Computational Neuroscience (**EC60007**)
Autumn 2023

Project I (18th August) Total Marks = 10 (1+3+3+3)
Due Date: 5 PM, 25th August (Hardcopy of write-up with figures to be submitted in my ECE locker and code m-file to be emailed to me at sharba@ece.iitkgp.ac.in **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:

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

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 $\frac{dy}{dt}\big|_{t=0} = 0$). When you run it for various values of $\mu > 0$ you should see oscillations.

c) Run your program for $\mu = 1$, $\mu = 0.1$ and $\mu = 100$ using ODE45 to solve the equations. The VDP is stiff for $\mu = 100$ 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 submissions should include:
Email: Only one m-file (email me the code at sharba@ece.iitkgp.ac.in) in MATLAB that when run in the command window will produce the required figures.

Locker: The writing corresponding to the answers should not exceed 1 page (12 font, 1.5 line spacing).

Please remember that all projects will be part of exams/class tests and that there will be specific questions for each of you.