Your competence will be assessed as you complete the GCC2 objective assessment. This course of study may take up to 5 weeks to complete.

**Introduction**

This course of study is aligned to the GCC2 objective assessment. The same study materials are utilized in the GCT2 objective assessment. If you have previously completed the GCT2 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 GCT2 assessment, then please proceed through this course of study in full.

**Overview**

Welcome to studies in complex numbers and trigonometry! In this course of study, you will learn about the complex number system, trigonometric functions, and trigonometric equations.

**Outcomes and Evaluations**

There are 3 competencies covered by this course of study; they are listed in the "Competencies for Precalculus (GCC2)" page.

**Teaching Dispositions Statement**

Please review the WGU Statement of Teaching Dispositions.

**Pre-Assessment**

You will complete the following pre-assessment:

- PGCC

**Objective Assessment**

You will complete the following objective assessment:

- GCC2

For specific information about this assessment, select this course under the "Course Details" section 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.

**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's Precalculus

**Enroll in Learning Resources**

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

You may already have enrolled in these resources 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 (Algebra & Trigonometry)**
The following textbook is available as an e-text through MyMathLab:


**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, learning communities, study notes, and FAQs 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. Please log in to your student account to use this resource.

**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

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.

An Introduction to Complex Numbers

Complex numbers are of the form $a + bi$, where $i$ is defined as the square root of -1. Complex numbers build upon your knowledge and study of real numbers. This extension of the real number system also extends the types and varieties of solvable problems.

Complex numbers were developed to solve problems of the type $x^2 + 2 = 0$.

Complex Numbers I

Perform the four basic arithmetic operations on complex numbers in rectangular coordinate form. Previous study of real number arithmetic operations included laws of commutativity, associativity, and distribution. Prior to completing similar operations on complex numbers, reflect on arithmetic operations on real numbers. This will prepare you to successfully compute in the complex numbers system.

Optional Review of Real Numbers

Read the following section in Algebra and Trigonometry in MyMathLab:

- section P1("Algebraic Expressions, Mathematical Models, and Real Numbers"), pages 6-9 and 11-12

Complex Numbers

Reflect upon what you currently know about complex numbers and record this in your math journal. Read the following section in Algebra and Trigonometry in MyMathLab:

- section 1.4 ("Complex Numbers")

Consider the following questions:

- What have you learned about complex numbers? Use precise language to record in your math journal your understanding of complex numbers as detailed in this section.
• When is a number real, complex, or pure imaginary?
• How is the imaginary unit $i$ defined?

Complete the following exercises in section 1.4 ("Complex Numbers") of *Algebra and Trigonometry* in MyMathLab:

• exercises 1-53, odd numbers only
"John and Betty's Journey Into Complex Numbers"

Read the following:

• "John and Betty's Journey Into Complex Numbers" (pp.12-24)

Complex numbers in rectangular form are brought to life by this adventure into the world of complex numbers.

**Closure Property**

A set is closed under an operation when any two elements of the set can be combined using that operation and still remain in the set. See the following website for additional examples:

• **Closure Property**

**Table of Closures**

Complete the following table of closures and make sure you can justify your reasoning for each entry. Make sure to read the footnotes, which help show how to justify reasoning properly and give some hints and definitions. See the following website for answers:

• "Numbers"

Note: This site follows an unstated convention that "closure under division" means "closure under division except for division by zero." WGU does NOT follow that convention (see footnote 2) so on pre-assessments and exams, expect different answers for closure under division than you will see on this site.

<table>
<thead>
<tr>
<th>Number System</th>
<th>Closure</th>
<th>+</th>
<th>?</th>
<th>x</th>
<th>÷</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural</td>
<td></td>
<td>Yes (1)</td>
<td>No (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whole</td>
<td></td>
<td>No (2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integer</td>
<td></td>
<td>Yes (3)</td>
<td>No (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rational</td>
<td></td>
<td></td>
<td>No (4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrational</td>
<td></td>
<td></td>
<td></td>
<td>No (5)</td>
<td></td>
</tr>
<tr>
<td>Real</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Imaginary (6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Complex | Algebraic | Transcendental
--- | --- | ---

1. No, because 7-3 is still a natural number, but 3-7 is a negative number, not part of the naturals.
2. No, because division by zero is always undefined.
3. Yes, because subtraction might change the sign, but it will still be an integer.
4. No, because, for example, -1 and 2 are integers, but (-1)/(2) is one-half, NOT an integer.
5. No (in a sneaky way), because √2 is irrational, but √2 × √2 = 2, and 2 is NOT irrational.
6. Please note that the imaginary numbers should be taken to be the "purely" imaginary numbers along with zero; in other words, they are all numbers of the form bi, where b can be any real number, including zero.

Please complete the following additional practice problems:

- "Additional Practice with the Closure Property"

**Trigonometric Functions**

Trigonometric functions require an understanding of radian and degree measure, right triangle geometry, and the unit circle. These topics are the foundation for a clear idea of how the trigonometric functions appear graphically, as well as the important characteristics of trigonometric functions. Graphical examples of the trigonometric functions will be presented.

Trigonometric functions can be used to describe naturally occurring phenomena as well as to model real life situations, such as tide patterns.

**Trigonometric Functions, Part 1**

Trigonometric graphs and trigonometric data include sine, cosine, tangent, cotangent, secant, and cosecant. Consider the following questions:

- What do you remember about each of these functions?
- What do you hope to learn about each of these trigonometric functions?

Reflect on graphical similarities and differences, such as period, amplitude, range, and domain, of each trigonometric function.

**Angles and Radian Measure**

Read about radian and degree measure in the following section of Algebra and Trigonometry in MyMathLab:

- page 482 of section 5.1 ("Angles and Radian Measure")

Complete the following exercises in section 5.1 to practice converting from degree measure to radian measure, and from radian measure to degree measure (such as from 235 degrees to radians and from 2.5 radians to degrees). Express the level of detail in minutes and seconds.
- exercises 13-28 and 41-56

**Right Triangle Trigonometry**

Read about right triangle trigonometry in the following section of *Algebra and Trigonometry* in MyMathLab:

- page 497 of section 5.2 ("Right Triangle Trigonometry")

Know the trigonometric function values of special angles (such as 0°, 90°, 60°, etc.), and use these values to calculate the trigonometric functions of angles greater than 360°. Consider creating a visual cue to remember these special angles. Record this memory tool in your journal.

Complete the following exercises in section 5.2 ("Right Triangle Trigonometry"):

- exercises 1-29, odd numbers only; and 39-53 odd, numbers only

**Trigonometric Functions of Any Angle**

Read about the unit circle in the following section of *Algebra and Trigonometry* in MyMathLab:

- section 5.3 ("Trigonometric Functions of Any Angle")

Pay close attention to the unit circle pictured on page 524.

Complete the following exercises in section 5.3 ("Trigonometric Functions of Any Angle"):

- exercises 1-75, odd numbers only

**Trigonometric Functions of Real Numbers, Periodic Functions**

The unit circle is further described in *Algebra and Trigonometry* section 5.4 ("Trigonometric Functions of Real Numbers: Periodic Functions") in MyMathLab. Pay close attention to the periodic properties of trigonometric functions.

Complete the following exercises in section 5.4 ("Trigonometric Functions of Real Numbers: Periodic Functions"):

- exercises 1-31, odd numbers only

**Trigonometric Functions, Part 2**

The journey into trigonometric functions will continue as you become familiar with the graphs of trigonometric functions.

**Graphs of Trigonometric Functions**

Read the following sections of *Algebra and Trigonometry* in MyMathLab:

- section 5.5 ("Graphs of Sine and Cosine Functions")
- section 5.6 ("Graphs of Other Trigonometric Functions")

Record in your math journal the definitions of the six basic trigonometric and circular functions. Consider similarities and differences between these six functions and record your observations.

Complete the following exercises in section 5.5 ("Graphs of Sine and Cosine Functions"):

- exercises 1-59, odd numbers only

Complete the following exercises in section 5.6 ("Graphs of Other Trigonometric Functions"):

- exercises 1-43, odd numbers only; and 75-84, all

*Note: The formulas used in this text to model periodic behavior can differ slightly from what is used in other texts, and in particular, in Precalculus Task 5. The formulas, while different from each other, both model periodic behavior and neither is correct or incorrect. Be mindful of how each portion of the formula is used and apply the information from specific situations appropriately.*

**Trigonometric Functions, Part 3**
You will further explore trigonometric functions by learning their inverses, and certain applications, as well as learning to verify trigonometric identities.

**Inverse Trigonometric Functions**

Read the following section of *Algebra and Trigonometry* in MyMathLab:

- section 5.7 ("Inverse Trigonometric Functions")

Practice finding the inverse of the given trigonometric functions in each of the examples in the text. Record your solutions in your math journal. Be sure to note any particular pitfalls or key points to remember as you are finding inverses, such as range or domain considerations.

Complete the following exercises in section 5.7 ("Inverse Trigonometric Functions"):

- exercises 1-73, odd numbers only, and 74

**Applications of Trigonometric Functions**

Read the following section of *Algebra and Trigonometry* in MyMathLab:

- section 5.8 ("Applications of Trigonometric Functions") part 1 (through p. 589)

Be alert to the world around you to find naturally occurring trigonometric data. Consider how well trigonometric data model real life data.

Complete the following exercises in section 5.8 ("Inverse Trigonometric Functions"): 
Verifying Trigonometric Identities

Read the following section of *Algebra and Trigonometry* in MyMathLab:

- section 6.1 ("Verifying Trigonometric Identities")

Write down in your journal and familiarize yourself with the use of the fundamental trigonometric identities on page 606. Memorize or be able to derive the Pythagorean identities.

Complete the following exercises in section 6.1 ("Verifying Trigonometric Identities"):

- exercises 1-31, odd numbers only

Sum and Difference Formulas

Read the following section of *Algebra and Trigonometry* in MyMathLab:

- section 6.2 ("Sum and Difference Formulas")

Write down in your journal and memorize the sum and difference formulas, which are found throughout the reading.

Complete the following exercises in section 6.2 ("Sum and Difference Formulas"):

- exercises 1-39, odd numbers only

Double Angle Formulas

Read the following section of *Algebra and Trigonometry* in MyMathLab:

- section 6.3 ("Double-Angle, Power-Reducing, and Half-Angle Formulas") part 1 (through p. 630)

Write down in your journal and memorize the double angle formulas found on page 627.

Complete the following exercises in section 6.3 ("Double-Angle, Power-Reducing, and Half-Angle Formulas"):

- exercises 1-31, odd numbers only

Write down in your journal the following formulas, found in the *Algebra and Trigonometry* text in MyMathLab:

- power-reducing formulas (p. 630)
- half-angle formulas (p. 631)
- product-to-sum formulas (p. 639)
• sum-to-product formulas (p. 640).

These may be used in the next section on solving trigonometric equations, but you will not need to memorize them.

**More Examples of Proving Identities**

For additional examples of proving trigonometric identities, watch the videos in the following section of Thinkwell’s Precalculus:

- section 7.3 (“Proving Trigonometric Identities”)

**Trigonometric Functions, Part 4**

Trigonometric functions also appear in equations that model real-world situations. In this topic, you will learn to solve trigonometric equations as well as use the Law of Sines and the Law of Cosines.

**Trigonometric Equations**

Read the following section of *Algebra and Trigonometry* in MyMathLab:

- section 6.5 (“Trigonometric Equations”)

Take time to solve several given trigonometric equations and record the solutions in your journal. Note any difficult steps in the solution process. Trigonometric manipulations can be daunting. Practice considering concepts of domain and range, and keep your journal open to the page of trigonometric identities. These are often fundamental in solving trigonometric functions.

Complete the following exercises in section 6.5 (“Trigonometric Equations”):

- exercises 1-83, odd numbers only

**Law of Sines**

Read the following section of *Algebra and Trigonometry* in MyMathLab:

- section 7.1 (“The Law of Sines”)

Write down in your journal the Law of Sines (p. 664) and memorize it.

Complete the following exercises in section 7.1 (“The Law of Sines”):

- exercises 1-55, odd numbers only

**Law of Cosines**

Read the following section of *Algebra and Trigonometry* in MyMathLab:

- section 7.2 (“The Law of Cosines”)
Write down in your journal the law of cosines (p. 677) and memorize it.

Complete the following exercises in section 7.2 ("The Law of Cosines"):

- exercises 1-23, odd numbers only
- exercises 33-49, odd numbers only

**Continued Introduction to Complex Numbers**

Complex numbers can be written in rectangular or polar form. Recall your study of the rectangular coordinate form of complex numbers. Why might another form for writing complex numbers exist? As you study polar coordinate form of complex numbers, pay particular attention to computing the polar equivalent of a complex number in rectangular coordinate form.

Complex number computation is facilitated by converting \( a + bi \) to its polar equivalent.

**Complex Numbers II**

Perform the four basic arithmetic operations on complex numbers in polar coordinate form. Previous study of real number arithmetic operations included laws of commutativity, associativity, and distribution. Reflect on arithmetic operations on real numbers and complex numbers in rectangular coordinate form to help prepare you to successfully compute in the complex numbers system with rectangular and polar forms.

**Polar Coordinates**

Read the following section of *Algebra and Trigonometry* in MyMathLab:

- section 7.3 ("Polar Coordinates")

In this section, you will learn how to plot real numbers in polar form. Describe in your journal the concepts of angle and radius in your own words.

Complete the following exercises in section 7.3 ("Polar Coordinates"):

- exercises 1-47, odd numbers only

**Complex Numbers in Polar Form; DeMoivre's Theorem**

Read the following section of *Algebra and Trigonometry* in MyMathLab:

- section 7.5 ("Complex Numbers in Polar Form; DeMoivre's Theorem") (through p. 712)

Record what you remember of polar coordinates. Then, work through the examples in the text to better understand complex numbers in polar form.

Access the following in Thinkwell's Precalculus:

- section 8.5 ("Complex Numbers in Trigonometric Form")
- lecture video for section 8.5.1 ("Graphing a Complex Number and Finding its Absolute
- video for section 8.5.2 ("Expressing a Complex Number in Trigonometric or Polar Form")

Continue pondering the concept of complex numbers in polar form as you review several visual examples of complex numbers in both rectangular and polar form.

Access the following in Thinkwell's Precalculus:

- section 8.6 ("Powers and Roots of Complex Numbers")
- section 8.6.1 ("Using DeMoivre's Theorem to Raise a Complex Number to a Power")

Memorize DeMoivre's Theorem on page 712 of Algebra and Trigonometry in MyMathLab.

Complete the following exercises in section 7.5 ("Complex Numbers in Polar Form; DeMoivre's Theorem") of Algebra and Trigonometry in MyMathLab:

- exercises 1-63, odd numbers only

"John and Betty's Journey Into Complex Numbers"

Read the following pages of "John and Betty's Journey Into Complex Numbers".

- pages 24-34

Final Review

Congratulations on completing the activities in this course of study! This section will guide you through the assessment process.

Skills Checks

Please complete the following skills checks before taking the pre-assessment. These skills checks are organized around three main content areas. These skills checks will help you review content as well as identify areas where you need further practice.

A best practice for using these skills checks is to treat them as the assessment. Each skills check is timed; do each in one sitting, and do not get help from any other source while completing it. Use a calculator, a pencil, and a blank piece of paper only. This method will give you the best indication of your preparation for the assessment.

As you complete each attempt, click on "Review Skills Checks." This will give you the option to walk through problems, see additional examples, or go to the textbook section that covers a particular topic, and, in some cases, there are additional interactive resources.

Skills checks may be repeated for new problems. Once you have mastered the skills checks, consistently scoring in the 80s and 90s, you will be ready to pass the pre-assessment and then schedule the exam.
Skill Checks

Complete the following skill checks in MyMathLab:

- "GCC Complex Number System Skills Check"
- "GCC Trig Functions Skills Check"
- "GCC Trig Equations and Identities Skills Check"

Assessment Information

The activities in this course of study have prepared you to complete the GCC2 objective assessment. If you have not already completed the assessment, you will do so now.

You are allowed to use a calculator.

Accessing Pre-Assessments

Complete the following pre-assessment:

- PGCC

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

Accessing Objective Assessments

Complete the following objective assessment:

- GCC2

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