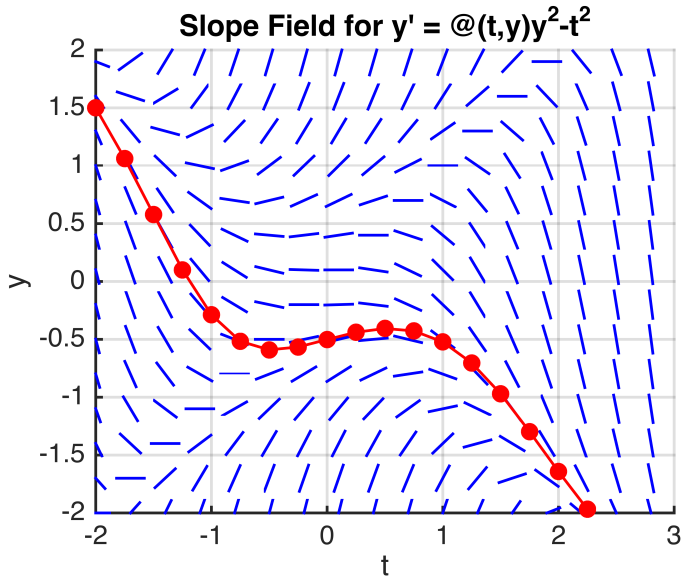
UBC MECH 221: MATLAB Computer Lab 2

Slope fields and Euler's method




```
>> f = @(t,y) y^2 - t^2;
>> slope_field_euler(f,[-2,3],[-2,2],0.3,1.5,0.25)
```

Instructions

Write a function called `slope_field_euler` with 6 input parameters:

```
function slope_field_euler(f,tspan,yspan,grid_step,y0,time_step)
% Plot the slope field of the first order differential equation y' = f(t,y)
% and plot an approximate solution using Euler's method
```

where:

`f` is a function handle defining the right side of a differential equation $y' = f(t, y)$

`tspan` is an array of length 2 defining the t limits of the plot

`yspan` is an array of length 2 defining the y limits of the plot

`grid_step` is a number defining the space between grid points where slope lines are plotted

`y0` is a number defining initial condition $y(t_0) = y_0$ where t_0 is `tspan(1)`

`time_step` is a number defining the time step used in Euler's method

The function should perform the following tasks:

- ☐ Plot the slope field of the differential equation $y' = f(t, y)$:
  - ☐ Create an array `t` of t values from `tspan(1)` to `tspan(2)` and incremented by `grid_step`
  - ☐ Create an array `y` of y values from `yspan(1)` to `yspan(2)` and incremented by `grid_step`
  - ☐ Write nested for loops to plot a line of slope $f(t, y)$ at each point (t, y) in the grid defined by the arrays `t` and `y`
  - ☐ Do **not** use the MATLAB function `quiver`
- ☐ In the same figure as the slope field, plot an approximate solution using Euler's method:
  - ☐ Create an array `T` of t values from `tspan(1)` to `tspan(2)` and incremented by `time_step`
  - ☐ Loop over `T` to compute an array `Y` of y values using Euler's method

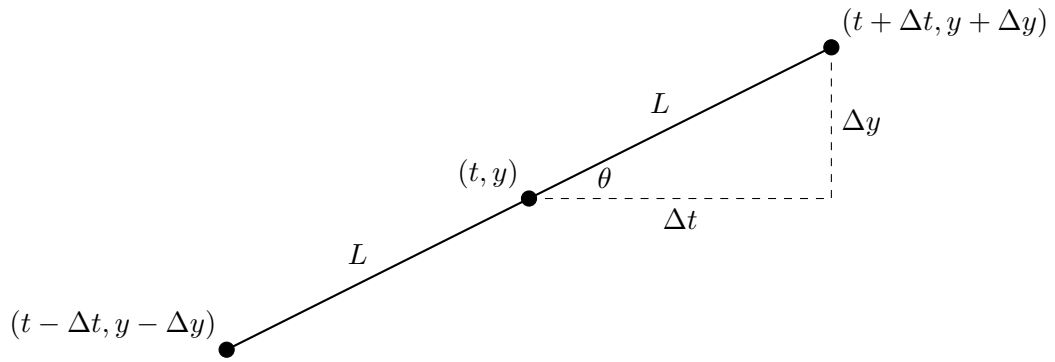
    $$y_{n+1} = y_n + f(t_n, y_n) \cdot h$$

    where h is the `time_step` and the intial value y_0 is given by `y0`.
  - ☐ Plot the approximate solution in the same figure as the slope field. It is possible that the solution will go beyond the y limits of the plot and so the Euler's method computation should stop if y_n is outside the interval `yspan`.
- ☐ Add style to your plot such as a title and labels.
- ☐ Include comments at the beginning of your function to describe its purpose and inputs and **include your name and student number**, and include comments in the body of the function to explain your code.

When you have completed each item above and are satisfied with your function, submit your M-file (called `slope_field_euler.m`) to Connect.

Hints

To plot a straight line of length $2L$ and slope m in the ty-plane centred at (t, y), consider the picture



where $\Delta t = L\cos\theta$ and $\Delta y = L\sin\theta$ such that $\theta = \arctan m$.