



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:



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

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<https://digitalcommons.trinity.edu/mono/8/>

XIMERA

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



Why XIMERA?

XIMERA Get Help

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 .

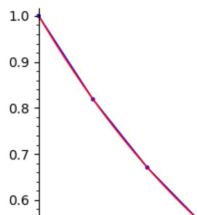
```

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
 EXP(x=..., y=...) See <http://trac.sagemath.org/5930>



XIMERA Get Help

The following dynamic interactive will help you visualize the curves.

XIMERA Get Help

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

+ - e^{-kt}

or

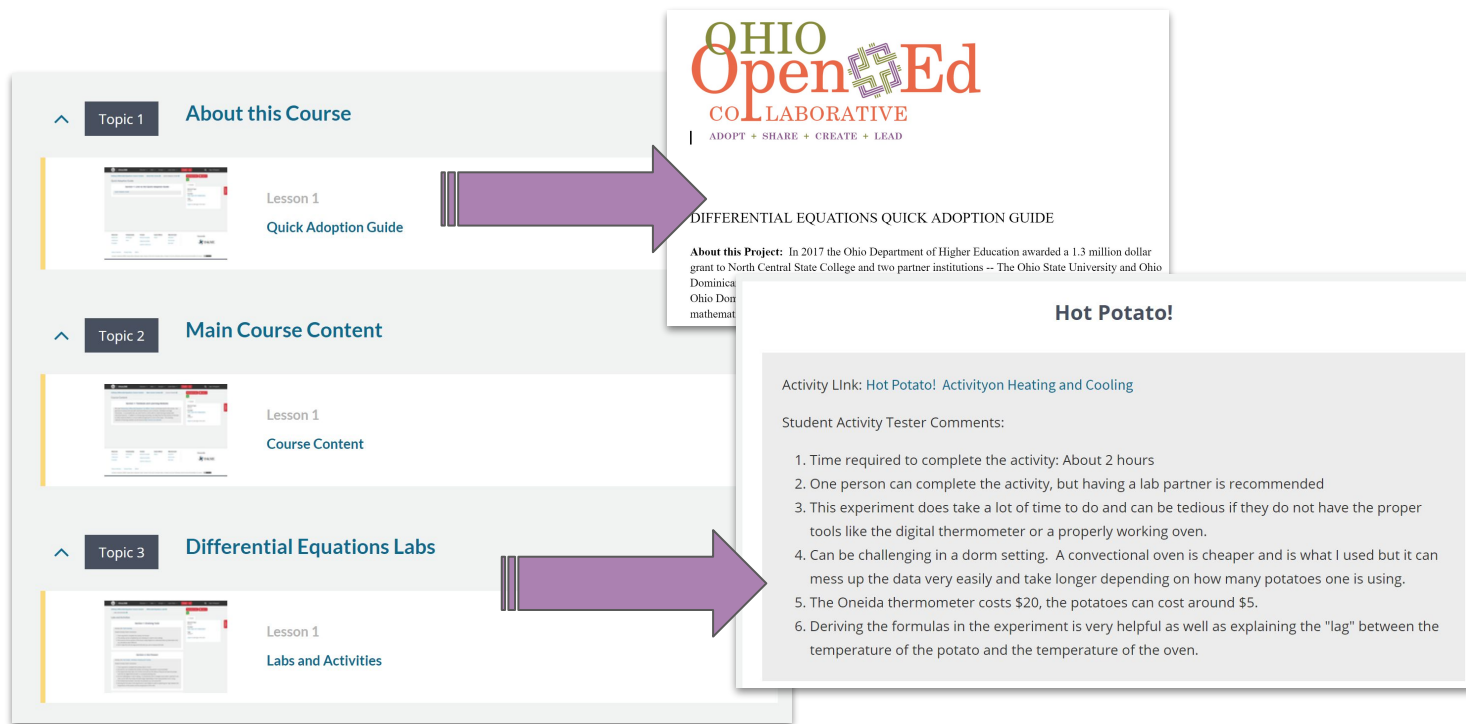
+ e^{-kt} .

(4)



Where to find Our Ohio OER on ODE

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



The image shows a screenshot of the Ohio OpenEd Collaborative courseware interface. It features three main sections: 'Topic 1 About this Course', 'Topic 2 Main Course Content', and 'Topic 3 Differential Equations Labs'. Arrows point from specific content within these sections to detailed views of that content.

Topic 1 About this Course

Lesson 1
Quick Adoption Guide

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DIFFERENTIAL EQUATIONS QUICK ADOPTION GUIDE

About this Project: In 2017 the Ohio Department of Higher Education awarded a 1.3 million dollar grant to North Central State College and two partner institutions -- The Ohio State University and Ohio Dominican University to develop and implement a new mathematics curriculum for Ohio's community colleges.

Topic 2 Main Course Content

Lesson 1
Course Content

Hot Potato!

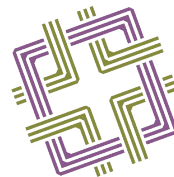
Activity Link: [Hot Potato! Activity on Heating and Cooling](#)

Student Activity Tester Comments:

1. Time required to complete the activity: About 2 hours
2. One person can complete the activity, but having a lab partner is recommended
3. This experiment does take a lot of time to do and can be tedious if they do not have the proper tools like the digital thermometer or a properly working oven.
4. Can be challenging in a dorm setting. A convectional oven is cheaper and is what I used but it can mess up the data very easily and take longer depending on how many potatoes one is using.
5. The Oneida thermometer costs \$20, the potatoes can cost around \$5.
6. Deriving the formulas in the experiment is very helpful as well as explaining the "lag" between the temperature of the potato and the temperature of the oven.

Topic 3 Differential Equations Labs

Lesson 1
Labs and Activities



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 ?.

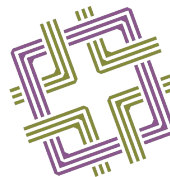
 Reveal Hint

Sage cells

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

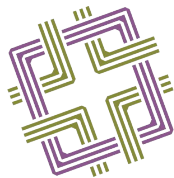


Evaluate



Interactive Elements in our OER

Desmos interactives



Using MyOpenMath with our OER

Thank you David Lippman of Pierce College!

Course Browser [X]

Filter results: Level ▼ Primary textbook (1) ▼ Modality ▼ Contents ▼ [Clear Filters](#)

238 Differential Equations - Trench

Template Course

Contributed by David Lippman (Pierce College)

Level Differential Equations

Primary textbook Elementary Differential Equations, Trench

Modality Classroom instruction

Contents Formative Assessments (homework, ~1 per day or section)

Covers chapters 1-6 and 8-10 from the Trench text. This is a minimal course, with only 1-5 exercises for most sections, meant to be supplemented with problems from the text.

Preview Course

Copy This Course



Using MyOpenMath with our OER

Assignments include video links, practice mode, other features

● Question 1

✓ 0/1 pt ↺ 2 ↻ 99 ⓘ Details

Let $y(t)$ represent your retirement account balance, in dollars, after t years. Each year the account earns 4% interest, and you deposit 4% of your annual income. Your current annual income is \$38000, but it is growing at a continuous rate of 2% per year.

Write the differential equation modeling this situation.

$$\frac{dy}{dt} = \text{[input box]} \quad \text{[key icon]}$$

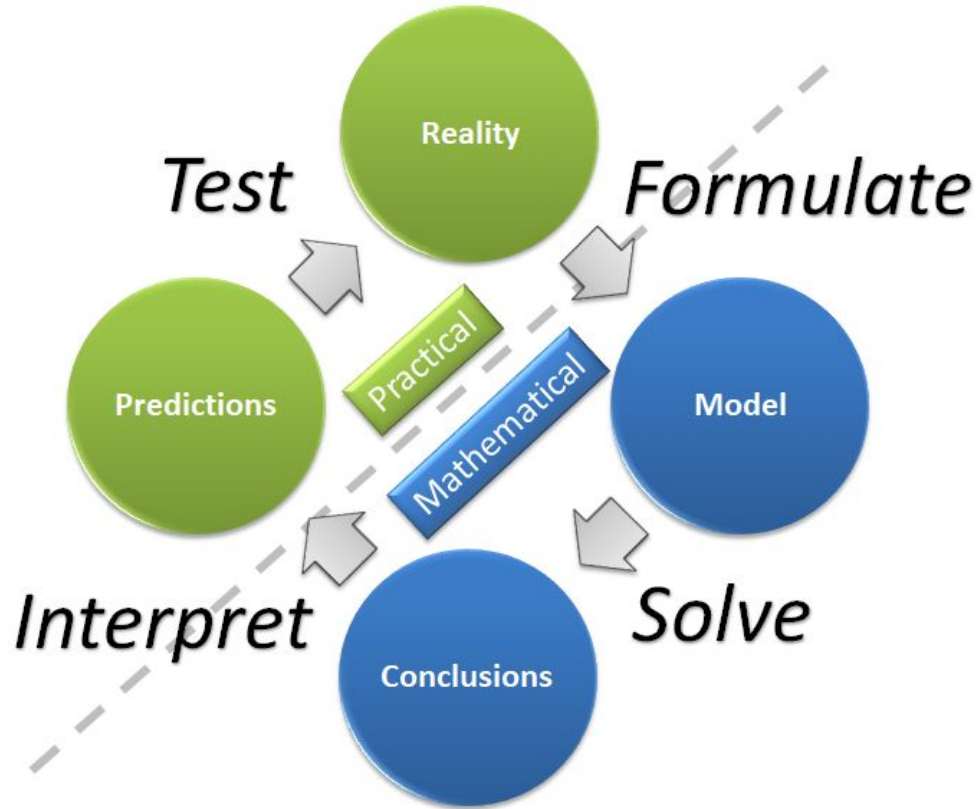
Question Help:  Video

Submit Question

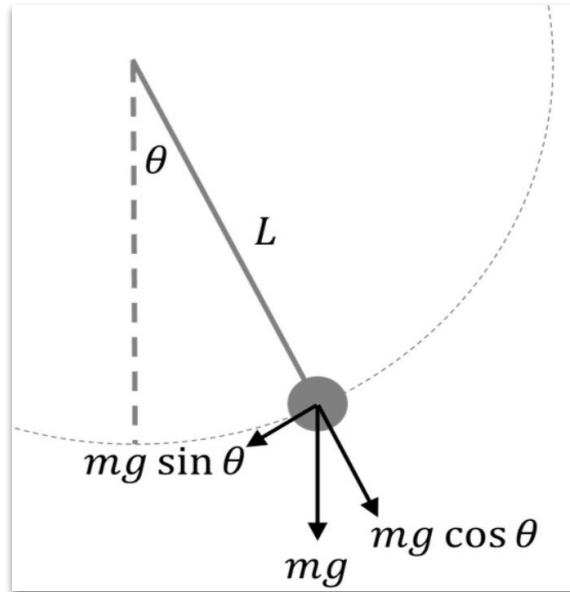
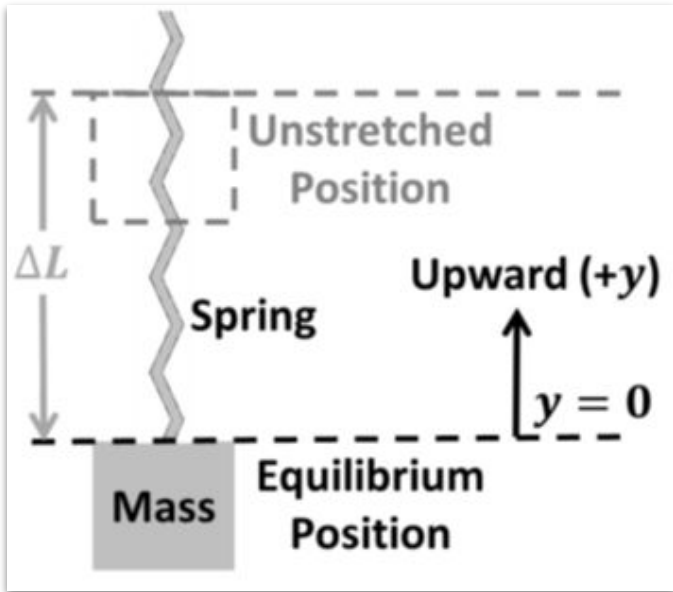
Videos courtesy of mathispower4u.com



Modeling Applications



Modeling Applications

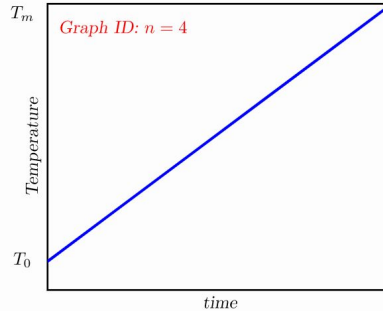
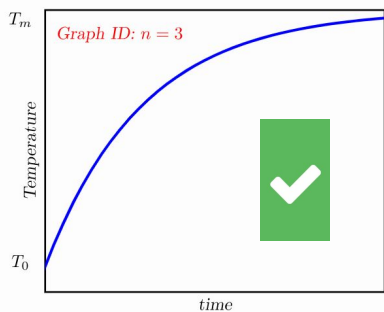
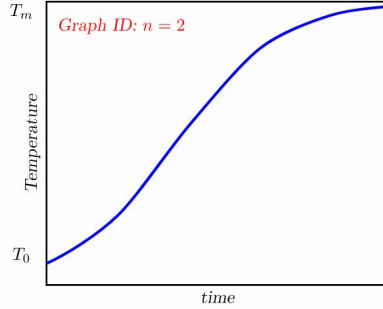
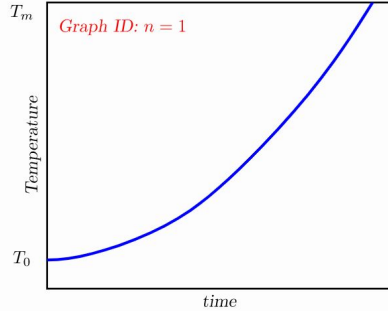


Hot Potato

Activity on Ximera

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

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

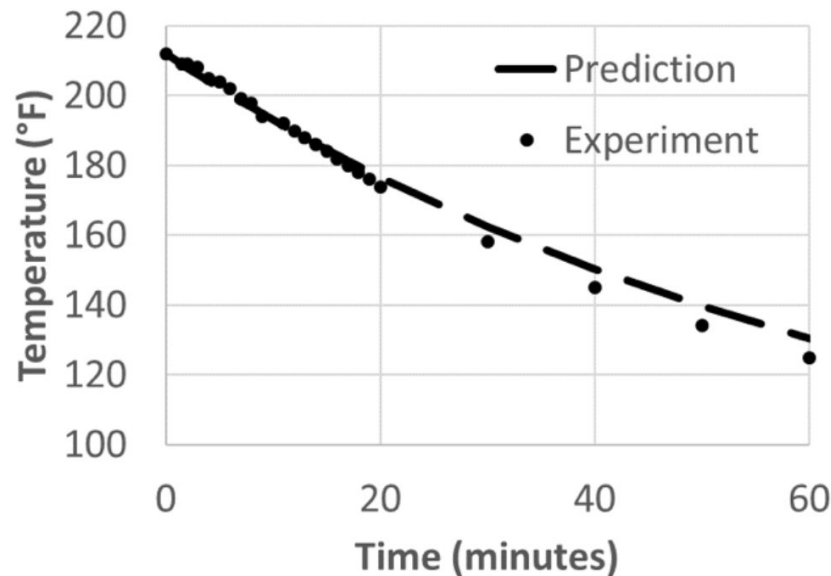
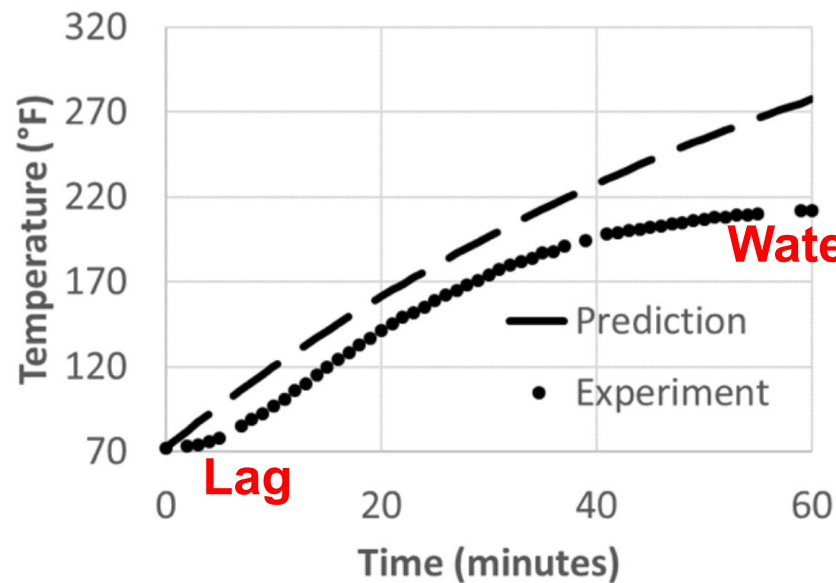


Heat in Oven at 425 °F
for One Hour. Estimate
decay constant, k .

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

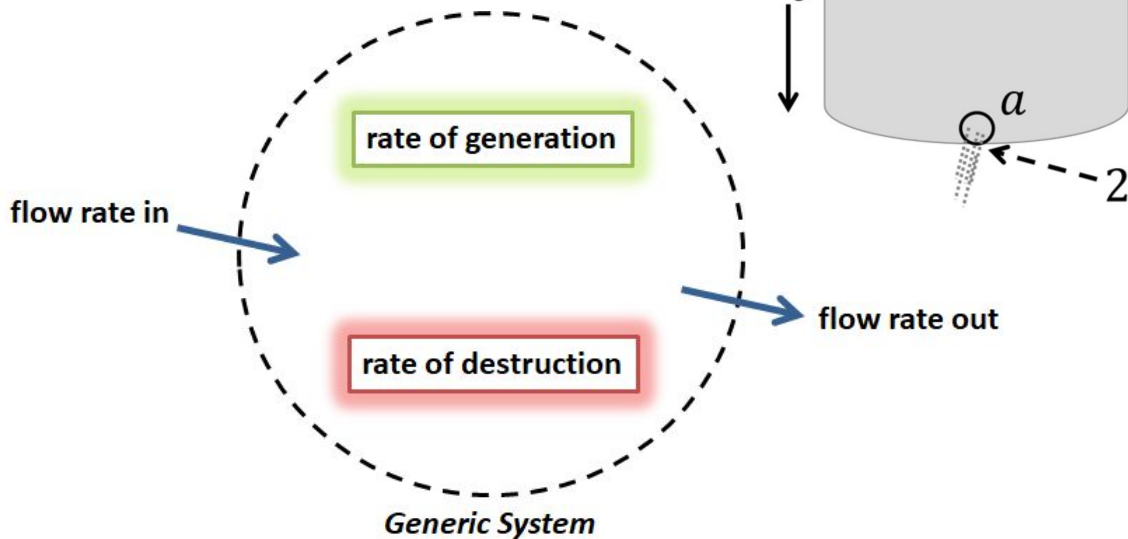


Hot Potato



Tank Draining

[Activity on Ximera](#)



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

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

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

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

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

the shorter version:

$$\text{in} - \text{out} + \text{gen} - \text{dest} = \text{accum}$$



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!

