EEE8013 – Tutorial 1

1. A **linear** first order ODE is given by $x' + kx = u$

Find the numerical solution and write a brief summary for the effect of each parameter:

i. k=-1, u=0, $x(0)$=0
ii. k=1, u=0, $x(0)$=0
iii. k=-10, u=0, $x(0)$=0
iv. k=10, u=0, $x(0)$=0
v. k=1, u=0, $x(0)$=1
vi. k=1, u=0, $x(0)$=-1
vii. k=1, u=0, $x(0)$=10
viii. k=1, u=0, $x(0)$=-10
ix. k=1, u=-1, $x(0)$=0
x. k=1, u=1, $x(0)$=0
xi. k=1, u=-10, $x(0)$=0
xii. k=1, u=10, $x(0)$=0
xiii. k=1, u=1, $x(0)$=1

2. Solve (you can use the command roots() in Matlab) the following polynomial equation $r^2 + Ar + B = 0$ for:

i. A=3, B=2
ii. A=30, B=200
iii. A=-1, B=-2
iv. A=-3, B=2
v. A=-30, B=200
vi. A=2, B=2
vii. A=20, B=101
viii. A=2, B=101
ix. A=-2, B=2

3. A **linear** second order ODE is given by $x'' + Ax' + Bx = 0$. For the values of A and B given in Q2, find the numerical solutions and "map" the responses to the roots of the $r^2 + Ar + B = 0$ Can you derive a simple rule between the roots of the polynomial equation and the response (stable, unstable, fast, slow, oscillatory…) of the ODEs?

4. A non-linear 3rd order ODE is given by: $\dot{x} = a(y - x)$, $\dot{y} = bx - y - xz$, $\dot{z} = xy - cz$. Find the response for:

i. a=0.5, b=10, c=8/3, ($x(0)$,$y(0)$,$z(0)$)=(1,1,1)
ii. a=0.5, b=10, c=8/3, ($x(0)$,$y(0)$,$z(0)$)=(-1,-1,-1)
iii. a=2, b=10, c=8/3, ($x(0)$,$y(0)$,$z(0)$)=(1,1,1)
iv. a=2, b=10, c=8/3, ($x(0)$,$y(0)$,$z(0)$)=(-1,-1,-1)

What do you notice from these 4 responses?

v. a=28, b=10, c=8/3, ($x(0)$,$y(0)$,$z(0)$)=(1,1,1)
vi. a=28, b=10, c=8/3, ($x(0)$,$y(0)$,$z(0)$)=(-1,-1,-1)

Plot all responses in the (x,y) plane.