Computational Neuroscience **(EC60007)**
Autumn 2022

Project I (17th August) Total Marks = 10 (1+3+3+3)
Due Date: 26th August (to submitted in my ECE locker by 5 pm)

Project is meant to prepare you for simulating differential equations and as practice for MATLAB based coding. By now you should have familiarized yourself with the basic syntaxes of MATLAB and how they are used.

The Van-der-Pol (VDP) equation describes a non-linear oscillator given by:

$\frac{d^2y}{dt^2} - \mu(1 - y^2)\frac{dy}{dt} + y = 0$ for $\mu > 0$.

a) Reduce the VDP equation to two first order differential equations in terms of the two state variables *y* and $\mu^{-1}\dot{y}$.

b) Write an ODE file for the system derived in a) and a MATLAB routine/script to simulate the solutions from the initial condition [1,0] (that is, *y*(0)=1 and $\frac{dy}{dt}|_{t=0} = 0$). When you run it for various values of $\mu > 0$ you should see oscillations.

c) Run your program for μ = 1, μ = 0.1 and μ =100 using ODE45 to solve the equations. The VDP is stiff for μ = 100 meaning there are a mixture of large and small time constants, which is a difficult situation for ODE solvers. Compare the speed with which the simulations run with ODE45 and ODE15s (does not mean ODE15s is always better).

d) Write a routine to plot your solution in the phase plane (to be explained in class). Comment on the behavior of the oscillator as it converges from initial condition towards a steady state of periodic oscillation.

The submission should include:
Only one m-files in MATLAB that when run in the command window will produce the required figures. The writing corresponding to the answers should not exceed 1 page (12 font, 1.5 line spacing in MSWORD). Please remember that all projects will be part of exams/class tests and that there will be specific questions for each of you.