T^3 Workshop
Derivatives, Slope Fields *and more*

Bekki George
bekki@math.uh.edu

AP Calculus Resource Site

http://online.math.uh.edu/apcalculus/

Over 40 Online Quizzes and AP Practices Exams

http://www.estudy.uh.edu/

Derivatives

- The TI calculators do not differentiate in symbols, they can only find derivatives at a point.
- `nDeriv(function, variable, value, [h])`

nDeriv

- This functions uses the numeric approximation:

$$\frac{f(x+h)-f(x-h)}{2h}$$

- `nDeriv(function, variable, value, [h])`
- h is the step size used in the approximation of the derivative.
- The default value of h is 0.001

Checking Solutions

- We can use nDeriv to check symbolic solutions graphically.
- Here's how:
  - find f'(x) for some function
  - graph your answer along side y1=nDeriv(f(x),x,x)
- Let's try some…

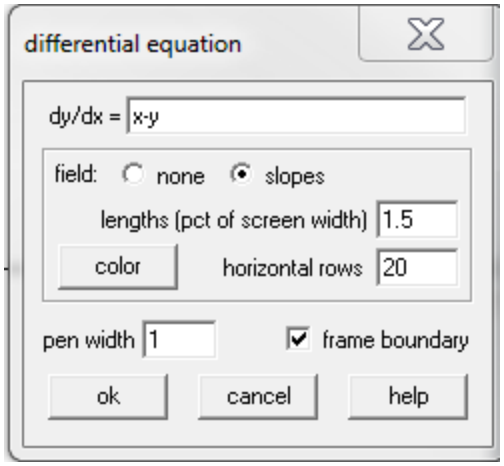
Slope Fields

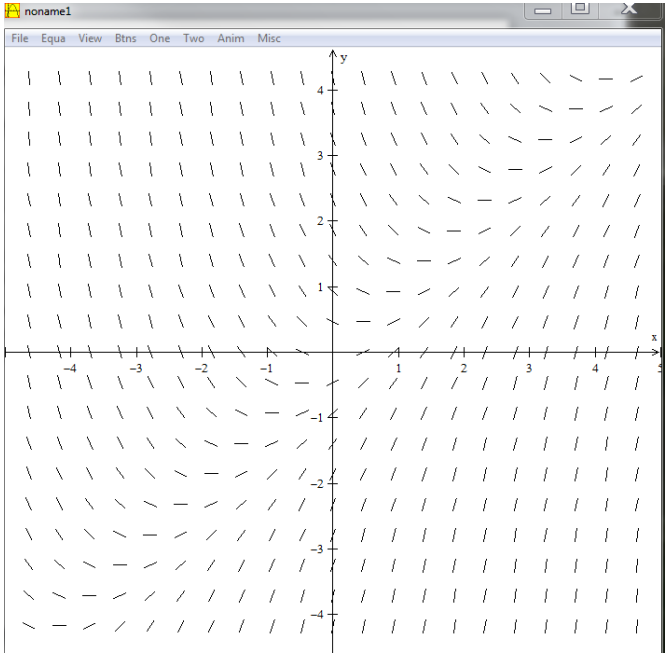
From the AB outline, students should be able to

- Give a geometric interpretation of differential equations via slope fields and the relationship between slope fields and solution curves for differential equations.
- Draw a slope field by hand.
  - Sketch a particular solution on a (given) slope field.
  - Interpret a slope field.

Creating Slope Fields for handouts using Winplot

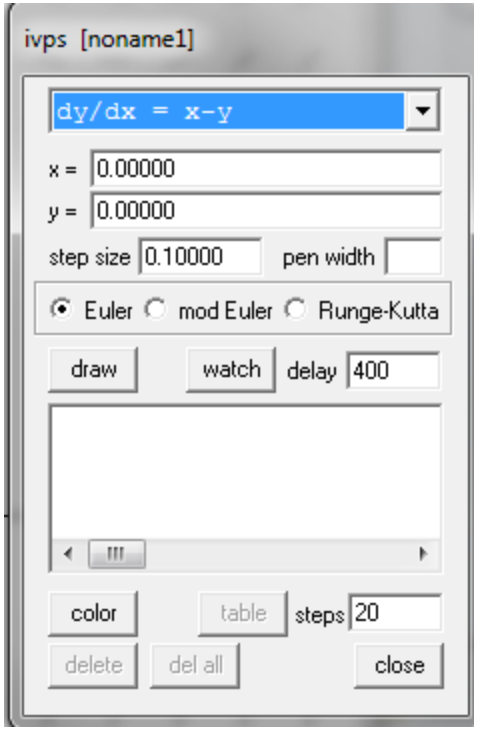
Equation->Differential->dy/dx=





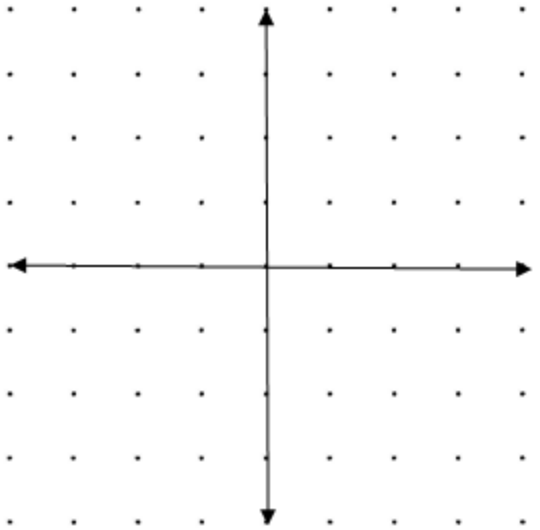
Now choose One->Initial Value Problem

Pick your x and y values then select draw:



Slope Fields – an Introduction

Intro Activity



Give all students a small square cut from an overhead transparency with a dot on it. The dots will each represent a coordinate point. Then give the class a problem such as $\frac{dy}{dx} = x^2$ or $\frac{dy}{dx} = x^3$ and talk about what this means (slope of tangent line at the point).

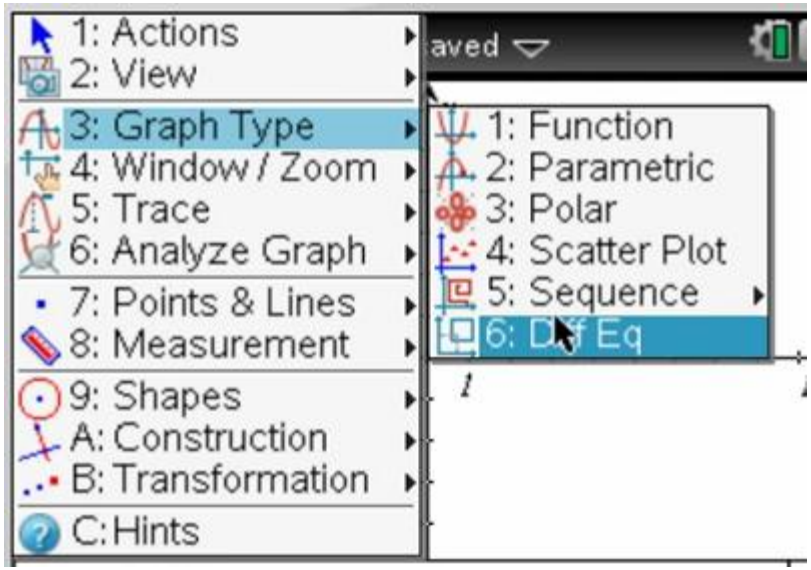
Have them each draw small tangent lines and come place on the overhead.

Expand to more difficult differential equations (some they cannot integrate easily).

Slope Fields on the TI

- The TI-83 family, TI-84 Plus family and TI-Nspire in TI-84 Plus Mode do not have the ability to graph Slope Fields.
- The TI-89, TI-Nspire and TI-Nspire CAS have the capability to draw slope fields.

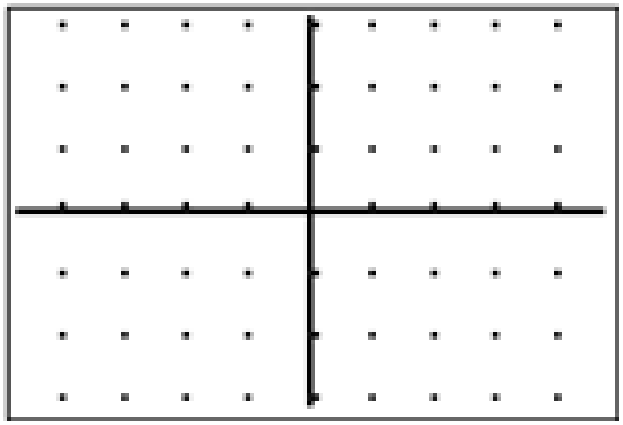
TI-Nspire


1: Actions
2: View
3: Graph Type
4: Window / Zoom
5: Trace
6: Analyze Graph
7: Points & Lines
8: Measurement
9: Shapes
A: Construction
B: Transformation
C: Hints
aved
1: Function
2: Parametric
3: Polar
4: Scatter Plot
5: Sequence
6: Diff Eq

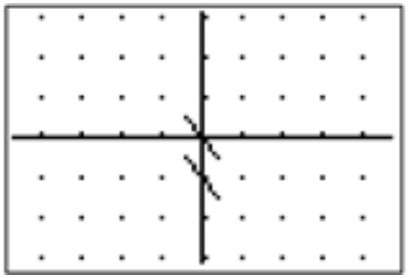
TI-83/84

- There are many programs that can be downloaded for the 83 and 84 to help draw slope fields.
- Here is the long way to do it…..

First turn GridOn



Now draw the segments



If you are already in Graph, you can arrow up/down/left/right to select the start and end of your line segments.

Sample Questions for **Calculus AB: Section II**

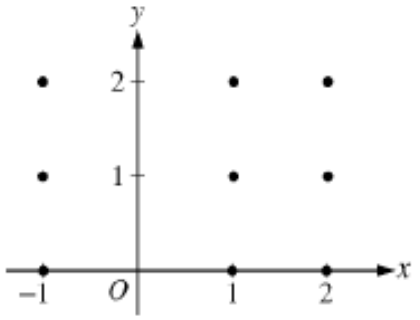
Question 5

Consider the differential equation $\frac{dy}{dx} = \frac{y-1}{x^2}$, where $x \neq 0$.

(a) On the axes provided, sketch a slope field for the given differential equation at the nine points indicated.
(Note: Use the axes provided in the exam booklet.)

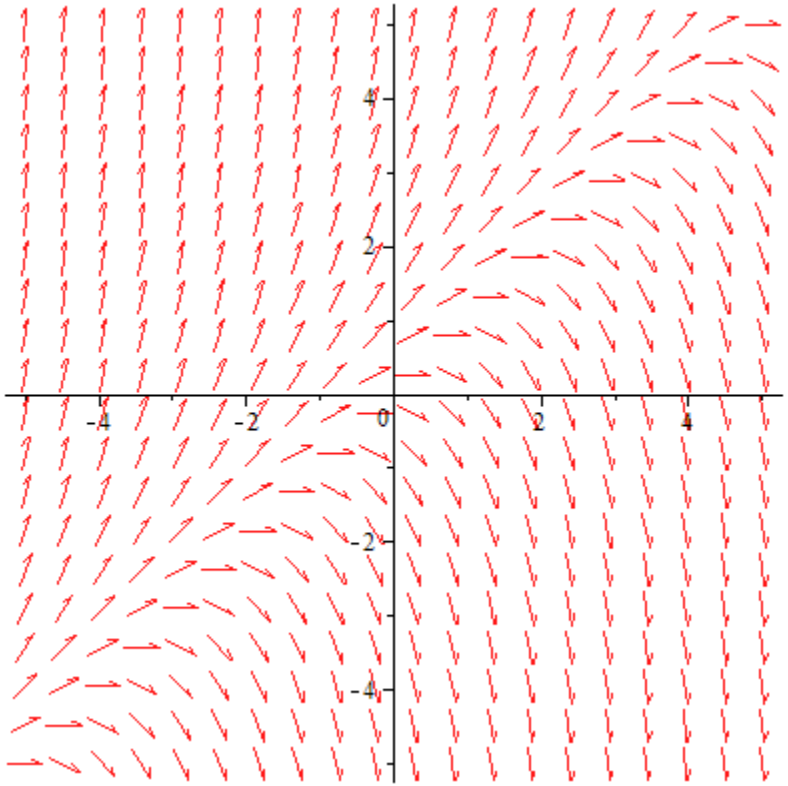
(b) Find the particular solution $y = f(x)$ to the differential equation with the initial condition $f(2) = 0$.

(c) For the particular solution $y = f(x)$ described in part (b), find $\lim_{x \to \infty} f(x)$.



Some More Problems:

Which of the following differential equations has the following slope field?



a) $\frac{dy}{dx} = \ln(y)$

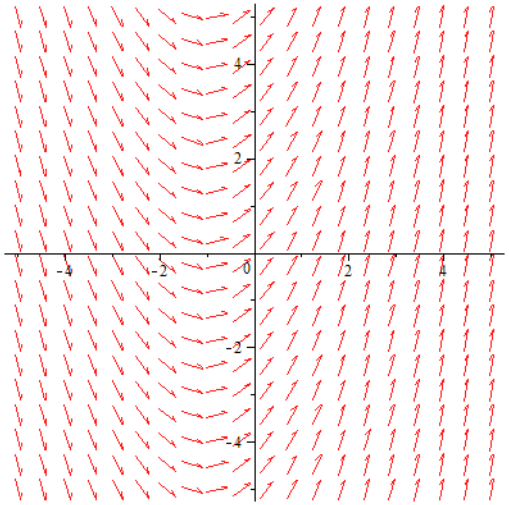
b) $\frac{dy}{dx} = x^2$

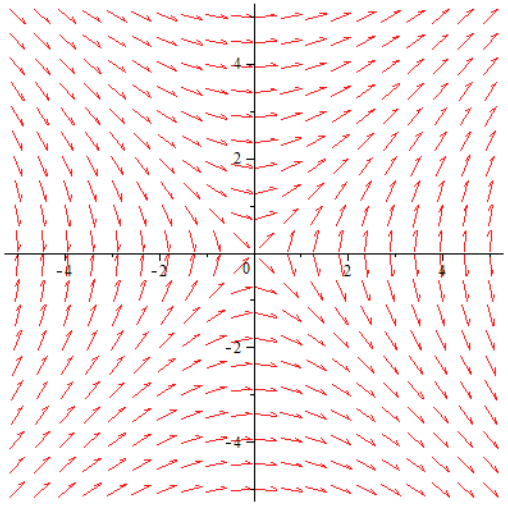
c) $\frac{dy}{dx} = y - x$

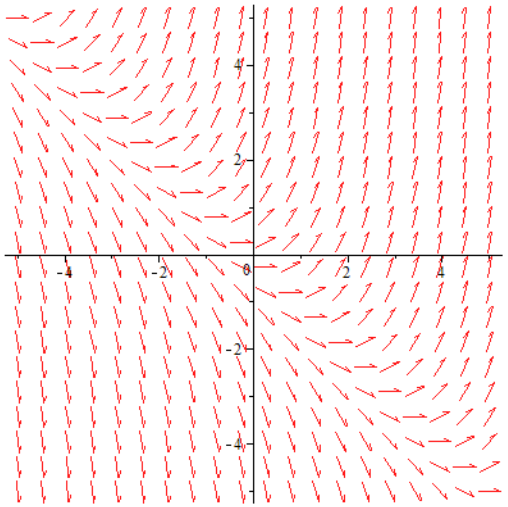
d) $\frac{dy}{dx} = \frac{x}{y}$

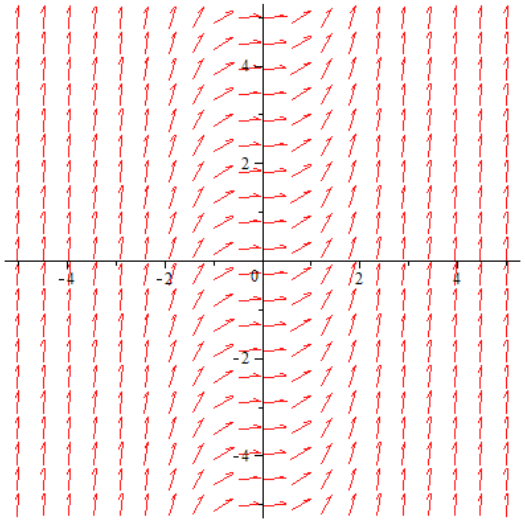
e) $\frac{dy}{dx} = x + 1$

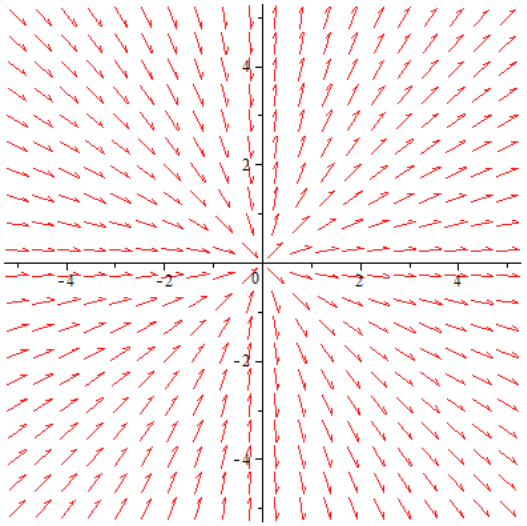
Which of the following is a slope field for the given differential equation? $\frac{dy}{dx} = \frac{x}{y}$



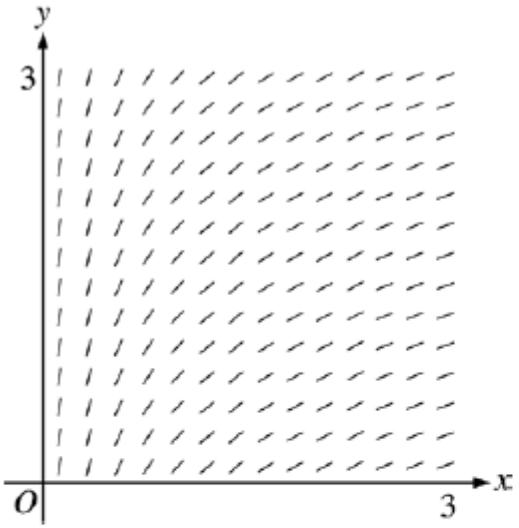








From Sample AP* exam



The slope field for a certain differential equation is shown above. Which of the following could be a specific solution to that differential equation?

(A) $y = x^2$
(B) $y = e^x$
(C) $y = e^{-x}$
(D) $y = \cos x$
(E) $y = \ln x$