Unit Plan for Math II Unit I

Unit Plan Title: Unit I: Extending the Number System

Grade Level: High School Math II

Unit Overview:

Lessons 1-3 should be considered optional review. Students will be able to explain orally or in written format a working definition of radicals using rational exponents with precision and fluency. They will be able to extend the properties of integer exponents to rational exponents while developing the notation appropriate to radicals. Students should be able to rewrite expressions containing radicals in terms of exponents and reverse the concept by rewriting rational exponents in terms of radicals, keeping fluency of equivalent expressions as a necessary understanding. Students will be able to explain orally or in written format, the definition of a polynomial or complex number and apply the basic operations of addition, subtraction and multiplication. They should be able to present their solutions as simplified complex numbers or polynomials. Students' knowledge of polynomials should include understanding that the solution sets are closed under the operations of addition, subtraction, and multiplication.

Unit Calendar:

Math II Unit I Extending the Number System Calendar

West Virginia College- and Career-Readiness Standards:

Objectives Directly Taught or Learned Through Inquiry/Discovery	Evidence of Student Mastery of Content
M.2HS.1 Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. (e.g. We define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3 = 5^{(1/3)3}$ to hold, so $(5^{1/3})^3$ must equal 5.)	Students investigate the rules of exponents related to rational exponents and radicals in several graphing calculator activities and they document their findings in the accompanying handouts from Texas Instruments. In a "research and respond" learning experience from SAS Curriculum Pathways, students research the applications of rational exponents and provide a written response. Online investigations such as *A Visual Approach to Simplifying Radicals, Discovering the Laws of Exponents* or *Can You Spot the Error* can be used to assess student comprehension formally and informally
M.2HS.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents.	Online quizzes, games and printable practice can be used to assess student comprehension formally and informally. Games such as *Rational Exponent Block* provide students opportunities to apply their reasoning.
M.2HS.3 Explain why sums and products of rational numbers are rational, that the sum of a rational number and an irrational number is irrational and that the product of a nonzero rational number and an irrational number is irrational. Instructional Note: Connect to physical situations, e.g., finding the perimeter of a square of area 2.	The *Theodorus Wheel Activity* permits student creativity as they investigate the connection of product of a nonzero rational number and an irrational number is irrational to a physical situation. Students investigate the rational vs. irrational number systems in several graphing calculator

	activities and they document their findings in the accompanying handouts from Texas Instruments. Online quizzes, games and printable practice can be used to assess student comprehension formally and informally. Accompanying lesson activities such as *Find Someone Who Can* encourages student interaction and error analysis as students work together to solve problems. Instructional video develops the activity and discussion in *Can the perimeter of a rectangle be an irrational number?"* An activity for student investigations*, Number System*; permits student discovery and uses manipulatives to develop numerical relationships. *Extending Irrational Numbers* permits students to develop irrational proof based upon Euclid's theories in an extension lesson. Online Computer practice and games include *Number Set Tiles* and *Rational and Irrational Numbers Game* for sorting activities.
M.2HS.4 Know there is a complex number i such that $i^2 = -1$, and every complex number has the form $a + bi$ with a and b real.	Multiple activities designed for the lesson such as *Introduction to the Power of i* provide students the opportunity to apply exponential rules to imaginary numbers and examine patterns and relationships. There are activities such *Find-n-Fix* where students work in groups to discover errors. Online quizzes, games and printable practice can be used to assess student comprehension formally and informally.
M.2HS.5 Use the relation $i^2 = -1$ and the commutative, associative and distributive properties to add, subtract and multiply complex numbers. Instructional Note: Limit to multiplications that involve i^2 as the highest power of i.	Multiple activities designed for the lesson such as *Create Problems* or *Complex Number Graphic Organizer* encourages students to work individually, in pairs or small groups to investigate algebraic properties related to adding, subtracting and multiplying complex numbers. Online quizzes, games (*Showdown* and *Rally the Table*) and printable practice can be used to assess student comprehension formally and informally.
M.2HS.6 Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract and multiply polynomials. Instructional Note: Focus on polynomial expressions that simplify to forms that are linear or quadratic in a positive integer power of x.	Multiple activities designed for the lesson, such as *Bulls-Eye* or *Polynomial Cards***,** encourage students to work individually, in pairs or small groups to investigate algebraic properties related to adding, subtracting and multiplying polynomials. A geometry application such as the calculation of surface area is connected to advertising on a rectangular prism in partners or small groups. Online quizzes, games (*Polynomial Station Activities*) and printable practice can be used to assess student comprehension formally and informally. In a "research and respond" learning experience from SAS Curriculum Pathways, students research the "*How are polynomials added and subtracted?*" and provide a written response.

Mathematical Habits of Mind:

Mathematical Habits of Mind	Evidence of Student Engagement in Mathematical Practices
1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	Proficient students clarify the meaning of real world problems and identify entry points to their solution. They choose appropriate tools and make sense of quantities and relationships in problem situations. Students use assumptions and previously-established results to construct arguments and explore them. They justify conclusions, communicate using clear definitions, and respond to arguments, deciding if the arguments make sense. They ask clarifying questions. Students reflect on solutions to decide if outcomes make sense. They discern a pattern or structure and notice if calculations are repeated, while looking for both general methods and shortcuts. As they monitor and evaluate their progress, they will change course if necessary.

Focus/Driving Question:

Can you think of multiple representations for the same number? How can the rules for exponents be used to write equivalent expressions for radicals, complex numbers and polynomials?

Student will Know:

How to explain the definition of rational exponents is related to the properties of integer exponents
The relationship between radical and rational exponent notation
How to rewrite expressions of radicals and rational exponents using the properties of exponents
How to explain the sums of rational numbers are rational
How to explain the sum of a rational number and irrational number yields an irrational result
How to explain the product of a nonzero rational number and irrational number yields an irrational result
How to connect rational and irrational operations to a physical situation such as perimeter
There is a complex number I such that $i^2 = -1$, and every complex number has the form $a + bi$ with a and b real.
That the relationship of $i^2 = -1$ be used with the algebraic properties of commutative, associative and distributive to add, subtract and multiply complex numbers
That polynomials are closed under the operations of addition, subtraction and multiplication
How to perform the operations of addition, subtraction and multiplication to polynomials

Student will Do:

Create explanations as to why sums of rational numbers are rational, sums of rational and irrational numbers are irrational and the product of a nonzero rational number and irrational number is irrational.
Look for patterns in imaginary numbers and their exponential value such that $i^2 = -1$

Connect rational and irrational operations to a physical situation such as perimeter
Create explanations regarding closure and the operations of addition, subtraction and multiplication

Resources/Websites:

Graphing Calculator, Word Wall Materials (construction paper, markers), foldable (white copy paper or notebook paper, markers or colored pencils, scissors), integer chips, poster board or cardstock, optional-computers
See individual lessons for websites.

Assessment Plan:

Students can be assessed through their writing of justifications and explanations in the frequent use of *Exit Slips* in lessons. For example, in lesson 1, they solve a problem providing the justifications for each application of exponential rules. A related activity to using proper notation and vocabulary is developed through teacher observation of several "pair and share" activities such as the investigation of multiple representations of expressions and the consideration of exact compared to approximate solutions. Student creation of problems occurs in the *My Quiz* and *Create Problems* activities where it is necessary to consider the problem being developed and its multiple representations. Students are informally assessed in the lessons through the use of java applets, interactive quizzes, TI graphing calculator activities and online research investigations. In the *Find Someone Who Can* activities, students solve problems for each other requiring communication and encouraging participation. *Extending Rational Numbers* requires students to apply critical thinking skills to provide indirect proof regarding rational and irrational numbers based upon Euclid's theorems. Small group assignments are another form of assessing student comprehension as evidenced by the *Number System Activity* where integer chips and a number line are used to investigate rational and irrational properties. Students create a *Theodorus Wheel* to demonstrate the properties of irrational and rational numbers in geometry application. At the end of the unit, students are asked to work in small groups to develop a game for review of the unit in *Is That Your Final Answer?* **(**Lesson 9)

Each lesson (1-8) contains questions for summarization and reflection which can be beneficial in teacher assessment and were designed to provide additional feedback on student learning. These can be used to guide future instruction or incorporated into a culminating unit assessment.

Major Projects: (Group) or (Individual)

Theodorus Wheel

Is That Your Final Answer?

Unit Reflection:

Each lesson contains a reflection component for students to consider the objectives of the lesson and the information they learned during the instructional process. Students should reflect upon the skills that were needed to generate their solutions. Lesson reflections suggest discussion in terms of either "pair-share", small group or whole group expression to encourage student development of the reflective process. As an instructor, it is beneficial (if your students are not familiar with the reflection process) to "model" by completing your own reflection in terms of the day's lesson. During the discussion, you can contribute your thoughts and gather feedback from students to guide the next lesson.

It is important to consider your observations of student learning and lesson effectiveness. Are there any objectives that students are unclear on? Consider your teaching practices and how the lesson organization worked with your students. How will you get students to think about what they have learned or should have mastered in instruction. Read their responses carefully to gain insight into student

understanding. For example, do you need to further develop the concept of equivalency or have they established mastery to continue further in the unit?

Career Connections:

Skills developed in this unit can be related to banking formulas (Business and Marketing Cluster), formulas used in exponential growth and decay of bacteria or chemistry formulas such as Boyle?s Law or astronomy, in terms of distance/scientific notation (Engineering and Technical Cluster, Health Cluster, Science and Natural Resources Cluster). Skills can also be related to formulas for velocity and gravity (Engineering and Technical Cluster, Science and Natural Resources Cluster). Equivalent expressions are necessary for converting units of measure, developing proportions, transformations and literal equations such as solving for a particular unknown in a formula. All of the following career clusters use the previously stated concepts: Arts and Humanities Cluster, Business and Marketing Cluster, Engineering and Technical Cluster, Health Cluster, Human Services Cluster and Science and Natural Resources Cluster.

Unit Plan Outline (Lesson Plans link):

Lesson 1: Integer Exponents
Lesson 2: Simplifying Radicals
Lesson 3: Comparing and Contrasting Equivalency (Exact vs. Approximate Solutions)
Lesson 4: Rational Exponents
Lesson 5: Rational and Irrational Numbers
Lesson 6: Intro to Complex Numbers
Lesson 7: Operations with Complex Numbers
Lesson 8: Polynomials
Lesson 9: Is That Your Final Answer?

Planning Calendar

Unit Title: Unit 1 - Extending the Number System

Day 1	Day 2	Day 3	Day 4	Day 5
Lesson 1: Integer Exponents (optional) **FQ**: Can you think of multiple representations for the same number? **WVCCRS**s: **M.2HS.1** Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. (e.g. We define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3 = 5^{(1/3)3}$ to hold, so $(5^{1/3})^3$ must equal 5.) MHM1, MHM2, MHM3, MHM5, MHM6, MHM7, MHM8 **V:** base, equal expressions, equivalent expressions, evaluate, exponent, exponential form, perfect square **L:** Students create a factor tree and connect to exponents. **I/E:** Creating a classroom list of exponential list and personalizing examples. **S/D:** Solve a problem and justify with rules of exponents. **R:** Pair and share activity with react statements.	**Lesson 2:** Simplifying Radicals **FQ**: What is the relationship between a perfect square number and its root? Do you know if a number is considered exact or approximate? When is it appropriate to use an exact answer? Approximate? **WVCCRS**s: **M.2HS.1** Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. (e.g. We define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3 = 5^{(1/3)3}$ to hold, so $(5^{1/3})^3$ must equal 5.) MHM1, MHM2, MHM4, MHM5, MHM6, MHM7, MHM8 **V:** radical, radicand, radical sign, rational number, irrational number, terminating decimal, repeating decimal, square root, simplest form of a radical **L:** Discuss the relationship between a perfect square and its root. **I/E:** Use a foldable and/or video to explore the patterns of perfect squares and develop vocabulary S/D: Students simplify a radical without calculators (both exact and approximate) and write an explanation in a pair-and-share, **R:** Use 3-2-1 to write 3 statements about radical and square roots.	**Lesson 3:** Comparing and Contrasting Equivalency (Exact vs. Approximate Solutions) **FQ**: Can you think of multiple representations for the same number? Do you know if a number is considered exact or approximate? When is it appropriate to use an exact answer? Approximate? **WVCCRS**s: **M.2HS.1** Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. (e.g. We define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3 = 5^{(1/3)3}$ to hold, so $(5^{1/3})^3$ must equal 5.) MHM2, MHM3, MHM4, MHM8 **V:** equivalent expression, exact solution, approximate solution **L:** Use a partner activity and video to convert decimal number into radicals. **I/E:** Use the **Equivalency of Square Roots and Sorting Activity** to look for patterns. **S/D:** Students create an expression using exponents and radicals preparing 3 equivalent expressions for created problem. (Partner Activity) **R:** Exit slip with 3 response statements.	**Lesson 4:** Rational Exponents **FQ**: How can radical notation be used to express equivalency in terms of rational exponents? **WVCCRS**s: **M.2HS.1** Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. (e.g. We define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3 = 5^{(1/3)3}$ to hold, so $(5^{1/3})^3$ must equal 5.) **M.2HS.2** Rewrite expressions involving radicals and rational exponents using the properties of exponents. MHM1, MHM3, MHM5, MHM6, MHM7, MHM8 **V:** index, power, radical, radicand, rational exponents **L:** Use video to review exponential relationships and connect to fractional exponents. **I/E:** Use TI Activity to recognize equivalencies between radical and exponents. **S/D:** Use the **Find Someone Who Can Activity – Rational Exponents** to assess student comprehension. **R:** List relevant facts regarding equivalent expressions on the vertices of a triangle for future reference. (Triangle Review)	**Lesson 5:** Rational and Irrational Numbers **FQ**: How are the solutions between sums/products of rational and irrational numbers different? **WVCCRS**s: **M.2HS.3** Explain why sums and products of rational numbers are rational, that the sum of a rational number and an irrational number is irrational and that the product of a nonzero rational number and an irrational number is irrational. Instructional Note: Connect to physical situations, e.g., finding the perimeter of a square of area 2. MHM2, MHM4, MHM5, MHM7, MHM8 **V:** rational, irrational **L:** Use a Venn diagram in **Real Number System Notes PowerPoint** to categorize numerical examples and develop vocabulary. **I/E:** Use the Wheel of Theodorus to investigate definitions of rational and irrational numbers. **S/D:** Students create their own definitions and examples for the **Rational and Irrational Graphic Organizer**. **R:** using **Rational and Irrational Reflection**, students compare and justify their reasoning the classification of two numbers.

Day 6	Day 7	Day 8	Day 9	
Lesson 6: Intro to Complex Numbers **FQ**: Why are complex numbers needed to supplement the real number system? **WVCCRS**s: **M.2HS.4** Know there is a complex number i such that $i^2 = -1$, and every complex number has the form $a + bi$ with a and b real. MHM1, MHM2, MHM3, MHM6, MHM8 **V:** imaginary number, real number, complex number in standard form **L:** View a video on the role of complex numbers – Why do we need them? **I/E:** Use the **Introduction to the Powers of i Activity** to assist students in developing patterns in the exponential powers of i. **S/D:** Use the **Imaginary Numbers Exit Slip** to create their own examples. **R:** Use **Think-Pair-Share** to reflect "Why are complex numbers needed to supplement the real number system?"	**Lesson 7:** Operations with Complex Numbers **FQ**: How are algebraic properties applied to complex numbers? **WVCCRS**s: **M.2HS.5** Use the relation $i^2 = -1$ and the commutative, associative and distributive properties to add, subtract and multiply complex numbers. Instructional Note: Limit to multiplications that involve i^2 as the highest power of i. MHM1, MHM3, MHM5, MHM6, MHM8 **V:** Review of Lesson 6 **L:** Use Classifying Complex Number PowerPoint to guide students to standard form of a complex number. **I/E:** **Use Graphic Organizer – adding, subtracting, and multiplying**, to summarize in their own words the process of adding, subtracting, and multiplying complex numbers. **S/D:** Use the Think-Pair-Share **Complex Numbers Exit Slip** to connect imaginary numbers to their related values. **R:** Student written response to "How are algebraic properties applied to complex numbers?" demonstrating addition, subtraction, and multiplication of complex numbers.	**Lesson 8:** Polynomials **FQ**: If I start with a polynomial and combine it with another polynomial, do I always get a polynomial? **WVCCRS**s: **M.2HS.6** Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract and multiply polynomials. Instructional Note: Focus on polynomial expressions that simplify to forms that are linear or quadratic in a positive integer power of x. MHM1, MHM6 **V:** closure, coefficient, constant, degree, leading term, like term, monomial, binomial, polynomial, standard form, term, trinomial L: Find the total surface area of a package. **I/E:** Use **Polynomial Cards** for exploration on polynomials**.** **S/D:** Use **Find Some Who** Can to practice operations of polynomials. **R:** Use the **Polynomial Exit Slip** to demonstrate the operations of polynomial are closed under addition, subtraction, and multiplication.	**Lesson 9:** Is That Your Final Answer? **FQ**: What are complex numbers? How do they relate to polynomials? How does my knowledge of radicals and exponents connect to knowledge of complex numbers and polynomials? **WVCCRS**s: **M.2HS.1** Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. (e.g. We define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3 = 5^{(1/3)3}$ to hold, so $(5^{1/3})^3$ must equal 5.) **M.2HS.2** Rewrite expressions involving radicals and rational exponents using the properties of exponents. **M.2HS.3** Explain why sums and products of rational numbers are rational, that the sum of a rational number and an irrational number is irrational and that the product of a nonzero rational number and an irrational number is irrational. Instructional Note: Connect to physical situations, e.g., finding the perimeter of a square of area 2. **M.2HS.4** Know there is a complex number i such that $i^2 = -1$, and every complex number has the form $a + bi$ with a and b real. **M.2HS.5** Use the relation $i^2 = -1$ and	

			the commutative, associative and distributive properties to add, subtract and multiply complex numbers. Instructional Note: Limit to multiplications that involve i^2 as the highest power of i. **M.2HS.6** Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract and multiply polynomials. Instructional Note: Focus on polynomial expressions that simplify to forms that are linear or quadratic in a positive integer power of x. MHM1, MHM5, MHM6 **V:** Unit Vocabulary **L:** Brainstorm on different types of games that may be used to create a unit review. **I/E:** Use **Game Task Document** to review concepts covered in unit. **S/D:** Presentation of games created. **R:** Reflect on the unit and created product using **The Final Evaluation**.	