

## Assignment-2 Instructions

1. Last date of submission: **5-April-2019**
2. You have to submit **program files** (.m or .py file) **only**.
3. **Display** all the results, including the equilibrium points, eigenvalues, eigenvectors, jacobian matrix, and the plots **clearly**. Everything should be coded
4. We evaluate **only working code**. **Syntax errors** leads to zero marking .
5. You have to **clearly comment** on the program that, code is for which question and what are the results it will generate.
6. Upload all the codes as a single zip file with your **name and roll number** in the file name (e.g. Rahul\_16126.zip)
7. Late submission will lead to **complete loss** of your marks.

**Assignment-2: There are two coding questions that carries overall 10 M.**

**Q1:** Consider the following **three linear difference** equations:

$$(1) \begin{pmatrix} x_{t+1} \\ y_{t+1} \end{pmatrix} = \begin{pmatrix} 3 & 0 \\ 1 & 2 \end{pmatrix} \begin{pmatrix} x_t \\ y_t \end{pmatrix}$$

$$(2) \begin{pmatrix} x_{t+1} \\ y_{t+1} \end{pmatrix} = \begin{pmatrix} 1 & -1 \\ 2 & 4 \end{pmatrix} \begin{pmatrix} x_t \\ y_t \end{pmatrix}$$

$$(3) \begin{pmatrix} x_{t+1} \\ y_{t+1} \end{pmatrix} = \begin{pmatrix} 1 & 2 \\ -1 & 1 \end{pmatrix} \begin{pmatrix} x_t \\ y_t \end{pmatrix}$$

Write a general program in MATLAB/PYTHON to find (a)-(e) given below for the above difference equations.

(a) Find all the equilibrium points. (b) Find the eigenvalues and corresponding eigenvectors. (c) plot the eigenvectors got from (b). (d) Plot the direction field of the corresponding difference equation. (e) From the plot in (d) determine its stability. (6M)

**Q2:** For the **nonlinear difference** equations given below in the **form**

$$\begin{aligned} P_{t+1} &= P_t(1 + 1.3(1 - P_t)) - .5P_tQ_t, \\ Q_{t+1} &= .3Q_t + 1.6P_tQ_t, \end{aligned}$$

(a) determine the jacobian using the program and plot the steady state and direction field for the population values close to equilibrium point  $(P^*, Q^*) = (.4375, 1.4625)$ . Determine the type of dynamics from both the phase plane and time series plot. Is the dynamics stable or unstable? Can you plot the eigenvectors in this case? (4M)

**Note:** Display all the results, including the equilibrium points, eigenvalues, eigenvectors, jacobian matrix, and the plots clearly. Everything should be coded.