Imperial College London

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Department of Bioengineering

BE3-HMIB – Modelling in Biology (MiB), Prof Guy-Bart Stan & Dr Tom Ouldridge

Training coursework 5 (Optional)

A second order ODE system

Consider the second order linear ordinary differential equation

$$\frac{d^2y}{dt^2} + \eta\frac{dy}{dt} + y = 0$$

where η is a positive parameter.

1. Write the equation as a system of two first order ODEs and integrate it numerically with Matlab's `ode45`, with initial conditions $\{y(0) = 2,\ \dot{y}(0) = 10\}$ and $t \in [0, 100]$. Perform the calculation for three different dampings: $\eta = \{0, 0.03, 7\}$. Plot the three trajectories $y(t)$ as a function of time on the same figure.
2. Represent the same trajectories in phase space by plotting $\dot{y}$ as a function of y for the three different values of η.
3. Explain the difference between the cases with $\eta = 0.03$ and $\eta = 7$ in the phase plane. At what value of η does one expect to switch from one behaviour to the other?

> In this coursework you may need to use the following Matlab commands: `ode45`, `function`, `plot`, `hold`, `dsolve`. You can check the Matlab help by using `help COMMAND`.