

Course: Pre-Calculus                      Instructor: Mr. Brian Gottschalk

Textbook: **PRECALCULUS WITH LIMITS: A Graphing Approach**, Larson, Hostetler & Edwards: Houghton Mifflin.

## **COURSE PURPOSE**

Pre-calculus is an advanced analysis course which focuses on God's order as it relates to mathematics. It is intended for high school or college bound students who are interested in taking Calculus or perusing a career where higher-level mathematics is required. The material covered will expand the students' knowledge of mathematical notation, algebraic concepts and processes that are directly related to Calculus. As a result the knowledge gained will be most beneficial for those students planning on taking Calculus, or in achieving any other educational and career goals the Lord has guided them towards.

## **COURSE OUTCOMES**

The students will:

1. Exhibit competence in symbolic manipulation involving linear, quadratic, exponential, and logarithmic functions.
2. Show an understanding of the use of polar coordinates and complex numbers.
3. Demonstrate the ability to work with vectors and determinants.
4. Demonstrate ability in calculating with sequences and series.
5. Show an understanding of the applications of matrices.
6. Show mastery of the effective and appropriate use of handheld technology.
7. Demonstrate understanding of limits and derivatives.

## **COURSE GOALS**

1. Students will learn to continuously refine their God given mathematical skills to become more advanced problem solvers.
2. Students will be able to communicate mathematically at an advanced level by orally explaining a problem solving process.
3. Students will gain a deeper respect for the unique plan that the Lord has laid out for all of his creation, especially us.

## **COURSE OUTLINE**

### Unit 1

Chapter 1: Functions and their Graphs

The students will...

- Evaluate functions and find their domains.
- Analyze graphs of functions.
- Identify and graph shifts, reflections, and nonrigid transformations of functions by hand and with calculator.
- Find arithmetic combinations and compositions of functions.

- Find inverse functions graphically and algebraically.

S.O.-2, 6

D.O.-1.1, 2.1, 4.2

W.S.S.-A.12.4,5, B.12.4,6, C.12.3, F12.2,3,4

Text: pages 1-86

Days: 15-20

## Unit 2

### Chapter 2: Polynomial and Rational Functions

The students will...

- Sketch and analyze graphs of quadratic and polynomial functions.
- Use long division and synthetic division to divide polynomials by other polynomials.
- Determine the number of rational and real zeros of polynomial functions, and find the zeros.
- Perform operations with complex numbers and plot complex numbers in the complex plane.
- Determine the domains, find the asymptotes, and sketch the graphs of rational functions.

S.O.-2, 6

D.O.-2.1, 3.1,3, 4.4

W.S.S.-A.12.1,4, B.12.3,5,6, E.12.1, F.12.2,3,4

Text: pages 87-174

Days: 20-25

## Unit 3

### Chapter 3: Exponential and Logarithmic Functions

- Recognize, evaluate, and graph exponential and logarithmic functions.
- Rewrite logarithmic functions with different bases.
- Use properties of logarithms to evaluate, rewrite, expand, or condense logarithmic expressions.
- Solve exponential and logarithmic equations.
- Use exponential growth models, exponential decay models, Gaussian models, logistic models, and logarithmic models to solve real-life problems.

S.O.-2, 6

D.O.-1.2, 2.1, 4.2

W.S.S.-A.12.1,4, B.12.2,6, F.12.2,4

Text: pages 175-244

Days: 15-20

## Unit 4

### Chapter 7: Linear Systems and Matrices

The students will...

- Solve systems of equations by Gaussian elimination, by Gauss-Jordan elimination, by using inverse matrices, by Cramer's Rule, and graphically.

- Recognize a linear system in row-echelon form and use back-substitution to solve the system.
- Solve nonsquare systems of equations
- Use systems of equations to model and solve real-life problems.
- Write matrices, identify their order, and perform elementary row operations.
- Perform operations with matrices.
- Find inverses of matrices.
- Find the determinants of square matrices.

S.O.-2, 6

D.O.-2.1, 4.2

W.S.S.- A.12.3, 4,5, B.12.6, E.12.2, F.12.2, 4

Text: pages 451-554

Days: 15-20

### Unit 5

#### Chapter 8: Sequences and Series

The students will...

- Use sequence, factorial, and summation notation to write the terms and sums of sequences.
- Recognize, write, and use arithmetic sequences and geometric sequences.
- Use mathematical induction to prove statements involving a positive integer  $n$ .

S.O.-2, 6

D.O.-1.2, 2.3, 3.1

W.S.S.-A.12.1,3, F.12.1

Text: pages 555-593

Days: 15-20

### Unit 6

#### Chapter 9: Parametrics

Evaluate sets of parametrics equations as single rectangular equations and find sets of parametric equations for graphs.

- Rewrite sets of parametric equations as single rectangular equations and find sets of parametric equations for graphs.

The students will...

S.O.-2, 6

D.O.-2.1, 3.3, 4.2, 4.4

W.S.S.-A.12.3,4, B.12.3,6, C.12.1,4, E.12.1, F.12.4

Text: pages 669-698

Days: 5-10

### Unit 7

#### Chapter 6: Vectors

- Represent vectors as directed line segments and perform mathematical operations on vectors.
- Find direction angles of vectors.
- Find the dot product of two vectors and use properties of the dot product.

S.O.-2, 6  
 D.O.-1.2, 2.1, 3.1  
 W.S.S.-A.12.4, B.12.3, C.12.1,3,3, D.12.3, F.12.4  
 Text: pages 409-431  
 Days: 10-15

### Unit 8

#### Chapter 11: Limits and an Introduction to Calculus

The students will...

- Estimate limits and use properties and operations of limits.
- Find limits by direct substitution and by using the dividing our and rationalizing techniques.
- Approximate slopes of tangent lines, use the limit definition of slope, and use derivatives to find slopes of graphs.
- Evaluate the derivative of an equation analytically by using the power, product, quotient and chain rules.
- Evaluate limits of infinity and find limits of sequences.
- Find limits of summations and use them to find areas of regions bounded by graphs of functions.

S.O.-2, 6  
 D.O.-1.2, 2.3, 3.1  
 W.S.S.-A.12.4,5, D.12.1, F.12.1,4  
 Text: pages 741-794  
 Days: 20-25

### **INSTRUCTIONAL STRATEGIES**

Lecture-40%  
 Question and Answer-20%  
 Discussion-20%  
 Guided Practice-15%  
 Group work-5%

### **GRADING**

#### Quarter Grading

Homework/Journal	20%
Quizzes	20%
Take Home Tests/Projects	20%
Tests	40%

#### Semester 1 Grade

1 <sup>st</sup> Quarter	40%
2 <sup>nd</sup> Quarter	40%
Final Exam	20%

#### Semester 2 Grade

3 <sup>rd</sup> Quarter	40%
4 <sup>th</sup> Quarter	40%
Final Test/Project	20%

**CLASSROOM GUIDELINES:**

1. Students must be in their seats by the time the bell rings.
2. Students are to be active learners.
3. Students are to show Christian respect to the teacher and their peers.

**STUDENTS RESPONSIBILITIES:**

1. Students are responsible for using the gifts the Lord has given them to their fullest potential.
2. Homework should be completed before the student enters the classroom.
3. All work will be shown for every problem according to the guidelines shown in class.
4. Bring binder with paper, pencil and a graphing calculator to class every day. (**TI-83plus is preferable**)

## **APPENDIX**

Math Department Outcomes

Course: Precalculus

Instructor: Mr. Brian Gottschalk

### **Math Department Outcomes**

#### Unit 1: Functions and their Graphs

- 1.1 Distinguishes the proper place and role of mathematics in their mission to serve God.
- 2.1 Develops a repertoire of problem solving techniques.
- 4.2 Documents a logical sequence of symbolic manipulation.

#### Unit 2: Polynomial and Rational Functions

- 2.1 Develops a repertoire of problem solving techniques.
- 3.1 Integrates the use of mathematics into other academic and real-life areas.
- 3.3 Is capable of effectively using technology as a tool for problem solving.
- 4.4 Demonstrates the use of various technologies in expressing mathematical ideas and competencies.

#### Unit 3: Exponential and Logarithmic Functions

- 1.2 Recognizes God's logical order and expression in creation as evidenced in the structure of mathematics.
- 2.1 Develops a repertoire of problem solving techniques.
- 4.2 Documents a logical sequence of symbolic manipulation.

#### Unit 4: Linear Systems and Matrices

- 2.1 Develops a repertoire of problem solving techniques.
- 4.2 Documents a logical sequence of symbolic manipulation.

#### Unit 5: Sequences and Series

- 1.2 Recognizes God's logical order and expression in creation as evidenced in the structure of mathematics.
- 2.3 Is a logical thinker and uses the principles of logic to:
  - 2.3.1 deduce tentative conclusions to real-life problems
  - 2.3.2 justify the validity of conclusions
  - 2.3.3 derive valid solutions
- 3.1 Integrates the use of mathematics into other academic and real-life areas.

#### Unit 6: Parametrics

- 2.1 Develops a repertoire of problem solving techniques.
- 3.3 Is capable of effectively using technology as a tool for problem solving.
- 4.4 Demonstrates the use of various technologies in expressing mathematical ideas and competencies.

### Unit 7: Vectors

1.2 Recognizes God's logical order and expression in creation as evidenced in the structure of mathematics.

2.1 Develops a repertoire of problem solving techniques.

3.1 Integrates the use of mathematics into other academic and real-life areas.

### Unit 8: Limits and an Introduction to Calculus

1.2 Recognizes God's logical order and expression in creation as evidenced in the structure of mathematics.

2.3 Is a logical thinker and uses the principles of logic to:

2.3.1 deduce tentative conclusions to real-life problems

2.3.2 justify the validity of conclusions

2.3.3 derive valid solutions

3.1 Integrates the use of mathematics into other academic and real-life areas.

## **APPENDIX**

Wisconsin State Standards

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### **Wisconsin State Standards**

#### Unit 1

Chapter 1: Functions and their Graphs

W.S.S.: A.12.4 Develop effective oral and written presentations employing correct mathematical terminology, notation, symbols, and conventions for mathematical arguments and display of data

W.S.S.: A.12.5 Organize work and present mathematical procedures and results clearly, systematically, succinctly, and correctly

W.S.S.: B.12.4 In problem-solving situations involving the application of different number systems (natural, integers, rational\*, real\*) select and use appropriate

- computational procedures
- properties (e.g., commutativity\*, associativity\*, inverses\*)
- modes of representation (e.g., rationals as repeating decimals, indicated roots as fractional exponents)

W.S.S.: B.12.6 Routinely assess the acceptable limits of error when

- evaluating strategies
- testing the reasonableness of results
- using technology to carry out computations

W.S.S.: C.12.3 Present convincing arguments by means of demonstration, informal proof, counter-examples, or any other logical means to show the truth of

- statements (e.g., these two triangles are not congruent)
- generalizations (e.g., the Pythagorean\* theorem holds for all right triangles)

W.S.S.: F.12.2 Use mathematical functions\* (e.g., linear\*, exponential\*, quadratic\*, power) in a variety of ways, including

- recognizing that a variety of mathematical and real-world phenomena can be modeled\* by the same type of function
- translating different forms of representing them (e.g., tables, graphs, functional notation\*, formulas)
- describing the relationships among variable quantities in a problem
- using appropriate technology to interpret properties of their graphical representations (e.g., intercepts, slopes, rates of change, changes in rates of change, maximum\*, minimum\*)

W.S.S.: F.12.3 Solve linear and quadratic equations, linear inequalities, and systems of linear equations and inequalities

- numerically
- graphically, including use of appropriate technology
- symbolically, including use of the quadratic formula

W.S.S.: F.12.4 Model and solve a variety of mathematical and real-world problems by using algebraic expressions, equations, and inequalities

## Unit 2

### Chapter 2: Polynomial and Rational Functions

W.S.S.: A.12.1 Use reason and logic to

- evaluate information
- perceive patterns
- identify relationships
- formulate questions, pose problems, and make and test conjectures
- pursue ideas that lead to further understanding and deeper insight

W.S.S.: A.12.4 Develop effective oral and written presentations employing correct mathematical terminology, notation, symbols, and conventions for mathematical arguments and display of data

W.S.S.: B.12.3 Perform and explain operations on real numbers (add, subtract, multiply, divide, raise to a power, extract a root, take opposites and reciprocals, determine absolute value)

W.S.S.: B.12.5 Create and critically evaluate numerical arguments presented in a variety of classroom and real-world situations (e.g., political, economic, scientific, social)

W.S.S.: B.12.6 Routinely assess the acceptable limits of error when

W.S.S.: E.12.1 Work with data in the context of real-world situations by

- formulating hypotheses that lead to collection and analysis of one- and two-variable data
- designing a data collection plan that considers random sampling, control groups, the role of assumptions, etc.
- conducting an investigation based on that plan
- using technology to generate displays, summary statistics\*, and presentations

W.S.S.: F.12.2 Use mathematical functions\* (e.g., linear\*, exponential\*, quadratic\*, power) in a variety of ways, including

- recognizing that a variety of mathematical and real-world phenomena can be modeled\* by the same type of function
- translating different forms of representing them (e.g., tables, graphs, functional notation\*, formulas)
- describing the relationships among variable quantities in a problem
- using appropriate technology to interpret properties of their graphical representations (e.g., intercepts, slopes, rates of change, changes in rates of change, maximum\*, minimum\*)

W.S.S.: F.12.3 Solve linear and quadratic equations, linear inequalities, and systems of linear equations and inequalities

- numerically
- graphically, including use of appropriate technology
- symbolically, including use of the quadratic formula

W.S.S.: F.12.4 Model and solve a variety of mathematical and real-world problems by using algebraic expressions, equations, and inequalities

### Unit 3

#### Chapter 3: Exponential and Logarithmic Functions

W.S.S.: A.12.1 Use reason and logic to

- evaluate information
- perceive patterns
- identify relationships
- formulate questions, pose problems, and make and test conjectures
- pursue ideas that lead to further understanding and deeper insight

W.S.S.: A.12.4 Develop effective oral and written presentations employing correct mathematical terminology, notation, symbols, and conventions for mathematical arguments and display of data

W.S.S.: B.12.2 Compare real numbers using

- order relations ( $>$ ,  $<$ ) and transitivity\*
- ordinal scales including logarithmic (e.g., Richter, pH rating)
- arithmetic differences
- ratios, proportions, percents, rates of change

W.S.S.: B.12.6 Routinely assess the acceptable limits of error when

W.S.S.: F.12.2 Use mathematical functions\* (e.g., linear\*, exponential\*, quadratic\*, power) in a variety of ways, including

- recognizing that a variety of mathematical and real-world phenomena can be modeled\* by the same type of function
- translating different forms of representing them (e.g., tables, graphs, functional notation\*, formulas)
- describing the relationships among variable quantities in a problem
- using appropriate technology to interpret properties of their graphical representations (e.g., intercepts, slopes, rates of change, changes in rates of change, maximum\*, minimum\*)

W.S.S.: F.12.4 Model and solve a variety of mathematical and real-world problems by using algebraic expressions, equations, and inequalities

#### Unit 4

##### Chapter 7: Linear Systems and Matrices

W.S.S.: A.12.3 Analyze non-routine\* problems and arrive at solutions by various means, including models\* and simulations, often starting with provisional conjectures and progressing, directly or indirectly, to a solution, justification, or counter-example

W.S.S.: A.12.4 Develop effective oral and written presentations employing correct mathematical terminology, notation, symbols, and conventions for mathematical arguments and display of data

W.S.S.: A.12.5 Organize work and present mathematical procedures and results clearly, systematically, succinctly, and correctly

W.S.S.: B.12.6 Routinely assess the acceptable limits of error when

W.S.S.: E.12.2 Organize and display data from statistical investigations using

- frequency distributions
- percentiles\*, quartiles, deciles
- line of best fit\* (estimated regression line)
- matrices

W.S.S.: F.12.2 Use mathematical functions\* (e.g., linear\*, exponential\*, quadratic\*, power) in a variety of ways, including

- recognizing that a variety of mathematical and real-world phenomena can be modeled\* by the same type of function
- translating different forms of representing them (e.g., tables, graphs, functional notation\*, formulas)
- describing the relationships among variable quantities in a problem
- using appropriate technology to interpret properties of their graphical representations (e.g., intercepts, slopes, rates of change, changes in rates of change, maximum\*, minimum\*)

W.S.S.: F.12.4 Model and solve a variety of mathematical and real-world problems by using algebraic expressions, equations, and inequalities

### Unit 5

#### Chapter 8: Sequences and Series

W.S.S.: A.12.1 Use reason and logic to

- evaluate information
- perceive patterns
- identify relationships
- formulate questions, pose problems, and make and test conjectures
- pursue ideas that lead to further understanding and deeper insight

W.S.S.: A.12.3 Analyze non-routine\* problems and arrive at solutions by various means, including models\* and simulations, often starting with provisional conjectures and progressing, directly or indirectly, to a solution, justification, or counter-example

F.12.1 Analyze and generalize patterns of change (e.g., direct and inverse variation) and numerical sequences, and then represent them with algebraic expressions and equations

### Unit 6

#### Chapter 9: Parametrics

W.S.S.: A.12.3 Analyze non-routine\* problems and arrive at solutions by various means, including models\* and simulations, often starting with provisional conjectures and progressing, directly or indirectly, to a solution, justification, or counter-example

W.S.S.: A.12.4 Develop effective oral and written presentations employing correct mathematical terminology, notation, symbols, and conventions for mathematical arguments and display of data

W.S.S.: B.12.3 Perform and explain operations on real numbers (add, subtract, multiply, divide, raise to a power, extract a root, take opposites and reciprocals, determine absolute value)

W.S.S.: B.12.6 Routinely assess the acceptable limits of error when

W.S.S.: C.12.1 Identify, describe, and analyze properties of figures, relationships among figures, and relationships among their parts by

- constructing physical models
- drawing precisely with paper-and-pencil, hand calculators, and computer software
- using appropriate transformations\* (e.g., translations, rotations, reflections, enlargements)
- using reason and logic

W.S.S.: C.12.4 Use the two-dimensional rectangular coordinate system\* and algebraic procedures to describe and characterize geometric properties and relationships such as slope\*, intercepts\*, parallelism, and perpendicularity

W.S.S.: E.12.1 Work with data in the context of real-world situations by

- formulating hypotheses that lead to collection and analysis of one- and two-variable data
- designing a data collection plan that considers random sampling, control groups, the role of assumptions, etc.
- conducting an investigation based on that plan
- using technology to generate displays, summary statistics\*, and presentations

W.S.S.: F.12.4 Model and solve a variety of mathematical and real-world problems by using algebraic expressions, equations, and inequalities

## Unit 7

### Chapter 6: Vectors

W.S.S.: A.12.4 Develop effective oral and written presentations employing correct mathematical terminology, notation, symbols, and conventions for mathematical arguments and display of data

W.S.S.: B.12.3 Perform and explain operations on real numbers (add, subtract, multiply, divide, raise to a power, extract a root, take opposites and reciprocals, determine absolute value)

W.S.S.: C.12.1 Identify, describe, and analyze properties of figures, relationships among figures, and relationships among their parts by

- constructing physical models
- drawing precisely with paper-and-pencil, hand calculators, and computer software
- using appropriate transformations\* (e.g., translations, rotations, reflections, enlargements)
- using reason and logic

W.S.S.: C.12.3 Present convincing arguments by means of demonstration, informal proof, counter-examples, or any other logical means to show the truth of

- statements (e.g., these two triangles are not congruent)
- generalizations (e.g., the Pythagorean\* theorem holds for all right triangles)

W.S.S.: C.12.4 Use the two-dimensional rectangular coordinate system\* and algebraic procedures to describe and characterize geometric properties and relationships such as slope\*, intercepts\*, parallelism, and perpendicularity

W.S.S.: D.12.3 Determine measurements indirectly\*, using

- estimation
- proportional reasoning, including those involving squaring and cubing (e.g., reasoning that areas of circles are proportional to the squares of their radii)
- techniques of algebra, geometry, and right triangle trigonometry
- formulas in applications (e.g., for compound interest, distance formula)
- geometric formulas to derive lengths, areas, or volumes of shapes and objects (e.g., cones, parallelograms, cylinders, pyramids)
- geometric relationships and properties of circles and polygons (e.g., size of central angles, area of a sector of a circle)
- conversion constants to relate measures in one system to another (e.g., meters to feet, dollars to Deutschmarks)

W.S.S.: F.12.4 Model and solve a variety of mathematical and real-world problems by using algebraic expressions, equations, and inequalities

## Unit 8

### Chapter 11: Limits and an Introduction to Calculus

W.S.S.: A.12.4 Develop effective oral and written presentations employing correct mathematical terminology, notation, symbols, and conventions for mathematical arguments and display of data

W.S.S.: A.12.5 Organize work and present mathematical procedures and results clearly, systematically, succinctly, and correctly

D.12.1 Identify, describe, and use derived attributes\* (e.g., density, speed, acceleration, pressure) to represent and solve problem situations

W.S.S.: F.12.1 Analyze and generalize patterns of change (e.g., direct and inverse variation) and numerical sequences, and then represent them with algebraic expressions and equations

W.S.S.: F.12.4 Model and solve a variety of mathematical and real-world problems by using algebraic expressions, equations, and inequalities