Interpret functions that arise in applications in terms of a context (F.IF.4-6)

**Standard III.F.IF.4:** For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include* intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.

<table>
<thead>
<tr>
<th>Concepts and Skills to Master</th>
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</thead>
<tbody>
<tr>
<td>• Build on work from Secondary Mathematics I and Secondary Mathematics II to interpret key features of functions, including all polynomial, rational, square root, cube root, logarithmic, and trigonometric functions.</td>
</tr>
<tr>
<td>• Identify key features such as intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.</td>
</tr>
<tr>
<td>• Interpret key features using multiple representations (tables, graphs, equations, and verbal descriptions).</td>
</tr>
<tr>
<td>• Use key features to sketch a graph of the function.</td>
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</tbody>
</table>

**Related Standards: Current Course**  
III.F.IF.4, III.F.IF.6, III.F.IF.7

**Related Standards: Future Courses**  
P.F.IF.7,

**Support for Teachers**

**Critical Background Knowledge**

• Interpret key features of graphs and tables (I.F.IF.4 and II.F.IF.4)
• Find the average rate of change on a specified interval (I.F.IF.6 and II.F.IF.6)
• Graph functions and identify key features (I.F.IF.7 and II.F.IF.7)
• Compare functions using key features (I.F.IF.9 and II.F.IF.9)
• Graph and identify key features of linear, exponential, and quadratic functions (I.F.IF.4, II.F.IF.4).

**Academic Vocabulary**

asymptote, removable discontinuity, increasing, decreasing, interval, intercept, maximum, minimum, symmetry, end behavior, rational, discrete, domain, range

**Resources**

Curriculum Resources: http://www.uen.org/core/core.do?courseNum=5630#71625
Interpret functions that arise in applications in terms of a context (F.IF.4-6)

**Standard III.F.IF.5:** Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function $h(n)$ gives the number of person-hours it takes to assemble $n$ engines in a factory, then the positive integers would be an appropriate domain for the function.

### Concepts and Skills to Master

- Identify domain of a function from any representation for any function family from Secondary Mathematics.
- Relate the domain to context, explaining restrictions as a result of the context.

### Related Standards: Current Course

- III.A.CED.2, III.F.BF.4: All functions standards (domain is used throughout high school mathematics courses)

### Related Standards: Future Courses

- P.F.BF.4, P.F.IF.7d: All functions standards (domain is used throughout high school mathematics courses)

### Support for Teachers

#### Critical Background Knowledge

- Relate the domain of a function to the relationship it describes (I.F.IF.5 and II.F.IF.5)
- Familiarity with function notation and domain (I.F.IF.2)
- Understand the definition of function (8.F.1 and I.F.IF.1)
- Independent, dependent variables and input/output (8.F.1)

#### Academic Vocabulary

- domain, function, discrete, continuous, asymptotes

### Resources

**Curriculum Resources:** http://www.uen.org/core/core.do?courseNum=5630#71625
Interpret functions that arise in applications in terms of a context (F.IF.4-6)

**Standard III.F.IF.6**: Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>• Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Focus on all function families from Secondary Mathematics.</td>
</tr>
<tr>
<td>• Estimate the rate of change from a graph.</td>
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</tbody>
</table>

**Related Standards: Current Course**
III.F.IF.9, III.F.LE.3

**Related Standards: Future Courses**
Secant lines in Calculus

**Support for Teachers**

**Critical Background Knowledge**
• Calculating and interpreting the rate of change in linear, exponential, and quadratic functions (I.F.IF.6 and II.F.IF.6)
• Determine the rate of change from a description of a relationship or from two (x,y) values and interpret its meaning (8.F.4)

**Academic Vocabulary**
average rate of change, interval, secant line

**Resources**
Curriculum Resources: http://www.uen.org/core/core.do?courseNum=5630#71625
### Analyze functions using different representations (F.IF.7-9)

**Standard III.F.IF.7:** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

- **b.** Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions. Compare and contrast square root, cubed root, and step functions with all other functions.
- **c.** Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.
- **d.** Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.
- **e.** Graph exponential and logarithmic functions, showing intercepts and end behavior; and trigonometric functions, showing period, midline, and amplitude.

### Concepts and Skills to Master
- Given an equation of any function from this standard, graph with or without technology, and show key features of given function.
- Compare and contrast new functions from Secondary III with all other functions.

<table>
<thead>
<tr>
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<th>Related Standards: Future Courses</th>
</tr>
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</table>

### Support for Teachers

**Critical Background Knowledge**
- Graph functions showing key features (I.F.IF.7 and II.F.IF.7)
- Interpret key features of a graph (I.F.IF.4 and II.F.IF.4)
- Identify and use transformation of functions (I.F.BF.3 and II.F.BF.3)

**Academic Vocabulary**
- square root, cube root, piecewise, logarithmic, step, period, midline, amplitude, frequency

**Resources**
- Curriculum Resources: [http://www.uen.org/core/core.do?courseNum=5630#71625](http://www.uen.org/core/core.do?courseNum=5630#71625)
Analyze functions using different representations (F.IF.7-9)

**Standard III.F.IF.8:** Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

**Concepts and Skills to Master**
- Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.
- Extend the work from Secondary II (II.F.IF.8) to include functions from this course.
- Transition between equivalent forms to identify desired key features

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<tr>
<td>III.A.SSE.1, III.A.SSE.2, III.A.APR.3, III.A.APR.4, III.A.APR.6, III.F.BF.3</td>
<td>P.F.IF.7d</td>
</tr>
</tbody>
</table>

**Support for Teachers**

**Critical Background Knowledge**
- Identify when two expressions are equivalent (6.EE.4); understand that rewriting an expression in different forms can shed light on problem and how quantities are related (7.EE.2)
- Write a quadratic function in different but equivalent forms (II.F.IF.8)

**Academic Vocabulary**

**Resources**
- Curriculum Resources: http://www.uen.org/core/core.do?courseNum=5630#71625
Analyze functions using different representations (F.IF.7-9)

**Standard III.F.IF.9:** Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

**Concepts and Skills to Master**
- Compare properties of two functions, keeping the following in mind:
  - properties include key features from III.F.IF.4
  - function pairs include any combination of functions from Secondary Mathematics I, II, and III
  - representations include algebraically, graphically, numerically in tables, or by verbal descriptions

**Related Standards: Current Course**
- III.F.IF.4, III.F.IF.7, III.F.LE.3

**Related Standards: Future Courses**
- P.F.IF.7

**Support for Teachers**

**Critical Background Knowledge**
- Compare properties of two functions in different representations (I.F.IF.9 and II.F.IF.9)
- Find intercepts, rates of change, and end behavior (I.F.IF.4 and II.F.IF.4)

**Academic Vocabulary**
- asymptote, discontinuity, period, midline, amplitude, frequency

**Resources**
- Curriculum Resources: http://www.uen.org/core/core.do?courseNum=5630#71625