Our Ohio OER on ODE

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OHIO
OpenEd
COLLABORATIVE
ADOPT + SHARE + CREATE + LEAD

PROJECT PARTNERS

Lead Institution & Fiscal Agent:	University Partners:	Community College Partners:	Additional Partners:
North Central State College	The Ohio State University Ohio Dominican University	OACC Northwest State Community College Edison State Community College Terra State Community College Central Ohio Technical College Southern State Community College Clark State Community College Washington State Community College Rhodes State College Stark State College Columbus State Community College Hocking College Lorain County Community College Lakeland Community College Sinclair Community College Marion Technical College	OhioLINK Ohio's Academic Library Consortium Achieving the Dream Community Colleges Count

About this course

Our goal was to create a course package that is:

- Modular
- Interactive
- Includes hands-on student activities
- Appropriate for a wide variety of institutions and instructional settings
- Mapped to Ohio common learning outcomes standards

Additional mathematics courses:

- Linear Algebra
- Abstract Algebra
- Calculus I and II
- Precalculus
- Statistics
- College Algebra

https://ohiolink.oercommons.org/hubs/OOEC

Textbook and Platform

William F. Trench
Elementary Differential Equations
License: CC-BY-NC-SA
https://digitalcommons.trinity.edu/mono/8/

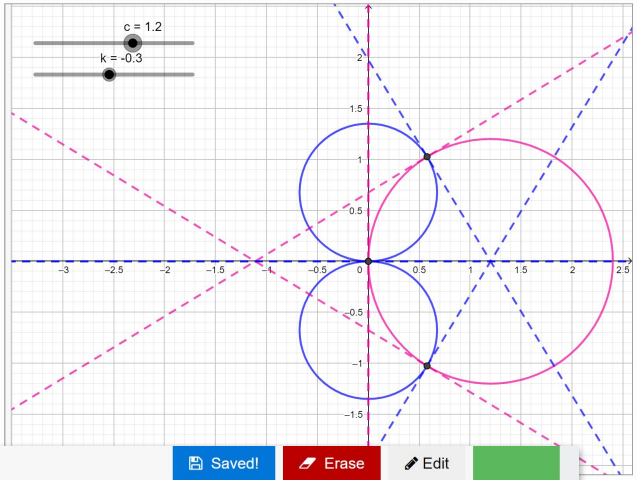
XIMERA

https://ximera.osu.edu/ode/main

Why XIMERA?

XIMERA Get Help Saved! Erase Edit

The following dynamic interactive will help you visualize the curves.



XIMERA Get Help Save Era

The following interactive Sage Cell offers a visual comparison between Runge-Kutta and Euler's methods for the initial value

$$y' + 2y = x^3 e^{-2x}, \quad y(0) = 1$$

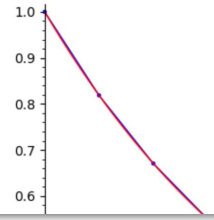
You can experiment with different values of h.

```
20  ptsE=eulers_method((x^3)*e^(-2*x)-2*y,0,1,h,1-h,algorithm="none")
21
22  P1 = list_plot(ptsRK)
23  P2 = line(ptsRK)
24
25  P5 = list_plot(ptsE)
26  P4 = line(ptsE)
27
28  (P1+P2+P3+P4+P5).show()
```

Evaluate

h 0.1000

/home/sc_serv/sagecell/interact_sagecell.py:428: Dep
arguments is deprecated and will be removed from a f
EXPR(x=..., y=...) See http://trac.sagemath.org/5930



XIMERA Get Help Saved! Erase Edit

Example 2. An object with temperature 72°F is placed outside, where the temperature is −20°F. At 11:05 the temperature of the object is 60°F and at 11:07 its temperature is 50°F. At what time was the object placed outside?

Explanation. Let $T(t)$ be the temperature of the object at time t. For convenience, we choose the origin $t_0 = 0$ of the time scale to be 11:05 so that $T_0 = 60$. We must determine the time τ when $T(\tau) = 72$. Substituting $T_0 = 60$ and $T_m = -20$ into (2) yields

Reveal Hint

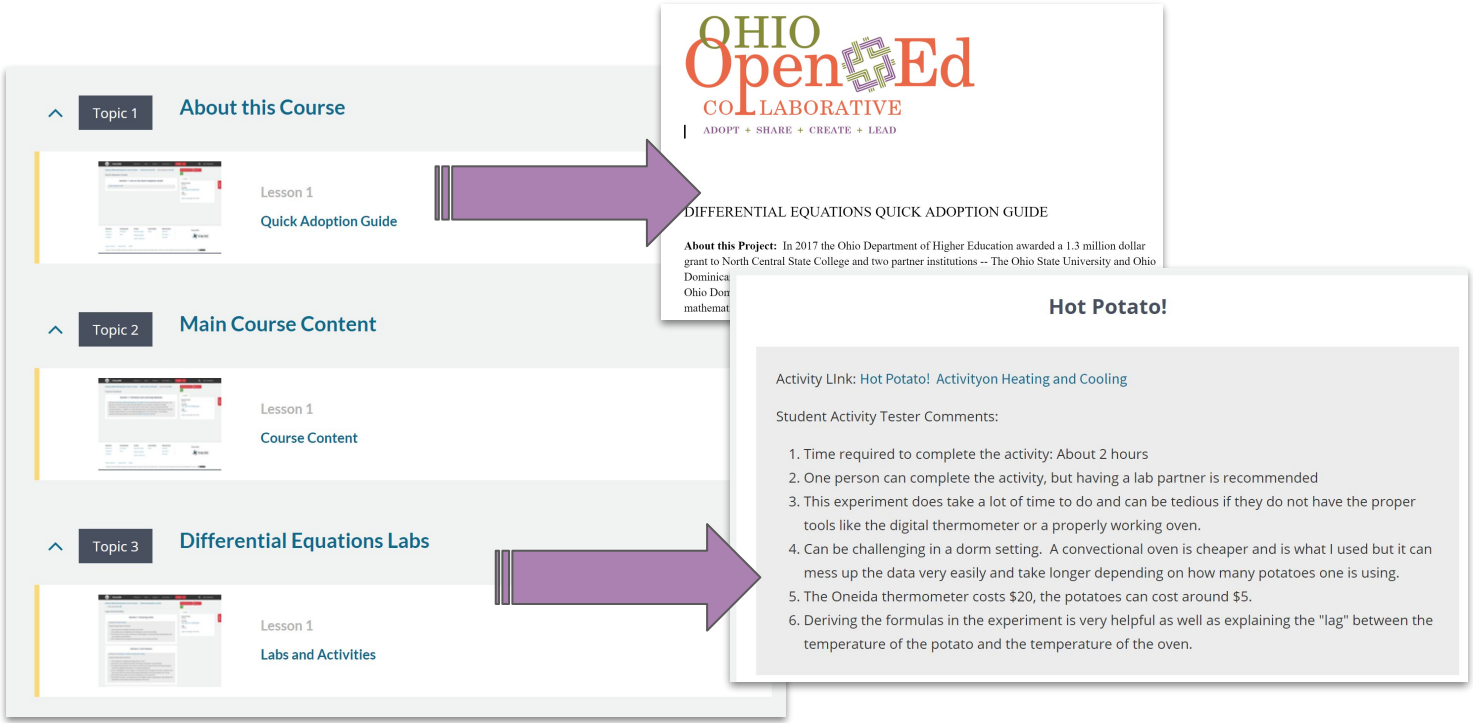
$$T = \square? + \left(\square? - \square? \right) e^{-kt}$$

or

$$T = \square? + \square? e^{-kt}. \qquad (4)$$

Where to find Our Ohio OER on ODE

OhioLINK OER Commons: https://ohiolink.oercommons.org/courseware/19



Using our OER in Your Course

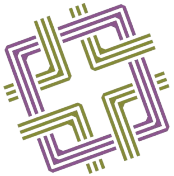
Adaptable to many different modalities

- Large lectures or small classrooms
- Inverted models
- Online or hybrid courses

Contains interactive elements to promote active reading

- Exercises to complete
- Sage cells
- Desmos interactives

Has been paired with MyOpenMath for exercises that can be graded online.



Interactive Elements in our OER

Exercises to complete

Question 1. Consider the solution y to the differential equation $y' = x + y$ which passes through the point $(1, -2)$. What is the slope of the tangent line to solution y at $x = 1$? The slope of y at $x = 1$ is ? .

Reveal Hint

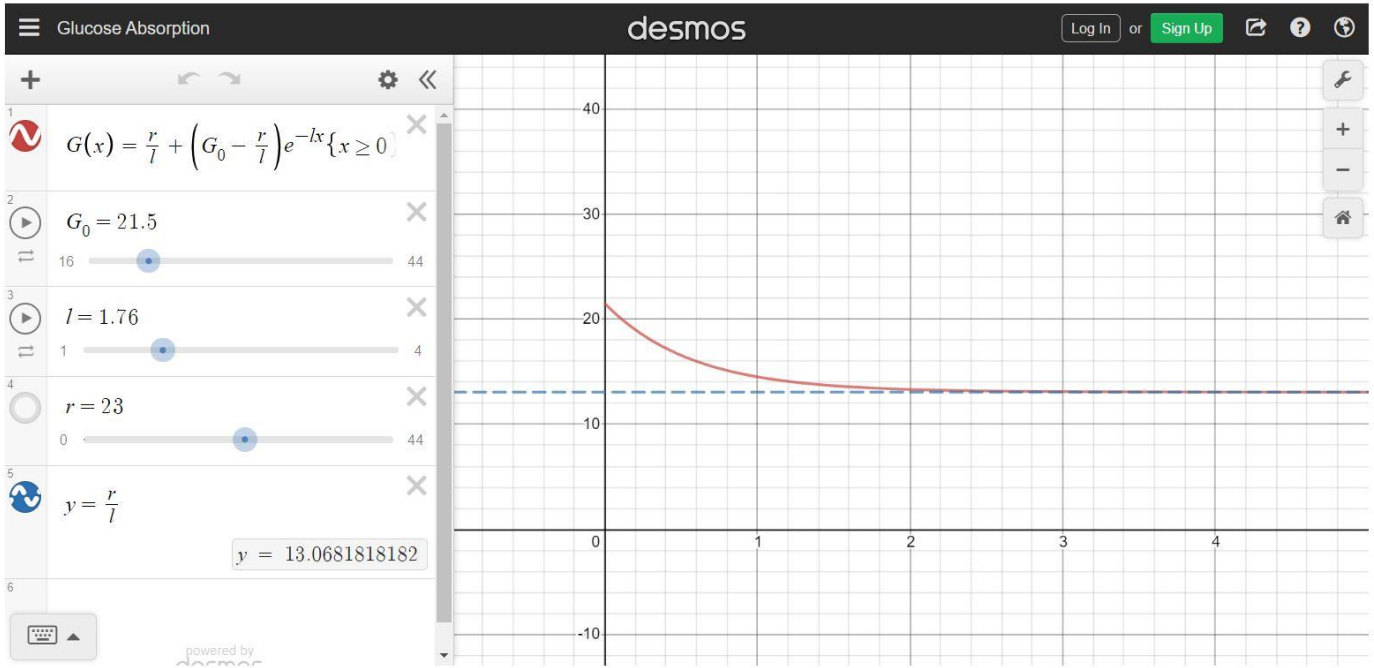
Sage cells

```
@interact
def _(a=input_box(1, width=5),b=input_box(1, width=5)):
    x,y=var('x,y')
    v=plot_slope_field(x+y,(x,-5,5),(y,-5,5),headaxislength=3, headlength=3)
    c=(b+a+1)/(e^a)
    d=plot(c*e^x-x-1,(x,-5,1.5))
    p=point((a,b),rgbcolor=hue(1))
    show(v+d+p)
```

Evaluate

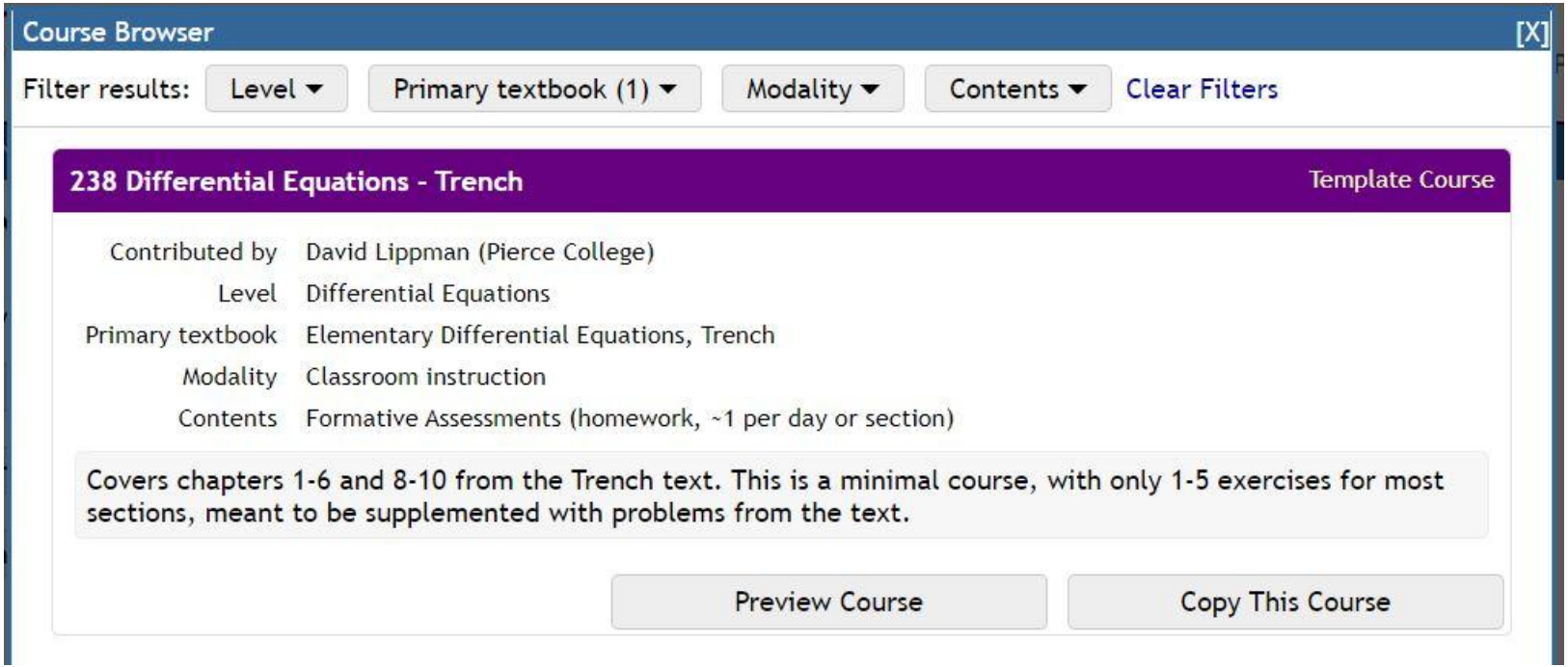
Interactive Elements in our OER

Desmos interactives



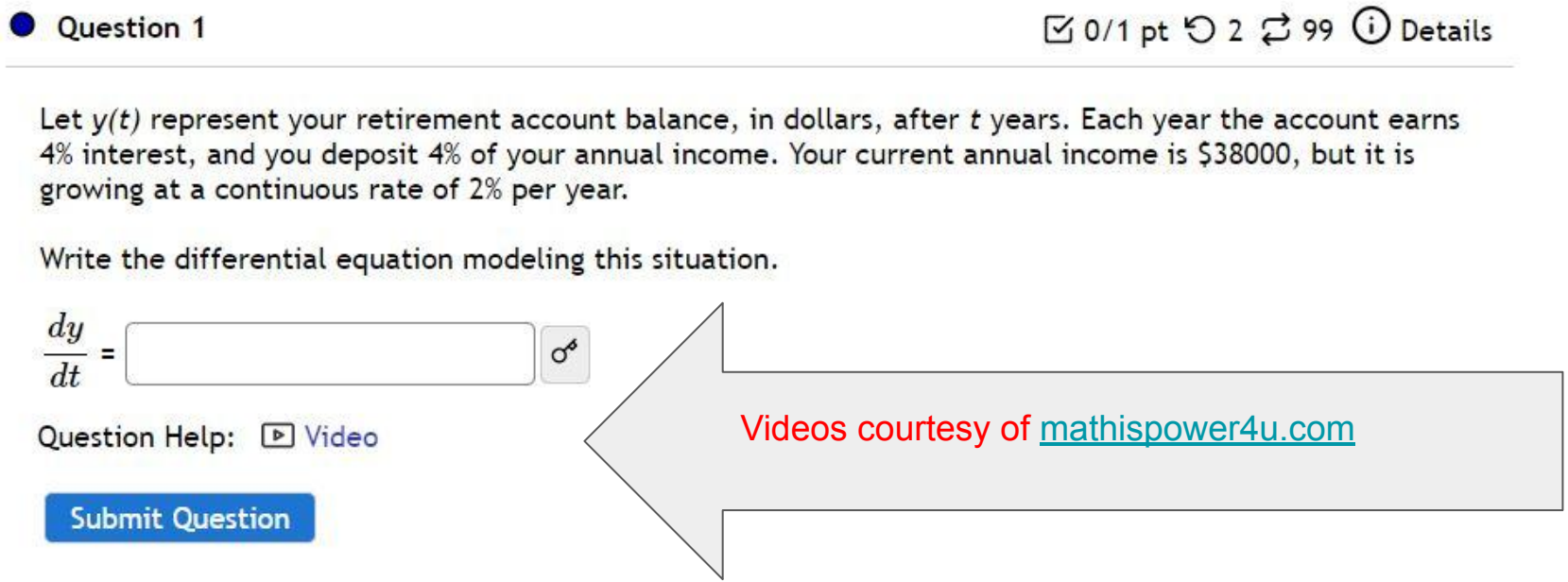
Using MyOpenMath with our OER

Thank you David Lippman of Pierce College!

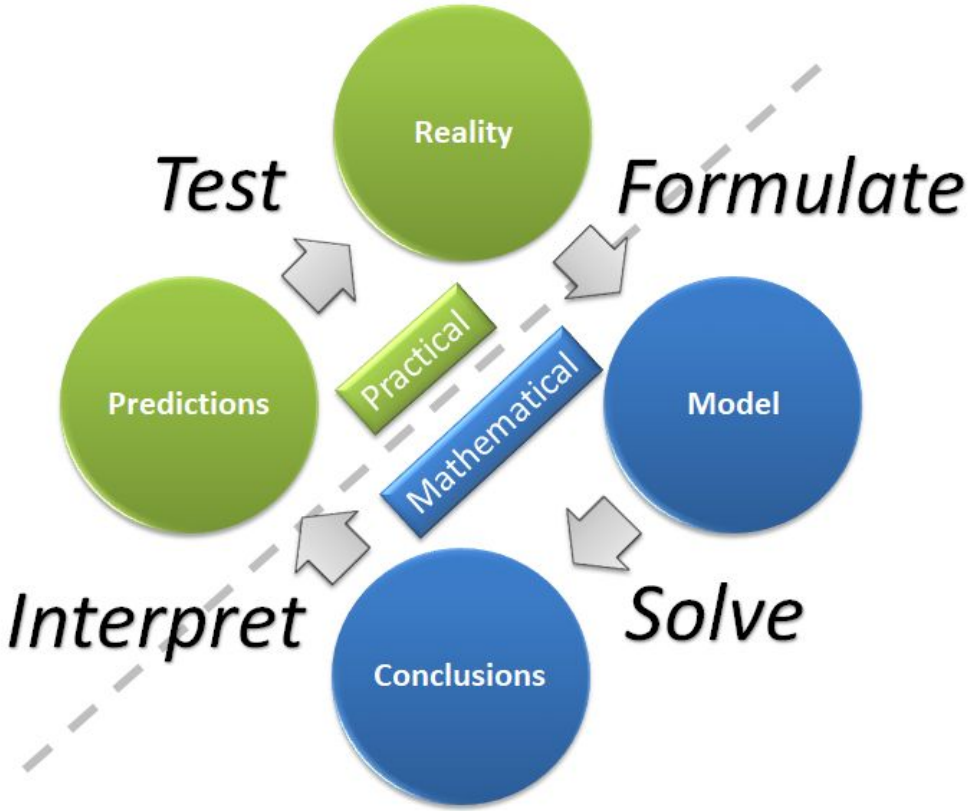


Using MyOpenMath with our OER

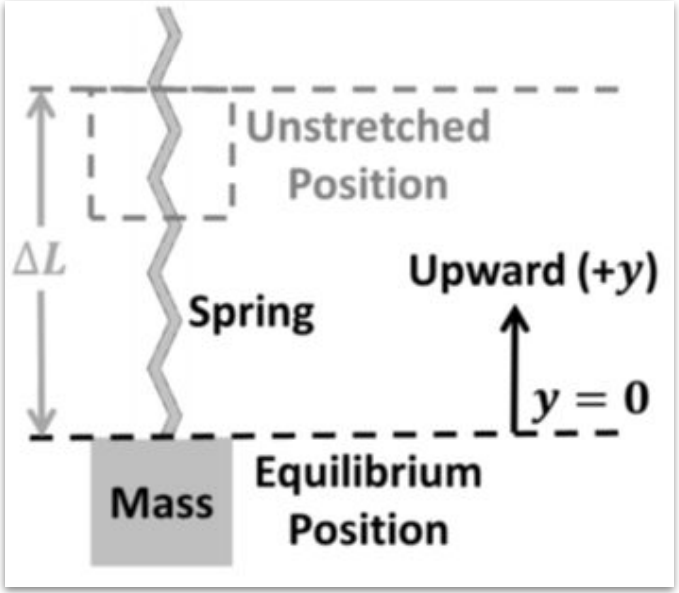
Assignments include video links, practice mode, other features

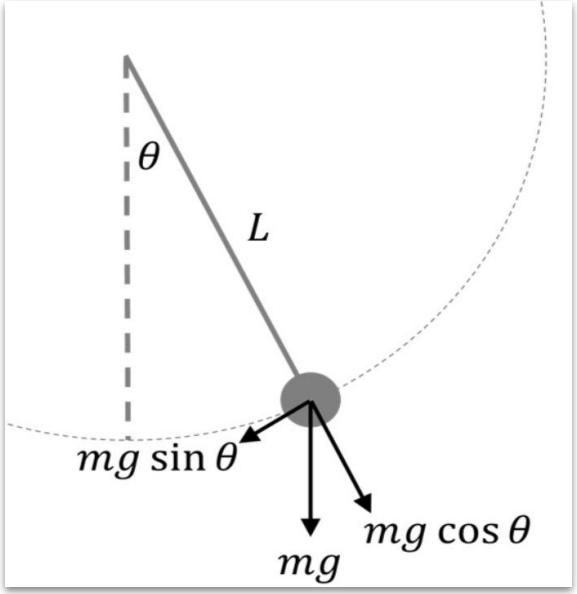


Modeling Applications



Modeling Applications



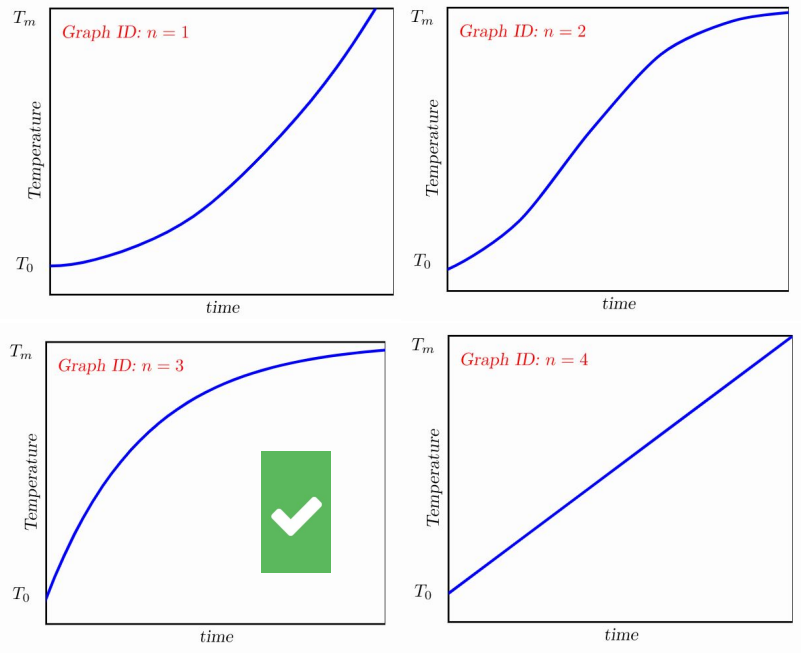


Hot Potato

$$\frac{dT}{dt} = -k(T - T_m)$$

[Activity on Ximera]

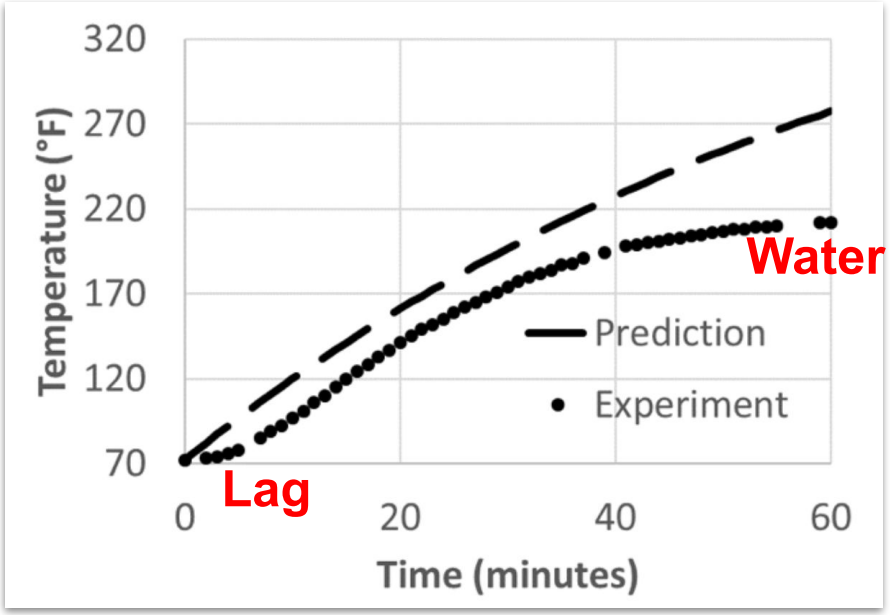
$$T = T_m - (T_m - T_0)e^{-kt}$$

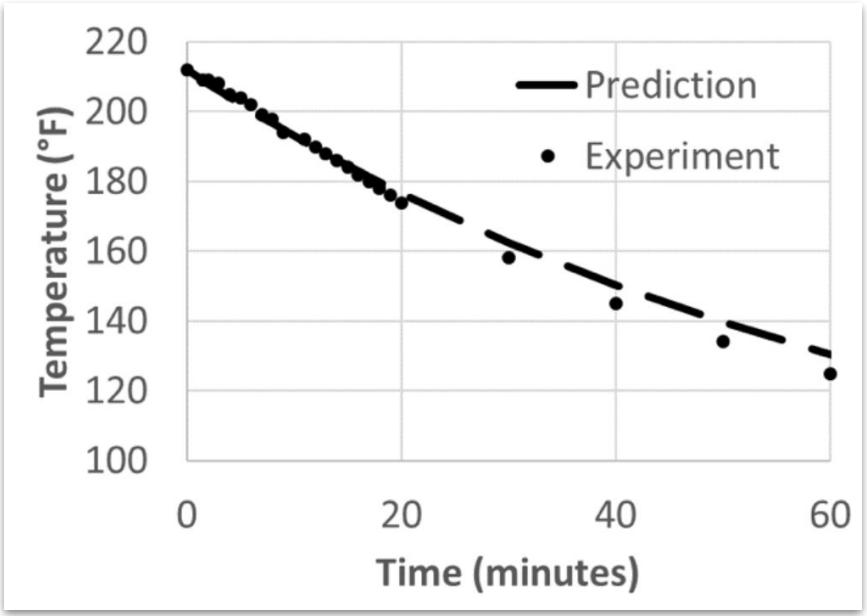


Heat in Oven at 425 °F for One Hour. Estimate decay constant, k.

Remove and cool, undisturbed. Predict time to cool to 180 °F.

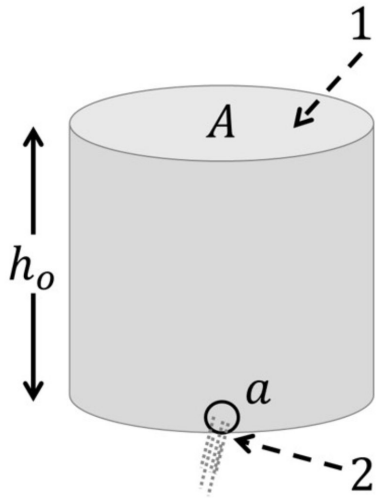
Hot Potato

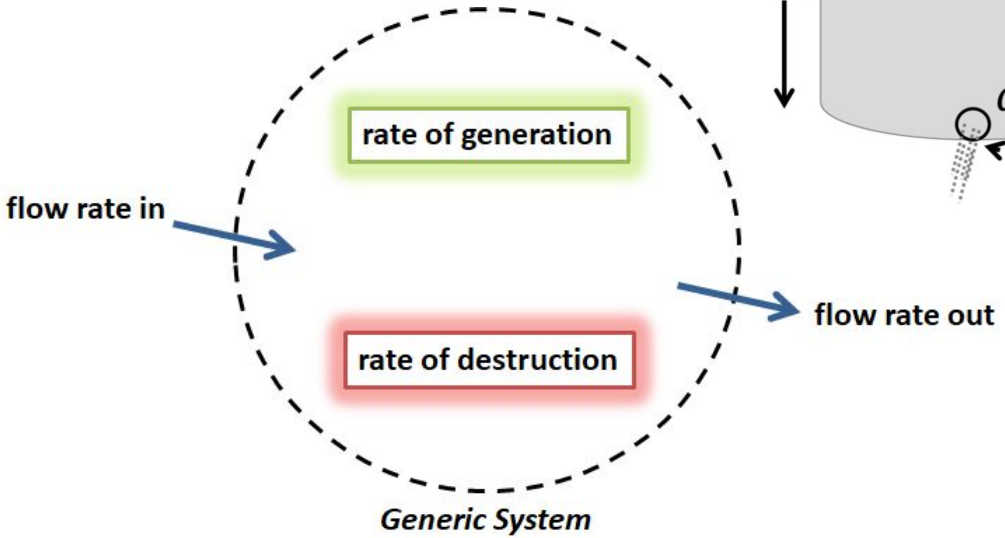

320
270
220
170
120
70
Temperature (°F)
0
20
40
60
Time (minutes)
Prediction
Experiment
Lag
Water b.p.


220
200
180
160
140
120
100
Temperature (°F)
0
20
40
60
Time (minutes)
Prediction
Experiment

Tank Draining

[Activity on Ximera]





flow rate in – flow rate out + rate of generation – rate of destruction = rate of accumulation

the shorter version:

in – out + gen – dest = accum

$$\frac{dh}{dt} = -k\sqrt{h}$$

$$k = \frac{a}{A}\sqrt{2g}$$

$$h = \left(\sqrt{h_0} - \frac{kt}{2}\right)^2$$

$$t_f = \frac{2\sqrt{h_0}}{k}$$

Tank Draining

Acknowledgements

- Christian Labrador and Emi Arima (our reviewers)
- Daniel Dotson (our librarian)
- Jim Fowler and Bart Snapp (XIMERA)
- Ohio Department of Higher Education
- William F. Trench, for giving us a great textbook as a starting point

Thank you, Brian Winkel, for the invitation to present here today!