Learning Goal *The student will be able to understand how the derivative is applied in the context of typical models.*
Objectives *Identify extrema of elementary functions. · Investigate Rolle's Theorem as it pertains to elementary functions. · Recognize the conditions in which the result of Rolle's Theorem applies.*
Essential Question *How are derivatives used to find detailed quantitative and qualitative information regarding elementary functions?*
Key Vocabulary *interval, maxima, minima, extrema, (to be) local*
Standards *MAFS.912.C.4.3: Find local and absolute maximum and minimum points.*
Assessment *Formative closing activity. See Addenda.*

The lesson proceeds according to *Table 1: Lesson Procedure*. Lesson contents and media are provided in the form of a website at
`https://wshilton.github.io/rollesthm/`.
The addenda in this document are provided as a physical copy to students as needed or as accomodations require. More precise formulations of lesson events are referenced in the corresponding addenda entry. The opening activity requires no verbal instruction, as it is a norm. The instructor completes any bureaucratic activities during this time while implementing highly-innovative monitoring protocols.

Table 1: Lesson Procedure

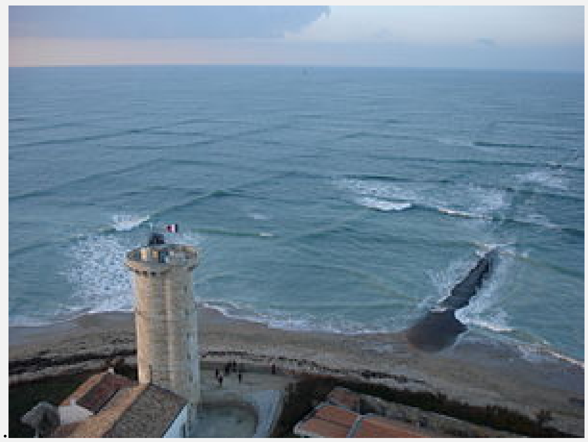
Time	Event	Addenda
00:00 – 05:00	Students complete and submit the opening activity.	1
05:00 – 07:00	Instructor reviews assigned activity. Relates this prior knowledge with anticipatory connection.	
07:00 - 10:00	Instructor writes and verbalizes Rolle's Theorem.	2
10:00 - 15:00	Instructor poses sequence of questions to check for understanding.	
15:00 - 25:00	Instructor reviews examples of applying Rolle's Theorem with active participation from students.	
25:00 - 26:00	Instructor discusses assignment of group activity.	
26:00 - 36:00	Students engage in group activity.	3
36:00 - 40:00	Instructor reviews group activity and addresses comprehension issues, as needed.	
40:00 - 41:00	Instructor assigns independent practice activity and closing activity.	
41:00 - 45:00	Students complete and submit closing activity and subsequently begin independent practice activity.	4

Resources *Projector · Internet-connected device · Group activity handout · Learning content management platform access*
References *cpalms.org*
Accommodations *ESL students are provided with primary-language transcripts of lesson courtesy district translation services · ESE students are provided with accommodations according to documented accommodations requirements per District policy · Paper copies of lesson notes are provided per accommodation · Audiovisual copies of lesson are provided per accommodation*

Addendum 1
Opening Activity

Students navigate to an endorsed learning content management platform to complete an activity. The activity is a free-response question as follows:

Question 1 of 1
Observe the wave structures in the following scene in Ille de Re, France.



To describe this water wave phenomenon mathematically, an approximate model of this system can be derived, in which wave profiles are inscribed as functions, f, which satisfy

$$K(f) := f_t + f f_x + \delta^2 f_{xxx} = 0.$$

Indeed, the zeros of K are all possible wave profiles in space and time, as modeled. One special zero of this wave equation has the form

$$f(x,t) = 12k^2\delta^2 \operatorname{sech}(k(x - 4k^2\delta^2 t)).$$

Point your browser to
`wshilton.github.io/rollesthm/sechwave.gif`
and to
`wshilton.github.io/rollesthm/sechwaveexperiment.gif`
to view media that illustrates the analytical and experimental instances of this wave form. Now identify the number of maxima and minima that appear in this special wave profile as t proceeds.
Response There are ___ maxima and ___ minima in this special wave profile as t proceeds.

Addendum 2
Rolle's Theorem

The following information is written and verbalized.

Rolle's Theorem Let $a, b \in \mathbb{R}$ and let $f : [a, b] \to \mathbb{R}$ be continuously differentiable. If $f(a) = f(b)$, then there exists $\xi \in (a, b)$ such that

$$f(b) - f(a) = f_x(\xi)(b - a).$$

Point your browser to
`wshilton.github.io/rollesthm/`
and navigate to the section titled Rolle's Theorem to hear the mathematical statement interpreted verbally.

Addendum 3
Group Activity

Students are assigned combinations of the following functions and intervals. The functions are graphed using technology and the groups are responsible for analyzing if Rolle's Theorem can be applied.

Point your browser to
`www.desmos.com/calculator/evlslnmtdt`
and navigate to the section titled Examples. We will discuss the examples as a group.

Functions

$$\frac{\sin(10x)}{x},$$

$$\operatorname{sech}^2(x),$$

$$e^{-x^3},$$

$$\sum_{n=0}^{\infty} e^{-\sqrt{2^n}} \cos(2^n x).$$

Intervals

$$(0, 1)$$

$$[0, 1]$$

$$(-\infty, \infty)$$

$$[-4, 7).$$

Addendum 4
Closing Activity

Students navigate to an endorsed learning content management platform to complete an activity. The activity is a question as follows:

Question 1 of 1 For a real-valued function defined on an interval, select the criterion needed to apply Rolle's Theorem:

It is necessary that $f(a) = f(b)$.

True, False, Undecidable

It is necessary that f is continuous on the interval.

True, False, Undecidable

It is necessary that f is differentiable on the interval.

True, False, Undecidable

It is necessary that f is piecewise on the interval.

True, False, Undecidable

It is necessary that f is nonzero and monotonic on the interval.

True, False, Undecidable