MATH 3341 — Fall 2021

Lab 14: Built-in ODE Solvers in MATLAB

If you haven't downloaded and unzipped `Math.3341.zip`. Download and unzip it under `H:` (H Drive if you are working on the Remote Lab). Change the current working directory by typing `cd H:\Math.3341\Math.3341.Lab.14` in the Command Window, and type `edit lab_14_script` in the Command Window to edit `lab_14_script.m`.

1 Direction Fields and Solution Curves

Given the following ODE and the initial condition,

$$\frac{dy}{dt} = -y - 5e^{-t}\sin(5t), \quad y(0) = -2, \quad t \in [0, 3].$$

(a) Define anoymous function `dydt` to be the right-hand side of the ODE.

(b) Define `a`, `b` to be the left and right endpoint of the interval $[0, 3]$, respectively.

(c) Define `t_step` to be the step size $\Delta t = 0.01$.

(d) Define `t_span` to be a vector starting from `a` to `b` with step size `t_step` using colon notation.

(e) Use `ode23` to solve the ODE.

(f) Plot `y_sol(:, i)` versus `t_sol(:, i)` with line style specified in the cell array `LineStyle`.

(g) Run the script and see whether it works. If it does work, add more initial conditions to `y0`: $y(0) = 0$, $y(0) = 2$, $y(0) = 4$.

2 System of ODEs

Next, use the built-in ODE solver `ode45` to solve the following system of ODEs:

$$\begin{cases} y_1'(t) = y_3, \\ y_2'(t) = y_4, \\ y_3'(t) = -2y_1 + (3/2)y_2, \\ y_4'(t) = (4/3)y_1 - 3y_2, \end{cases} \qquad \mathbf{y}(0) = \begin{bmatrix} -1 \\ 4 \\ 1 \\ 1 \end{bmatrix}, \quad t \in [0, 15].$$

(a) Define an anoymous function (you can refer to the example in reference page for `ode45`. To open the reference page, type `doc ode45` in the Command Window).

(b) Repeat the steps in Part 1 to define `a`, `b`, `t_step`, `t_span`, and `y0`.

(c) Use `ode45` to solve the system of ODEs.

(d) Plot `y(:, i)` versus `t` with line style specified in the cell array `LineStyle`.

(e) Plot `y(:, 3)` versus `y(:, 1)`.

At last, run the script `lab_14_script.m`. Upload the script file `lab_14_script.m`, and figure files `lab_14_figure_1.pdf`, `lab_14_figure_2.pdf`, `lab_14_figure_3.pdf` to Overleaf. Recompile, and submit the generated .pdf file on WyoCourses.

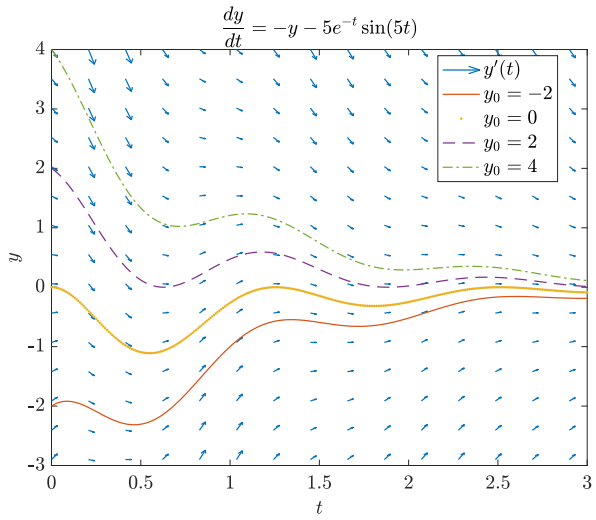

Figure 1: Expected result for Direction Fields and Solution Curves

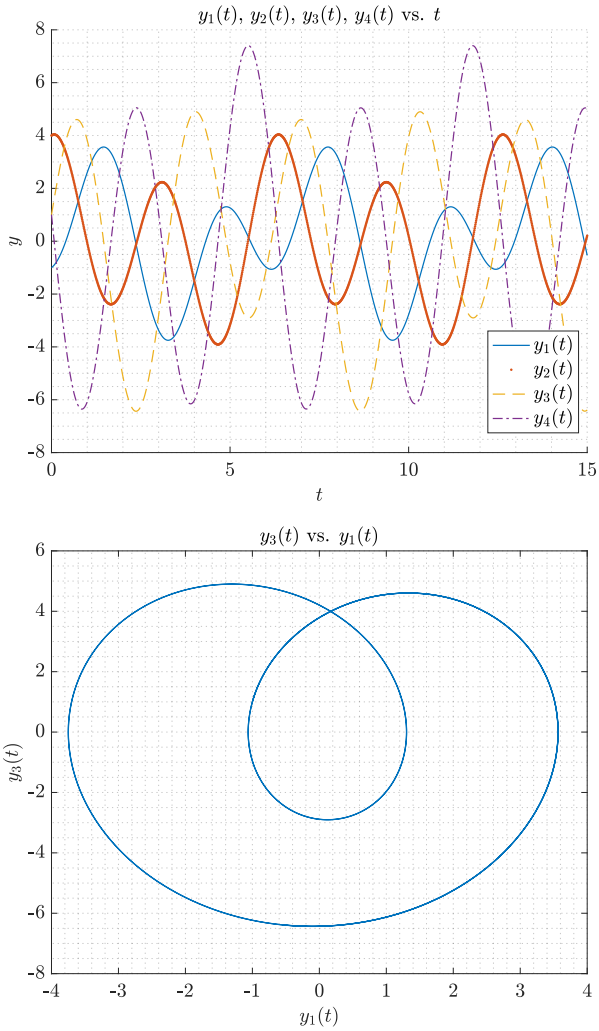

Figure 2: Expected result for System of ODEs