Your competence will be assessed as you complete the GFC2 objective assessment. This course of study may take up to 8 weeks to complete.

Introduction

This course of study is aligned to the GFC2 objective assessment. The same study materials are utilized in the GFT2 performance assessment. If you have previously completed the GFT2 assessment, then you should have already completed the required study activities found in this course of study. You may wish to review the assignments here, but you are not required to repeat these activities. If you have not yet completed the GFT2 assessment, then please proceed through this course of study in full.

Overview
Calculus is the mathematics of change. It allows mathematicians and scientists to analyze events that are more dynamic than those that can be solved by algebra alone. In fact, calculus originated from the study of several important problems for which algebra was insufficient. One such problem is that of finding the slope of a curve; another, finding instantaneous velocity. A third problem is that of finding the area under a curve. You will study these problems and more as you progress through this course of study. Calculus is not a theoretical branch of mathematics; calculus is used by scientists, engineers, and economists and has enormous applications to our daily lives.

If you are in the middle school program, the skills that will be acquired will help you to better understand function behavior within a variety of real-world applications. If you are in the secondary program, the skills that will be acquired will prepare you for Calculus II, Calculus III, and other advanced topics in mathematics. Thus, it is essential that you master these concepts prior to moving forward. Perhaps someday you will teach precalculus or AP Calculus (AB or BC), and when you do, you will teach these very concepts! Regardless of whether you are in a middle school or a secondary school program, the skills that you will acquire are foundational.

Outcomes and Evaluation
There are 5 competencies covered by this course of study; they are listed in the "Competencies for Mathematics Content: Calculus I (GFC2)" page.

Teaching Dispositions Statement
Please review the Statement of Teaching Dispositions.

You will complete the following assessments as you work through the course of study.

Pre-Assessment
You will complete the following pre-assessment:

- PGFC
Objective Assessment
You will complete the following objective assessment:

- GFC2

For specific information about this assessment, click the link under the "Assessment Type" column of your Degree Plan.

Preparing for Success

The information in this section is provided to help you become ready to complete this course of study. As you proceed, you will need to be organized in your studies in order to gain competency in the indicated areas and prepare yourself to pass the final assessments.

Your Learning Resources

Enroll in or order the learning resources for this course as early as possible so as to give them time to arrive and give you enough time to become familiar with them.

Note: The resources you are using to master the competencies for this assessment will also be valuable as you prepare for the Praxis II exam and any state-mandated mathematics content exams. Therefore, it is recommended that you complete each activity contained in this document.

Automatically Enrolled Learning Resources

You will be automatically enrolled at the activity level for the following learning resources. Simply click on the links provided in the activities to access the learning materials.

Thinkwell

You will access the materials in the following Thinkwell course at the activity level within this course of study. This web-based resource includes multimedia video lectures, review notes, interactive animations, and sample exercises:

- Thinkwell Calculus, ONLINE, CRN 03U

Enroll in the Learning Resources

You will need to enroll in or subscribe to an additional learning resource as a part of this course of study.

You may already have enrolled in this resource for other courses. Please check the "Learning Resources" tab and verify that you have access to the following learning resources. If you do not currently have access, please enroll or renew your enrollment at this time.

Note: For instructions on how to enroll in or subscribe to learning resources through the "Learning Resources" tab, please see the "Acquiring Your Learning Resources" page.

MyMathLab

Enroll in MyMathLab to obtain the following e-textbook:
Additional Preparation
There are many different learning tools available to you within your course of study in addition to the learning resources already discussed. Take the time to familiarize yourself with them and determine how best to fit them into your learning process.

**Message Boards, FAQs, Note-Taking Tool**

Message boards, FAQs, and a note-taking tool are available in every course of study.

Use the "Additional Learning Tools" page to review these tools.

**The WGU Central Library**

The [WGU Central Library](#) is available online to WGU students 24 hours a day. The library offers access to a number of resources, including over 60,000 full-text e-books; articles from journals, magazines, and newspapers; course e-reserves; and tutorials on how to use these resources and the library. The library also includes a reference service for help with research questions or navigating the library.

**Course Mentor Assistance**

Course mentors are available to help you. Their job is to aid understanding in areas where you need to improve and to guide you to learning resources. Request their help as needed when preparing for assessments.

Course mentors cannot provide reviews of entire assessments. If you fail assessment attempts, review the provided feedback first, then ask the course mentor specific questions about what you can do to meet the competency standard. Request course mentor assistance as necessary in preparing for second attempts at objective assessments or performance task revisions.

Mentors cannot guarantee you pass as they do not evaluate assessments; however, they can provide the assistance and advice necessary to help you succeed.

**Other Preparations**

**Purchase an Appropriate Calculator**
Acquire a graphing calculator and familiarize yourself with how to use it. Refer to [WGU Calculator Guidelines](#) for details regarding calculators that are acceptable on WGU exams and to [WGU Calculator Recommendations](#) for calculator suggestions for your program.

**Limits and Continuity**

Informally, a limit is the value that a function approaches as the input approaches a specific value. This concept is essential in the study of calculus. It distinguishes calculus from algebra and allows us to solve problems that cannot be solved with algebra alone. Limits help us describe the behavior of a function and define other important concepts, such as continuity. A function is continuous if there are no interruptions in the graph of the function. In other words, the graph of the function can be sketched without lifting your pencil off the paper. In this subject,
we will explore these concepts and learn how use them to solve problems.

**Limits**

The limit of a function allows us to explore the behavior of a function as the input of the function value approaches a specific value. This "informal" definition is the central theme of this topic. You will explore an intuitive understanding of limits, explore various methods for estimating limits, and develop skills for using algebra techniques to calculate the value of limits.

**Rates of Change and Limits**

Read the following section in *Thomas’ Calculus* within MyMathLab:

- section 2.1 ("Rates of Change and Limits")

Complete exercises:

- 1-9, odd
- 21-29, odd

*Note: The answers to odd-numbered questions can be found in the "Answers" section in the back of the text. Do not look at the answer before attempting to solve the problems. Solve the problem first and then check your answer. Struggling with a problem will help you deepen your understanding, build your problem solving skills, and commit the skills to memory.*

**Calculating Limits Using the Limit Laws**

Read the following section in *Thomas’ Calculus* within MyMathLab:

- section 2.2 ("Calculating Limits Using the Limit Laws")

Complete exercises:

- 1-41, odd
- 49-51, all

**The Formal Definition of a Limit**

Review the video on "Limits" within the following Thinkwell Calculus sections:

- section 2.1.3 ("The Formal Definition of a Limit")

**The Precise Definition of a Limit**

Read the following section in *Thomas’ Calculus* within MyMathLab:

- pages 85-88 of section 2.3 ("The Precise Definition of a Limit")

Complete exercises:

- 1-13, odd
Note: You will not be asked to complete a formal delta-epsilon proof in this course of study. You will, however, be asked to explain the formal definition of a limit.

One-Sided Limits and Limits at Infinity

Read the following section in Thomas’ Calculus within MyMathLab:

- section 2.4 ("One-Sided Limits and Limits at Infinity")

Complete exercises:

- 1-59, odd

Infinite Limits and Vertical Asymptotes

Read the following section in Thomas’ Calculus within MyMathLab:

- section 2.5 ("Infinite Limits and Vertical Asymptotes")

Calculus I Skills Checks: Limits

Complete the following skills check in MyMathLab:

- Calculus I Skills Checks: Limits

Answer the questions under exam-like conditions. Reviewing resources while you are completing the questions is not a good study method. Instead, skip the problems that you cannot answer. If you feel like you are skipping too many of the problems then you are not ready to attempt the skills check and should go back and review the previous topics.

After completing the skills check, click on "Review Skills Checks" to access the right answers. Follow the links to the relevant videos, animations, worked examples, additional practice problems, and pages in the textbook to review the information related to these problems.

Alternate between taking the skills check and reviewing the items answered incorrectly. Each time you retake the skills check, it has slightly different problems.

Continuity

In mathematics, continuity has much that same meaning as in other contexts. We say that a function is continuous if its graph can be sketched in one motion without lifting your pencil from the paper. In other words, a function is continuous if there are no interruptions in its graph. In this topic, you will explore the concept of continuity by reviewing informal definitions, learning how continuity can be defined in terms of limits, and using continuity to analyze the behavior of functions.

Introduction to Continuity

Review the video on "Limits" within the following Thinkwell Calculus sections:

- section 2.1.8 ("Continuity and Discontinuity")
Continuity

Read the following section in *Thomas' Calculus* within MyMathLab:

- section 2.6 ("Continuity")

Complete exercises:

- 1-39, odd
- 45-51, odd

Calculus I Skills Checks: Continuity

Complete the following skills check in CourseCompass:

- Calculus I Skills Checks: Continuity

When completing a skills check, you should answer the questions under exam like conditions, click on "Review Skills Checks" in order to review resources associated with missed problems, and repeat this process until you are scoring near 100%.

Differentiation

Finding the slope of a line is an important skill in algebra. But what does it mean to find the slope of a curve? For a curve, the "slope" is constantly changing. Finding the "slope" of a curve at a given point, or more accurately, the slope of the tangent line at a given point is one way to describe differentiation. Isaac Newton is credited for providing the first general solution to this problem.

Introduction to Differentiation

The concept of a derivative is one of the most important applications of limits, and can be explored from several different perspectives. In this topic, you will explore the concept of a derivative as the slope of the tangent line to a curve and as the instantaneous rate of change. You will also formally define the derivative using the concept of a limit.

Instantaneous Rate of Change

Review the video on "An Introduction to Derivatives" within the following Thinkwell Calculus section:

- section 3.1.3 ("The Derivative")

Tangents and Derivatives

Read the following section in *Thomas’ Calculus* within MyMathLab:

- section 2.7 ("Tangents and Derivatives")

Complete the following exercises:
The Derivative as a Function

Read the following section in *Thomas’ Calculus* within MyMathLab:

- section 3.1 (“The Derivative as a Function”)

Complete the following exercises:

- 1-21, odd
- 27-31, odd

Computing Derivatives I

In the previous topic you explored the concept of a derivative. In this topic you will learn differentiation rules that allow you to find the derivative of functions quickly and easily, without having to apply the definition of a derivative. These are foundational skills and need to be committed to memory.

Polynomials, Exponentials, Products, and Quotients

Read the following section in *Thomas’ Calculus* within MyMathLab:

- section 3.2 (“Differentiation Rules for Polynomials, Exponentials, Products, and Quotients”)

Complete the following exercises:

- 1-43, odd

Note: You don’t need to know how to prove the theorems described in this section. However, you do need to be able to use these “differentiation rules” effortlessly to find the derivatives of functions.

Position, Velocity, and Acceleration

Review all the videos on "Applications of Differentiation" within the following Thinkwell Calculus section:

- section 7.1 (“Position and Velocity”)

The Derivative as a Rate of Change

Read the following section in *Thomas’ Calculus* within MyMathLab:

- section 3.3 (“The Derivative as a Rate of Change”)

Complete the following exercises:

- 1-25, odd
Computing Derivatives II

In the previous topic you learned how to find the derivative of simple algebraic functions. In this topic you will learn additional rules for finding the derivative of trigonometric functions and a powerful technique, called the chain rule, for finding the derivative of composite functions.

Derivatives of Trigonometric Functions

Read the following section in *Thomas’ Calculus* within MyMathLab:

- section 3.4 ("Derivatives of Trigonometric Functions")

Complete the following exercises:

- 1-45, odd

*Note: You don’t need to know how these rules are derived. Focus on memorizing the rules and reviewing the examples. Quick recollection of these rules is essential when using them to solve more complex problems.*

Computational Techniques: The Chain Rule

Review all the videos on "Computational Techniques" within the following Thinkwell Calculus sections:

- section 4.3 ("The Chain Rule")

The Chain Rule

Read the following section in *Thomas’ Calculus* within MyMathLab:

- pages 188-194 of section 3.5 ("The Derivative as a Rate of Change")

Complete the following exercises:

- 23-65, odd

Computing Derivatives III

In this topic you continue your study of techniques for finding derivatives. You will learn how to find the derivative of equations that are defined implicitly (i.e. not of the form, y=f(x)) and how to find the derivative of the natural log function. You will conclude this topic by exploring two common applications of derivatives.

Implicit Differentiation Introduction

Review all the videos on "Implicit Differentiation" within the following Thinkwell Calculus sections:

- section 6.1 ("Implicit Differentiation Basics")
- section 6.2 ("Applying Implicit Differentiation")

Implicit Differentiation
Read the following section in *Thomas' Calculus* within MyMathLab:

- section 3.6 ("Implicit Differentiation")

Complete the following exercises:

- 1-49, odd

**Computational Techniques: The Natural Log Function**

Review the videos on "Special Functions" within the following Thinkwell Calculus sections:

- section 5.3.2 ("The Derivative of the Natural Log Function")

**Derivatives of Logarithms**

Read the following section in *Thomas' Calculus* within MyMathLab:

- pages 214-220 of section 3.7 ("Derivatives of Inverse Functions and Logarithms")

Complete the following exercises:

- 11-39, odd
- 55-87, odd

**Related Rates Videos**

Review all the videos on "Applications of Differentiation" within the following Thinkwell Calculus section:

- section 7.4 ("Related Rates")

**Related Rates**

Read the following section in *Thomas' Calculus* within MyMathLab:

- section 3.9 ("Related Rates")

Complete the following exercises:

- 1-29, odd

**Linearization**

Read the following section in *Thomas' Calculus* within MyMathLab:

- pages 240-244 of section 3.10 ("Linearization and Differentials")

Complete the following exercises:

- 1-13, odd
Differentiation Review
In the previous topics you learned rules for finding derivatives for a variety of different functions and equations. In this topic you will learn how to look at a function and decide which rule to apply. You will also learn how to integrate these rules together to find the derivative of more complex functions that require you to use multiple rules.

Calculus I Skills Checks: Differentiation

Complete the following skills check in MyMathLab:

- Calculus I Skills Checks: Differentiation

When completing a skills check, you should answer the questions under exam like conditions, click on "Review Skills Checks" in order to review resources associated with missed problems, and repeat this process until you are scoring near 100%.

Applications of Derivatives

In the previous subject you learned important techniques for finding the derivative of a function. In this subject you will apply these techniques in order to explore important applications of derivatives. You will learn how to use derivatives to determine important features of a graph, calculate limits that cannot be determined algebraically, and solve problems that require you to maximize or minimize a function.

Extreme Values
In this topic you begin your study of important applications of derivatives. You will learn how to use differentiation to determine the minimum and maximum values (a.k.a. extrema) of a function.

Curve Sketching: Introduction

Review the videos on "Curve Sketching" within the following Thinkwell Calculus sections:

- section 8.2.1 ("Critical Points")
- section 8.2.2 ("Maximum and Minimum")

Extreme Values of Functions

Read the following section in Thomas’ Calculus within MyMathLab:

- section 4.1 ("Extreme Values of Functions")

Complete the following exercises:

- 1-61, odd

Mean Value Theorem
In this topic you will explore one of the most important concepts in calculus, the Mean Value Theorem. Intuitively, the Mean Value Theorem states that there is a point at which the instantaneous rate of change is equal to the average rate of change. As a practical example, it
states that if a car travels 60 miles in two hours, there must be at least one moment in time when the car was traveling exactly 30 miles per hour.

**Curve Sketching: Three Big Theorems**

Review the videos on "Curve Sketching" within the following Thinkwell Calculus sections:

- section 8.1.3 ("Three Big Theorems")

**The Mean Value Theorem**

Read the following section in *Thomas' Calculus* within MyMathLab:

- section 4.2 ("The Mean Value Theorem")

Complete the following exercises:

- 1-21, odd
- 45-49, odd

*Note: You don't need to know how to prove the theorem, but you do need to understand how to apply it. This includes understanding the criteria for when the theorem holds (e.g. continuous function on a closed interval) and what the theorem means.*

**Analysis of Function Behavior**

In this topic you will explore how the first and second derivatives of a function help you analyze the behavior of the function. You will integrate these new skills with previous knowledge of functions in order to identify the key features of a function and sketch its graph.

**Curve Sketching: Critical Points**

Review the videos on "Curve Sketching" within the following Thinkwell Calculus sections:

- section 8.2.3 ("Regions Where a Function Increases or Decreases")
- section 8.2.4 ("The First Derivative Test")

**Monotonic Functions and the First Derivative Test**

Read the following section in *Thomas' Calculus* within MyMathLab:

- section 4.3 ("Monotonic Functions and the First Derivative Test")

Complete the following exercises:

- 1-39, odd

**Curve Sketching: Concavity**

Review the videos on "Curve Sketching" within the following Thinkwell Calculus sections:

- section 8.3.1 ("Concavity and Inflection Points")
Concavity and Curve Sketching

Read the following section in *Thomas' Calculus* within MyMathLab:

- section 4.4 ("Concavity and Curve Sketching")

Complete the following exercises:

- 1-61, odd
- 67-73, odd

Optimization

In a previous topic you learned how to use the derivative of a function to determine its maximum and minimum values. In this topic you will integrate this technique with problem solving skills for the purpose of finding the optimum value (i.e. maximum or minimum) for real-world applications. You will solve problems similar to finding the least expensive dimensions of a cylinder can that will give you a certain volume.

*Application of Differentiation: Optimization*

Review all the videos on "Applications of Differentiation" within the following Thinkwell Calculus section:

- section 7.3 ("Optimization")

*Applied Optimization Problems*

Read the following section in *Thomas' Calculus* within MyMathLab:

- section 4.5 ("Applied Optimization Problems")

Complete the following exercises:

- 1-53, every other odd

L'Hôpital's Rule

In a previous topic you learned algebraic techniques for finding the limit of a function. However, not all limits can be evaluated using algebra alone. In this topic you will learn how and when it is appropriate to use L'Hôpital's Rule, which is an application of differentiation, to solve limit problems that cannot be solved using algebraic techniques.

*L'Hôpital's Rule*

Review all the videos on "L'Hôpital's Rule" within the following Thinkwell Calculus sections:

- section 14.1 ("Indeterminate Quotients")
- section 14.2, all ("Other Indeterminate Forms")

*Indeterminate Forms and L'Hôpital's Rule*
Read the following section in *Thomas’ Calculus* within MyMathLab:

- section 4.6 ("Indeterminate Forms and L'Hôpital's Rule")

Complete the following exercises:

- 1-63, odd

**Numerical Approximations**

One of the fundamental topics in algebra is finding the solutions, or zeros, of a function. Most of the problems presented in an algebra class are designed to be solved using factoring methods. However, not all functions can be easily factored. In this topic you will study a technique for approximating the zero of a function. The technique was first described in a text written by Issac Newton, and is appropriately named Newton's Method.

**Linear Approximation: Newton's Method**

Review the videos on "Applications of Differentiation" within the following Thinkwell Calculus section:

- section 7.2.3 ("Newton's Method")

**Newton's Method**

Read the following section in *Thomas’ Calculus* within MyMathLab:

- section 4.7 ("Newton's Method")

Complete the following exercises:

- 1-7, all

**Applications of Derivatives Review**

In the previous topics you learned how to apply differentiation to solve real-world problems. In this topic you will review those skills in an integrated format.

**Calculus I Skills Checks: Applied Differentiation**

Please complete the following skills check in MyMathLab:

- Calculus I Skills Checks: Applied Differentiation

When completing a skills check you should answer the questions under exam like conditions, click on "Review Skills Checks" in order to review resources associated with missed problems, and repeat this process until you are scoring near 100%.

**Final Steps**

Congratulations on completing the activities in this course of study! This section will guide you through the assessment process.
Assessment Information
Having completed this course of study, you are now ready to complete the GFC2 objective assessment. You are allowed to use a calculator on the objective assessment.

Accessing Pre-Assessments

Complete the following pre-assessment:

- PGFC

For directions on how to receive access to pre-assessments, see the "Accessing Pre-Assessments" page.

Accessing Objective Assessments

Complete the following objective assessment:

- GFC2

For directions on how to receive access to objective assessments, see the "Accessing Objective Assessments" page.

Feedback

WGU values your input! If you have comments, concerns, or suggestions for improvement of this course, please submit your feedback using the following form:

- [Course Feedback]

ADA Policy

Western Governors University recognizes and fulfills its obligations under the Americans with Disabilities Act of 1990 (ADA), the Rehabilitation Act of 1973 and similar state laws. Western Governors University is committed to provide reasonable accommodation(s) to qualified disabled learners in University programs and activities as is required by applicable law(s). ADA Support Services serves as the principal point of contact for students seeking accommodations and can be contacted at ADASupport@wgu.edu. Further information on WGU?s ADA policy and process can be viewed in the student handbook at the following link:

- [Policies and Procedures for Students with Disabilities]