Course: *Algebra II Data Science* **Unit #:** *Unit 3 - Exponential and Logarithmic Functions*	**Year of Implementation:** 2024-2025

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Stage One - Desired Results

Link(s) to New Jersey Student Learning Standards for this course:
{provide all applicable links to standards here}
https://www.state.nj.us/education/cccs/2020/

- **Unit Standards:** *(keep each of the following headings in place)*
  - ***Content Standards***
    - Structure in Expressions A-SSE: B. 3
      - Write expressions in equivalent forms to solve problems.
    - Interpreting Functions F-IF: C. 7-8
      - Analyze functions using different representations
    - Building Functions F-BF: A. 1, B. 3, 5
      - Write a function that describes a relationship between two quantities.
      - Build new functions from existing functions.
    - Linear, Quadratic, and Exponential Models F-LE: A. 4
      - Construct and compare linear, quadratic, and exponential models and solve problems
  - ***21st Century Life & Career Standards***
    - 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas
    - 9.4.12.CI.3: Investigate new challenges and opportunities for personal growth, advancement, and transition
    - 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving
      https://www.state.nj.us/education/cccs/2020/2020%20NJSLS-CLKS.pdf
  - ***Interdisciplinary Content Standards***
    - SL.11-12.1. Initiate and participate effectively in a range of collaborative discussions (one-on- one, in groups, and teacher-led) with peers on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

- - **SL.11-12.4** Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience.
    - **L.11-12.6.** Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate
  - ***NJ Statutes:*** NJ State law mandates the inclusion of the following topics in lesson design and instruction as aligned to elementary and secondary curriculum.

    Amistad Law: N.J.S.A. 18A 52:16A-88 Every board of education shall incorporate the information regarding the contributions of African-Americans to our country in an appropriate place in the curriculum of elementary and secondary school students.

    Holocaust Law: N.J.S.A. 18A:35-28 Every board of education shall include instruction on the Holocaust and genocides in an appropriate place in the curriculum of all elementary and secondary school pupils. The instruction shall further emphasize the personal responsibility that each citizen bears to fight racism and hatred whenever and wherever it happens.

    LGBT and Disabilities Law: N.J.S.A. 18A:35-4.35 A board of education shall include instruction on the political, economic, and social contributions of persons with disabilities and lesbian, gay, bisexual, and transgender people, in an appropriate place in the curriculum of middle school and high school students as part of the district's implementation of the New Jersey Student Learning Standards (N.J.S.A.18A:35-4.36) A board of education shall have policies and procedures in place pertaining to the selection of instructional materials to implement the requirements of N.J.S.A. 18A:35-4.35.

    Diversity and Inclusion (N.J.S.A. 18A:35-4.36a) A board of education shall incorporate instruction on diversity and inclusion in an appropriate place in the curriculum of students in grades kindergarten through 12 as part of the district's implementation of the New Jersey Student Learning Standards.

    Asian American and Pacific Islanders (AAPI) P.L.2021, c.410 Ensures that the contributions, history, and heritage of Asian Americans and Pacific Islanders (AAPI) are included in the New Jersey Student Learning Standards (NJSLS) for Social Studies in kindergarten through Grade 12 (P.L.2021, c.416)

For additional information, see

NJ Amistad Curriculum: *https://www.nj.gov/education/amistad/about/*

Diversity and Inclusion: *https://www.nj.gov/education/standards/dei/index.shtml*

- *(Sample Activities/ Lessons): https://www.nj.gov/education/standards/dei/samples/index.shtml*

Asian American and Pacific Islanders:

- *Asian American and Pacific Islander Heritage and History in the U.S.*

  A Teacher's Guide from EDSITEment offering a collection of lessons and resources for K-12 social studies, literature and arts classrooms that center around the experiences, achievements and perspectives of Asian Americans and Pacific Islanders across U.S. history.

Transfer Goal: Students will be able to independently use their learning to manipulate forms to communicate meaningful information.

As aligned with LRHSD Long Term Learning Goal(s):https://www.lrhsd.org/Page/6163

1. Problem-Solving: apply and transfer autonomously and collaboratively mathematical concepts and problem- solving techniques to unfamiliar, varied and real-world situations
2. Reasoning: reason abstractly and quantitatively by applying mathematical representations, symbols and estimation techniques when engaging in problem-solving
3. Critical Thinking: construct and effectively communicate valid conclusions and critique the reasoning of others
4. Modeling: demonstrate mastery of concepts by evaluating models that others have constructed or by creating appropriate models of their own
5. Tools: identify the correct tools to solve problems, if applicable
6. Precision: determine an answer's appropriateness as a means of determining its validity, while using proper mathematical notation and units
7. Structure: use multiple representations, critical thinking skills, and prior knowledge to solve problems in new situations
8. Patterns: analyze data and recognize patterns in a variety of situations
9. Habits of Mind: approach new situations with curiosity, persistence, resourcefulness, and confidence; take risks, monitor their progress, accept and learn from setbacks, make adjustments, and reflect on their performance

Enduring Understandings	*Essential Questions*
Students will understand that. . .	

EU 1 expressions can be rewritten to produce other statements of equivalent forms. *EU 2* the characteristics of radical, exponential, logarithmic, and piecewise functions and their representations are useful when solving real world problems.	● What real world phenomena can be modeled using radicals, exponentials and logarithms? ● How can you compare exponential and logarithmic functions?
<u>Knowledge</u> *Students will know . . .* *EU 1* ● transformations for exponential and logarithmic functions. (A-SSE B3, A-CED A, F-IF, C8b) ● evaluate exponential and logarithmic expressions and equations. (F-IF C) ● logarithmic functions are the inverse of the exponential functions. (F-BF 4C) ● exponential rules (including rational exponents) are used to simplify exponential and logarithmic expressions. (F-LE) *EU 2* ● key features of the graphs of radical, exponential, logarithmic, and piecewise functions (domain, range, intercepts, increasing/decreasing intervals, asymptotes). (A-SSE B3, A-CED A, F-IF, C7e, 8b) ● exponential and logarithmic functions and their equations can be used to solve real world problems.(F-IF B) ● problems can be modeled using exponential or logarithmic functions. (F-IF B, F-IF C)	<u>Skills</u> *Students will be able to. . .* *EU 1* ● use properties of exponents (including rational exponents) to evaluate exponential expressions and equations. (F-LE) ● use inverse operations to move between logarithmic and exponential expressions. (F-BF B4) *EU 2* ● graph radical, exponential and logarithmic functions with and without transformations. (F-IF C7) ● identify domain, range, intercepts, asymptotes, and/or increasing/decreasing of radical, exponential, logarithmic and piecewise functions.. (F-IF C) ● use technology to evaluate logarithmic expressions and equations. (F-IF C) ● translate and solve exponential functions to model real-world phenomena. (F-IF B, F-IF C)

Stage Two - Assessment	
Stage Three - Instruction	

Learning Plan: **Suggested Learning Activities to Include Differentiated Instruction and Interdisciplinary Connections: Each learning activity listed must be accompanied by a learning goal of A= Acquiring basic knowledge and skills, M= Making meaning and/or a T= Transfer.** *{place A, M and/or T along with the applicable EU number in parentheses after each statement} All knowledge and skills must be addressed in this section with a corresponding lesson/activity which teaches each concept. The following color codes are used to notate activities that correspond with interdisciplinary connections and 21st Century Life & Career Connections (which involves Technology Literacy):* Red = Interdisciplinary Connection; Purple = 21st Century Life & Career Connection

- Activity #1 - Go around the class and have each student double the previous number, starting with the number 1. Write each number on the board. Note how quickly the numbers increase. Then start at 1 and have students give the fraction that is half the previous number. Write these alongside the doubled numbers. See if students recognize that these are reciprocals of the first set and note how quickly the numbers decrease. Tell them they will study growth and decay patterns in this lesson. (A, M, EU1)
- Activity #2 – The NCAA holds a championship basketball tournament each spring. The nation's top 64 teams in Division 1 are invited to play. When a team loses, it is out of the tournament. Determine the number of teams left in the tournament after Round 5. (M, EU1)
- Activity #3 – Nspire Activity – Graphing Logarithmic Functions - (M, EU1, EU2)
- http://education.ti.com/calculators/timathnspired/US/Activities/Detail?sa=1010&t=1168&id=16057
- Activity #4 – Graphing Calculator – Determining whether data best fits an exponential model – (M, EU2)

Exponential Functions in the Real World

The United States has continued to grow since the late 1700's. The following chart shows how the number of people per square mile changed from 1790-1980.

Year	People Per Square Mile	Year	People Per Square Mile	Year	People Per Square Mile	Year	People Per Square Mile

1790	4.5	1840	9.8	1890	17.8	1940	37.2
1800	6.1	1850	7.9	1900	21.5	1950	42.6
1810	4.3	1860	10.6	1910	26.0	1960	50.6
1820	5.5	1870	10.9	1920	29.9	1970	57.5
1830	7.4	1880	14.2	1930	34.7	1980	64

1) Graph the data on your calculator. (Remember, enter the numbers in the list, then go back to the Menu and use Stat to graph). What is happening in the graph?
2) What is the line of best fit? Draw it as well to see if it works.
3) a) Using the equation from Question 2, what would be the number of people per square mile in 2000? Go online and find out the actual amount of people per square mile in the United States. How close is the prediction?
Prediction: _____   Actual: _____   Difference: _____
   b) Was the prediction equation a good estimator? Why or why not?
4) As stated in the title, this is an exponential function. What other type of function would create a similar outcome? Why?

- Activity #5 – Research – Have students describe two specific situations, one for exponential growth and one for exponential decay. For each, they should produce a function and a graph, and use them to generate a meaningful value. (T, EU1, EU2)
- Activity #6 – Concentration Game – On index cards write 10 Exponential expressions and on 10 other write the Logarithmic equivalent – (A, EU1)
- Activity #7 - Natural Log Applications (A, M, T EU1, EU2)
  https://teacher.desmos.com/activitybuilder/custom/58752d0d39f53222057422c3
- Activity #8 – Simon Says – Have students demonstrate graphs of various functions using their hands – (T, EU1, EU2)

Suggested Sequence of Learning Activities:
- Exponential or Logarithmic function graph talk (M, EU2)
- Activity #1 outlined above (A, M, EU1)
- Graph Exponential Growth and Decay functions (A, EU1)
- Interpret/identify key components of radical function graphs, including domain and range (M, EU2)
- NCAA Activity outlined above (M, EU 1)
- Graph logarithmic equations (A, EU1)
- TI-NSpire Activity, link above (M, EU1, EU2)
- Simplify/evaluate exponential and logarithmic expressions using rational exponent properties, inverse properties, and properties of logarithms (A, EU1)
- Graphing calculator activity outlined above (M, T, EU2)

- Solve exponential and logarithmic equations using common logarithms and properties of logarithms (A, EU1, EU2)
- Research Activity #5 outlined above (T, EU1, EU2)
- Concentration Game Activity outlined above (A, EU1)
- Evaluate expressions and solve equations using base e and natural logarithm (A, EU1, EU2)
- Activity #7 outlined above (A, M, T, EU1, EU2)
- Simon Says Activity outlined above (T, EU1, EU2)
- Interpret/identify key components of piecewise function graphs, including domain and range (M, EU2)

Pacing Guide
{This chart will be identical in all of the units for this course.}

Unit #	Title of Unit	Approximate # of teaching days
1	Quadratic Functions	30
2	Polynomial Functions	19
3	Exponential and Logarithmic Functions	19
4	What Does Data Tell Us?	17
5	Modeling and Analyzing Univariate Data	17
6	Modeling and Analyzing Bivariate Data	17

7	Probability and Simulations	16

Instructional Materials

- TInSpire Calculator
- DESMOS online graphing calculator and activities
- Khan Academy
- Kuta Infinite Software

Accommodations

Special Education: The curriculum will be modified as per the Individualized Education Plan (IEP). Students will be accommodated based on specific accommodations listed in the IEP.

Students with 504 Plans: Students will be accommodated based on specific accommodations listed in the 504 Plan.

English Language Learners: Students will be accommodated based on individual need and in consultation with the ELL teacher.

Students at Risk of School Failure: Students will be accommodated based on individual need and provided various structural supports through their school.

Gifted and Talented Students: Students will be challenged to enhance their knowledge and skills through acceleration and additional independent research on the subject matter.