** _____

(a) 322 **(b)** 79 **(c)** 80.5 **(d)** 80

36. Find the median for the following set of numbers. **36.** _____

6, 14, 9, 13, 12, 11

(a) 10.83 **(b)** 11.5 **(c)** 11 **(d)** No median

37. Find the mode or modes for the following set of numbers. **37.** _____

2, 1, 5, 2, 8, 5, 9

(a) 2 **(b)** 5 **(c)** 2 and 5 **(d)** No mode

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38. Find the standard deviation for the following set of numbers. Round to the nearest hundredth.

$$15, 13, 20, 8, 22, 12$$

38. _____

(a) 27.20 **(b)** 5.22 **(c)** 4.76 **(d)** 15.88

39. Find the mean for the following grouped data. Round to the nearest hundredth.

39. _____

Interval	Frequency
1–3	8
4–6	12
7–9	20
10–12	32

(a) 8.17 **(b)** 6.5 **(c)** 7.17 **(d)** 9.17

40. The probability that a certain baseball team will win a given game is 0.46. If the team plays 100 games, find the expected number of wins and the standard deviation. (Round to the nearest hundredth if necessary.)

40. _____

(a) $\mu = 4.98; \sigma = 46$ **(b)** $\mu = 46; \sigma = 6.78$

(c) $\mu = 46; \sigma = 4.98$ **(d)** $\mu = 46; \sigma = 7.35$

41. Find the coordinates of the vertex of the graph of $f(x) = 2x^2 + 10x - 17$.

41. _____

(a) $\left(-\frac{5}{2}, -\frac{59}{2}\right)$ (b) $\left(\frac{5}{2}, -\frac{59}{2}\right)$ (c) $(-5, -42)$ (d) $(5, -42)$

42. Write the equation $m^P = q$ using logarithms.

42. _____

(a) $\log_m p = q$ (b) $\log_q p = m$

(c) $\log_p q = m$ (d) $\log_m q = p$

43. Solve $\left(\frac{1}{e}\right)^{2x} = 14$. (Round to nearest thousandth.)

43. _____

(a) -1.320 (b) 2.639 (c) -2.639 (d) 1.320

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44. Evaluate $\lim_{x \to 9} \frac{x-9}{\sqrt{x-3}}$. **44.** _____

(a) 0 (b) 3 (c) 6 (d) The limit does not exist.

45. Find all values of x at which $f(x) = \frac{x^2 - 5x + 6}{x^2 - 7x + 12}$ is not continuous. **45.** _____

(a) 3 (b) 4 (c) 3 and 4

(d) The function is continuous everywhere.

46. Find the average rate of change of $y = x^2 + x$ between $x = 4$ **46.** _____

(a) 9 (b) 10 (c) 17 (d) 25

47. Find the derivative of $y = -3x^3e^{2x}$. **47.** _____

(a) $-27x^2e^{2x} - 6x^3e^{2x}$ (b) $-18x^2e^{3x}$

(c) $-9x^2e^{2x} - 6x^3e^{2x}$ (d) $-6x^2e^{2x} - 6x^3e^{2x}$

48. Find the derivative of $y = \frac{x^2}{\ln 3x}$. **48.** _____

(a) $\frac{2x^2}{(\ln 3x)^2}$ (b) $\frac{6x \ln 3x - x}{3(\ln 3x)^2}$

(c) $\frac{2x \ln 3x - x}{(\ln 3x)^2}$ (d) $\frac{6x \ln 3x + x}{3(\ln 3x)^2}$

49. Find the instantaneous rate of change of $s(t) = \frac{t^2}{2} - \frac{2}{t^2}$ at $t = 2$. **49.** _____

(a) $\frac{3}{2}$ (b) $\frac{5}{2}$ (c) $\frac{7}{2}$ (d) $\frac{9}{2}$

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50. Find an equation of the tangent line to the curve $f(x) = -\frac{1}{x+2}$ at the point $\left(2, -\frac{1}{4}\right)$. **50.** _____

(a) $x - 16y = 6$ (b) $x - 4y = 3$

(c) $f'(x) = \frac{1}{16}$ (d) $y = \frac{1}{(x+2)^2}$

51. Find $h'(3)$ if $h(x) = -\frac{400}{\sqrt{3x+7}}$. **51.** _____

(a) 100 (b) $\frac{25}{8}$ (c) $\frac{75}{8}$ (d) 200

52. Find the largest open interval(s) over which the function $g(x) = x^3 - 12x^2 + 36x + 1$ is increasing. **52.** _____

(a) $(2, 6)$ (b) $(-\infty, 2)$

(c) $(-\infty, 6)$ (c) $(-\infty, 2)$ and $(6, \infty)$

53. Find the location and value of all relative extrema for the function $f(x) = \frac{x^2 + 5x + 3}{x - 1}$. **53.** _____

(a) Relative minimum of 1 at -2; relative maximum of 13 at 4

(b) Relative maximum of 1 at -2; relative minimum of 13 at 4

(c) Relative minimum of 1 at 4; relative minimum of 13 at -2

(d) No relative extrema

54. Find the coordinates of all points of inflection of the function $g(x) = x^3 - 6x^2$. **54.** _____

(a) $(2, -16)$ (b) $(2, -12)$ (c) $(2, 0)$ (d) $(-2, 16)$

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55. Find the third derivative of $f(x) = \sqrt{2x+1}$. **55.** _____

(a) $\frac{3}{8}(2x+1)^{-5/2}$ (b) $3(2x+1)^{-5/2}$

(c) $-(2x+1)^{-3/2}$ (d) $-\frac{1}{4}(2x+1)^{-3/2}$

56. Find the absolute minimum of $f(x) = x^4 - 4x^3 - 5$ on the interval $[-1, 2]$. **56.** _____

(a) -30 (b) 0 (c) -21 (d) No absolute minimum

57. Botanists, Inc., a consulting firm, monitors the monthly growth of an unusual plant. They determine that the growth (in inches) is given by

$$g(x) = 4x - x^2,$$

where x represents the average daily number of ounces of water the plant receives. Find the maximum monthly growth of the plant. **57.** _____

(a) 2 inches (b) 8 inches

(c) 4 inches (d) 6 inches

58. Find $\frac{dy}{dx}$, given $4x^2 - 7 = 3\sqrt{y} + \frac{2}{x^3}$. **58.** _____

(a) $\frac{4\sqrt{y}(4x^5 - 3)}{3x^4}$ (b) $\frac{4\sqrt{y}(4x^5 + 3)}{3x^4}$

(c) $\frac{4\sqrt{y}(4x^3 - 3)}{3x^2}$ (d) $\frac{4\sqrt{y}(4x^3 + 3)}{3x^2}$

59. If $xy = y + 6$, find $\frac{dy}{dt}$ if $\frac{dx}{dt} = -3$, $x = 4$, and $y = 2$. **59.** _____

(a) 2 (b) 0 (c) -2 (d) -4

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60. Evaluate dy, given $y = 45 - 2x - 3x^2$, with $x = 3$ and $\Delta x = 0.02$. **60.** _____

(a) -0.4 (b) 0.4 (c) 0.32 (d) -0.32

61. Using differentials, approximate the volume of coating on a cube with 3-cm sides, if the coating is 0.02 cm thick. **61.** _____

(a) $0.54\ \text{cm}^3$ (b) $27.54\ \text{cm}^3$

(c) $26.46\ \text{cm}^3$ (d) $81.54\ \text{cm}^3$

62. Find $\int (4x^2 + 3x - 5)\,dx$. **62.** _____

(a) $\frac{4}{3}x^3 + \frac{3}{2}x^2 - 5 + C$ (b) $\frac{4}{3}x^3 + \frac{3}{2}x^2 - 5x$

(c) $\frac{3}{4}x^3 + \frac{3}{2}x^2 - 5 + C$ (d) $8x + 3$

63. Find $\int \frac{-3}{(2x+5)}\,dx$. **63.** _____

(a) $-\frac{3}{2}\ln|2x + 5| + C$ (b) $-3\ln|2x + 5| + C$

(c) $-\frac{1}{6}\ln|2x + 5| + C$ (d) $\frac{1}{2}\ln|2x + 5| + C$

64. Evaluate $\int_0^1 2x\sqrt{4x^2 + 5}\,dx$. **64.** _____

(a) $\frac{3}{8}$ (b) $\frac{27 - 5\sqrt{5}}{6}$

(c) $\frac{27 - 5\sqrt{5}}{8}$ (c) $\frac{27 - 5\sqrt{5}}{4}$

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65. Find the area of the region between the x-axis and the graph of $f(x) = \sqrt{x+1}$ on the interval $[0,3]$. **65.** _____

(a) $\frac{14}{3}$ (b) 7 (c) $\frac{1}{4}$ (d) $\frac{21}{2}$

66. Find the area of the region enclosed by the graphs of $f(x) = 9 - x^2$ and $g(x) = x^2 - 9$. **66.** _____

(a) -36 (b) 36 (c) 0 (d) 72

67. Find $\int 3x^2e^{2x}\,dx$. **67.** _____

(a) $3e^{x^2} + C$ (b) $\frac{3}{2}x^2e^{2x} - \frac{3}{2}xe^{2x} + \frac{3}{4}e^{2x} + C$

(c) $x^3e^{2x} + C$ (d) $3x^2e^{2x} - 6xe^{2x} + 6e^{2x} + C$

68. Evaluate $\int_1^4 9x^2 \ln x\,dx$. **68.** _____

(a) $192\ln 4 - 45$ (b) $192\ln 4 - 65$

(c) $192\ln 4 - 51$ (d) $192\ln 4 - 63$

69. Find the average value of the function $f(x) = \sqrt{3x+1}$ over the interval $[0, 8]$. **69.** _____

(a) $\frac{31}{3}$ (b) $\frac{248}{9}$ (c) $\frac{31}{9}$ (d) $\frac{248}{3}$

70. Find the volume of the solid of revolution formed by rotating the region bounded by $f(x) = \sqrt{x-1}$, $y = 0$, and $x = 10$ about the x-axis. **70.** _____

(a) 40.5 (b) $\frac{81\pi}{2}$ (c) 18π (d) 40π

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71. Evaluate $\int_{-\infty}^{-2} \frac{1}{x^3}\,dx$. **71.** _____

(a) $-\frac{1}{8}$ (b) Diverges (c) $\frac{1}{64}$ (d) $-\frac{1}{64}$

72. Given $z = f(x, y) = x^2 - 3xy + 2y^3$, find $f_{yx}(0, -2)$. **72.** _____

(a) -16 (b) 2 (c) -24 (d) -3

73. Which of the following applies to the function $f(x, y) = 2x^2 + 8y^3 - 12xy + 7$? **73.** _____

(a) f has a relative maximum at $\left(\frac{9}{2}, \frac{3}{2}\right)$

(b) f has a relative minimum at $(0, 0)$

(c) f has a relative minimum at $\left(\frac{9}{2}, \frac{3}{2}\right)$

(d) f has a saddle point at $\left(\frac{9}{2}, \frac{3}{2}\right)$

74. Maximize $f(x, y) = x^2y$, subject to the constraint $y + 4x = 84$. **74.** _____

(a) 0 (b) 14 (c) 5488 (d) 3642

75. Find dz, given $z = \sqrt{x^2 + y^2}$, with $x = 3$, $y = 4$, $dx = -0.01$, and $dy = 0.02$. **75.** _____

(a) 0.022 (b) 0.01 (c) 0.001 (d) 0.05

76. Evaluate $\int_0^2 \int_2^4 x^2y\,dy\,dx$. **76.** _____

(a) $\frac{112}{3}$ (b) 16 (c) 32 (d) 12

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77. Find the general solution of the differential equation $\frac{dy}{dx} = \frac{e^{2x} - 4}{y^2}$. **77.** _____

(a) $y = \left(\frac{3}{2}e^{2x} - 12x + C\right)^{1/3}$ (b) $y = \frac{1}{2}e^{2x} - 4x + C$

(c) $y = \left(\frac{1}{2}e^{2x} - 4x + C\right)^{1/3}$ (d) $y^2 = e^{2x} - 4$

78. Find the particular solution of the differential equation $\frac{dy}{dx} = 7 - 2x + 3x^2; y = -2$ when $x = 0$. **78.** _____

(a) $y = 7x - x^2 + x^3 + C$ (b) $y = 7x - x^2 + x^3 - 2$

(c) $y = -x^2 + x^3 + C$ (d) $y = 7x - x^2 + x^3 + 2 + C$

79. The probability density function of a random variable is defined by $f(x) = \frac{1}{5}$ for $[20, 25]$. Find $P(X \leq 22)$. **79.** _____

(a) 0.2 (b) 0.8 (c) 0.4 (d) 0.6

80. Find the standard deviation for the probability density function $f(x) = 3x^{-4}$ on $[1, \infty)$. **80.** _____

(a) 1.5 (b) 0.866 (c) 0.75 (d) 0.67

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ANSWERS TO FINAL EXAMINATIONS

FINAL EXAMINATION, FORM A

1. \$3

2. 12

3. $C(x) = 100x + 300$

4. 800 units

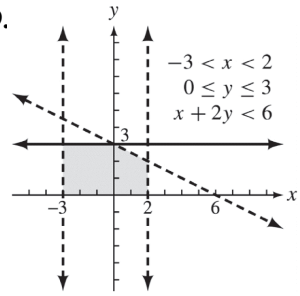
5. $\left(\frac{2}{3}, -\frac{3}{4}\right)$

6. $(1, -1, 2)$

7. $AB = \begin{bmatrix} 11 & -4 & 1 \\ -8 & 2 & 7 \end{bmatrix}$; BA does not exist.

8. $A^{-1} = \begin{bmatrix} \frac{3}{5} & -\frac{1}{5} & -\frac{1}{5} \\ -\frac{1}{5} & \frac{2}{5} & \frac{2}{5} \\ \frac{3}{5} & -\frac{1}{5} & -\frac{6}{5} \end{bmatrix}$

9.



10. (3, 3), (7, 3), (7, 7)

11. 33 at (7, 3)

12. Maximum of 10 at (2, 0)

13. Let x = the number of sidewalks;
y = the number of patios.

$$\begin{aligned} 2x + 4y &\le 8 \\ 3x + 3y &\le 21 \\ x &\ge 0 \\ y &\ge 0 \end{aligned}$$

Maximize $z = 450x + 700y$.

or

Let x_1 = the number of sidewalks;
x_2 = the number of patios.

$$\begin{aligned} 2x_1 + 4x_2 &\le 8 \\ 3x_1 + 3x_2 &\le 21 \\ x_1 &\ge 0 \\ x_2 &\ge 0 \end{aligned}$$

Maximize $z = 450x_1 + 700x_2$.

14.

$$\left[\begin{array}{ccccc|c} x_1 & x_2 & s_1 & s_2 & z & \\ \hline 2 & 4 & 1 & 0 & 0 & 8 \\ 3 & 3 & 0 & 1 & 0 & 21 \\ \hline -450 & -700 & 0 & 0 & 1 & 0 \end{array}\right]$$

15. Construct 4 sidewalks and no patios, for a profit of \$1800.

16. $x_1 = 350$, $x_2 = 0$, $x_3 = 0$, $s_1 = 200$, $s_2 = 0$, $z = 0$

17. 800

18. Maximize $z = 9x_1 + 11x_2 + 5x_3$

subject to: $2x_1 + 2x_2 + 7x_3 \le 6$
$5x_1 + 3x_2 + 2x_3 \le 8$

with $x_1 \ge 0$, $x_2 \ge 0$, $x_3 \ge 0$.

19. \$951.18

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20. \$2129.25

21. 2560

22. \$611.57

23. No pennies are made of silver.

24. True

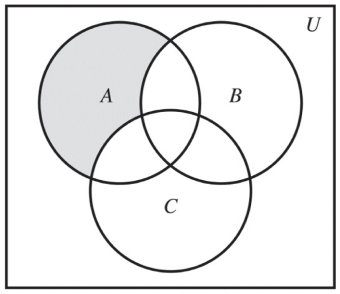
25. True

26. Valid

27. $q \rightarrow p$

28. **(a)** $\{b, c, f, g\}$ **(b)** $\{a, c, d, g\}$

29.



$A \cap (B' \cap C')$

30. 47

31. **(a)** $\{1H, 2H, 3H, 4H, 5H, 6H, 1T, 2T, 3T, 4T, 5T, 6T\}$

(b) $\frac{1}{4}$

32. 10,000

33. 60

34. $\frac{2}{55}$

35. **(a)** $\frac{1}{243}$ **(b)** $\frac{40}{243}$

36. $-\$0.25$

37. **(a)** 65.1 **(b)** 70.5
(c) 71 **(d)** 66

38. 4.53

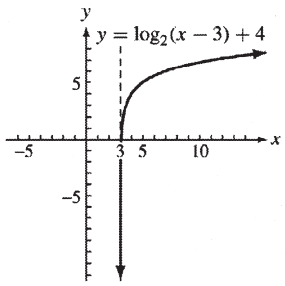
39. 4.24

40. $\mu = 31; \sigma = 3.43$

41. (7.5,157.5)

42. $\log_2 d = a$

43.



44. 4

45. 5

46. $\frac{1}{4}$

47. $y' = 7xe^{3x}(2 + 3x)$

48. $y' = \frac{x + 1 - x \ln(3x)}{x(x+1)^2}$

49. 14

50. $y = 8x + 9$

51. $-\frac{12}{125}$

52. Increasing on $(-\infty, 2)$ and $(6, \infty)$; decreasing on $(2, 6)$

53. Relative maximum of 1 at -2; relative minimum of 13 at 4

54. (a) $(-\infty, 0)$ and $(2, \infty)$ (b) $(0, 2)$
(c) $(0, -5)$ and $(2, -21)$

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55. $(x + 4)e^x$

56. Absolute maximum of 0 at 0; absolute minimum of -16 at 2

57. 20,000

58. $\frac{dy}{dx} = \frac{3 - 14x^{1/2}y}{14x^{3/2} + 30x^{1/2}y^2}$

59. 12

60. $dy = -18x(2 + x^2)^2\, dx$

61. 3π in.^{3}

62. $x^3 - \frac{7}{2}x^2 + 2x + C$

63. $\frac{1}{8}\ln|x + 9| + C$

64. $\frac{56}{9}$

65. $\frac{1}{2}(e^4 - 1)$

66. $\frac{10\sqrt{10}}{3} \approx 10.54$

67. $e^x(x^2 - 2x + 2) + C$

68. $\frac{3}{4}\left(3e^4 + 1\right) \approx 123.60$

69. 39

70. 120π

71. Converges; 1

72. -4

73. (a) None (b) -3 at $(-2, -2)$ (c) None

74. 5488 when $x = 14$ and $y = 28$

75. -0.12

36. $\frac{3}{2}e^4 - \frac{3}{2}e^2 \approx 70.81$

77. $y^2 = x + e^x + C$

78. $y = x^3 - \frac{7}{2}x^2 + 2x + 4$

79. 0.5

80. (a) $\frac{3}{2}$
(b) 0.75
(c) 0.866

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FINAL EXAMINATION, FORM B

Questions 1 through 40

1. (b)	**11.** (c)	**21.** (b)	**31.** (b)
2. (c)	**12.** (a)	**22.** (b)	**32.** (d)
3. (b)	**13.** (b)	**23.** (c)	**33.** (c)
4. (c)	**14.** (c)	**24.** (a)	**34.** (d)
5. (b)	**15.** (a)	**25.** (b)	**35.** (c)
6. (a)	**16.** (d)	**26.** (c)	**36.** (b)
7. (b)	**17.** (d)	**27.** (d)	**37.** (c)
8. (c)	**18.** (c)	**28.** (d)	**38.** (b)
9. (a)	**19.** (d)	**29.** (a)	**39.** (a)
10. (b)	**20.** (b)	**30.** (c)	**40.** (c)

Questions 41 through 80

41. (a)	**51.** (c)	**61.** (a)	**71.** (a)
42. (d)	**52.** (d)	**62.** (c)	**72.** (d)
43. (a)	**53.** (b)	**63.** (a)	**73.** (c)
44. (c)	**54.** (a)	**64.** (b)	**74.** (c)
45. (b)	**55.** (b)	**65.** (a)	**75.** (b)
46. (c)	**56.** (c)	**66.** (d)	**76.** (b)
47. (c)	**57.** (c)	**67.** (b)	**77.** (a)
48. (c)	**58.** (b)	**68.** (d)	**78.** (b)
49. (b)	**59.** (a)	**69.** (c)	**79.** (c)
50. (a)	**60.** (a)	**70.** (b)	**80.** (b)

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SOLUTIONS
TO
ALL EXERCISES

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Pretest, Form A

Find the value of each of the following expressions.

1. $(0.5)^3 \cdot (0.2)^2$ **1.** _____

2. $\sqrt{27\left(\frac{1}{3}\right)\left(1+\frac{1}{3}\right)}$ **2.** _____

3. $2000\left(1-\frac{1}{2}\right)^4$ **3.** _____

4. $\frac{8 \cdot 7 \cdot 6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}{4 \cdot 3 \cdot 2 \cdot 1}$ **4.** _____

5. $\frac{0.5\,(0.7)}{0.5\,(0.7)+2(0.35)}$ **5.** _____

6. Find the value of $\frac{3a(a+2b-1)}{a(a+1)}$ if $a = 6$ and $b = -2$. **6.** _____

Solve each of the following equations.

7. $18 - \frac{2}{3}y = \frac{5}{6}y$ **7.** _____

8. $3x - (4x + 8) = 25$ **8.** _____

9. $4\,(2z - 3) + 5 = -2\,(z + 6)$ **9.** _____

10. $0.03x + 0.05\,(200 - x) = 9$ **10.** _____

11. Solve the equation $q = \frac{3}{4}p - 8$ for p. **11.** _____

12. Solve the equation $4x - 5y = 8$ for y. **12.** _____

13. Find the coordinates of the point where the graph of $6x - 5y = 10$ crosses the x-axis. **13.** _____

14. Suppose $C = 35x - 250$. Find x when C is 450. **14.** _____

15. A coat that sells for \$125 is put on sale for \$80. Find the percent of markdown. **15.** _____

16. 66 is 120% of what number? **16.** _____

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17. Margaret can travel 216 miles on 9 gallons of gas. How many gallons will she need to travel 336 miles?

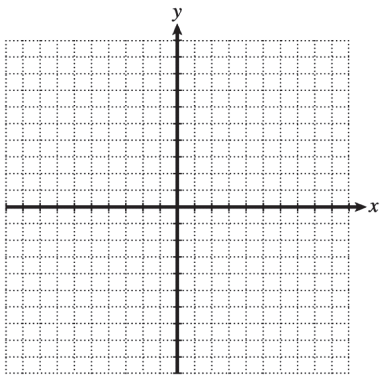
17. _____

18. Solve the inequality $3(2 - x) - 4(x + 6) < -2(x - 1)$.

18. _____

19. Graph the equation $5x - 2y = 10$.

19.



20. Find the slope of the line through the points with coordinates $(4, 7)$ and $(-3, 5)$.

20. _____

21. Write an equation in the form $ax + by = c$ for the line through the points with coordinates $(2, -3)$ and $(5, 6)$.

21. _____

22. Solve the following system of equations.

$$3x + 4y = 14$$
$$-2x + 5y = 29$$

22. _____

23. Which of the following describes the graph of the equation $x = -4$?

23. _____

(a) A line with slope -4 (b) A line with slope 4

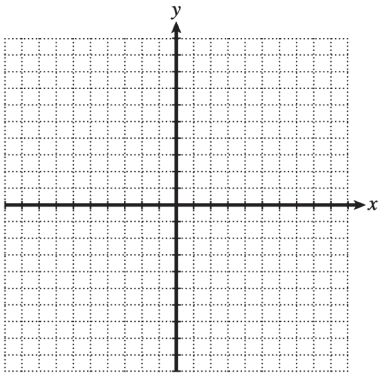
(c) A horizontal line (d) A vertical line

24. Find the slope of the line with equation $4x - 5y = 10$.

24. _____

25. Graph the inequality $3x + 5y \geq 15$.

25.



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FINITE MATHEMATICS AND CALCULUS WITH APPLICATIONS **Name:** _____

Pretest, Form B

Choose the best answer.

Find the value of each of the following expressions.

1. $(0.3)^2 \cdot (0.7)^1$ **1.** _____

(a) 2.1 (b) 0.63 (c) 0.21 (d) 0.063

2. $\sqrt{16\left(\frac{1}{2}\right)\left(1-\frac{1}{2}\right)}$ **2.** _____

(a) 8 (b) 4 (c) 2 (d) $4\sqrt{2}$

3. $4000\left(1+\frac{1}{2}\right)^3$ **3.** _____

(a) 13,500 (b) 9000 (c) 6000 (d) 3000

4. $\frac{9 \cdot 8 \cdot 7 \cdot 6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}{5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}$ **4.** _____

(a) 9876 (b) 6789 (c) 3024 (d) 120

5. $\frac{0.6\,(0.3)}{0.6\,(0.3)+0.4\,(0.9)}$ **5.** _____

(a) 2 (b) $\frac{1}{2}$ (c) $\frac{1}{3}$ (d) 0.54

6. Find the value of $\frac{2(a+1-b)}{a(a+1)}$ if $a = 10$ and $b = 5$. **6.** _____

(a) 1 (b) $\frac{6}{55}$ (c) $\frac{1}{11}$ (d) $-\frac{4}{15}$

Solve each of the following equations.

7. $12 - \frac{3}{4}r = \frac{5}{8}r + 23$ **7.** _____

(a) -8 (b) 8 (c) -1 (d) 4

8. $2x - (3x + 7) = 18$ **8.** _____

(a) 11 (b) -11 (c) 25 (d) -25

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9. $-2(k-1)+8=-2(k+3)$ **9.** _____

(a) 4 (b) 10 (c) -6 (d) No solution

10. $0.04x+0.07(900-x)=51$ **10.** _____

(a) 4000 (b) 400 (c) 317 (d) 2083

11. Solve the equation $q=-\frac{2}{7}p-3$ for p. **11.** _____

(a) $p=\frac{7}{2}q+\frac{21}{2}$ (b) $p=-\frac{7}{2}q-\frac{21}{2}$

(c) $p=\frac{7}{2}q-\frac{21}{2}$ (d) $p=7q+\frac{3}{2}$

12. Solve the equation $3x+6y=7$ for y. **12.** _____

(a) $y=-\frac{1}{2}x+7$ (b) $y=\frac{1}{2}x+\frac{7}{6}$

(c) $y=-2x+\frac{7}{3}$ (d) $y=-\frac{1}{2}x+\frac{7}{6}$

13. Find the coordinates of the point where the graph of $7x-4y=8$ crosses the y-axis. **13.** _____

(a) $(0,7)$ (b) $(0,4)$ (c) $(-2,0)$ (d) $(0,-2)$

14. Suppose $C=20x+500$. Find x when C is 650. **14.** _____

(a) 13,500 (b) 1150 (c) 7.5 (d) 3

15. A boat that sells for \$5000 is marked up to \$8000. What is the percent increase? **15.** _____

(a) 80% (b) 60% (c) 62.5% (d) 37.5%

16. 68 is 85% of what number? **16.** _____

(a) 125 (b) 80 (c) 57.8 (d) 54.4

17. Bob can travel 160 miles on 8 gallons of gas. How many gallons will he need to travel 400 miles? **17.** _____

(a) 80 (b) 30 (c) 20 (d) 16

18. Solve the inequality $4(5-2x)-2(x+7)\le -2-(x-80)$. **18.** _____

(a) $x\ge -8$ (b) $x\le -8$ (c) $x\ge 8$ (d) $x\le 8$

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