Q1: A torsional oscillator made of a disk with moment of inertia, I , hanging from a light rod with torsional torque $-sθ$ . The disk also experiences a *drag torque* equal to $-µ\dot{ θ}$, when moving with angular velocity $\dot{θ}$ . The top of the rod is driven with a driving torque:

$ τ=φ\_{0}\cos((nω\_{o})t)$ where $n$ = last non zero digit in your registration number

1. Write the equation of motion without damping and driving torque
2. For initial conditions at $t=0 $,$ \dot{θ}=0 and θ is max $ write the solution for $θ\left(t\right)$
3. By adding a *drag torque* equal to $-µ\dot{ θ}$ without the driving torque what is the condition for critical damping case.
4. Find the transient solution for $θ\left(t\right)$ for the case in part (c) with initial conditions at $t=0 $,$ \dot{θ}=0 and θ is max$
5. Now adding the torque given in the problem. Find the *steady-state* solution for $θ(t)$
6. What is the phase difference between the driving torque and $ \dot{θ}\left(t\right).$
7. For the general case where $ τ=φ\_{0}\cos((ω)t)$ Plot the amplitude $A(ω)$ and phase $δ(ω)$ of your solution for the general solution as a function of $ω$. For your plot, assume that the natural frequency of oscillation of the system $ω\_{0}=1$ , and plot two curves on the same plot with $\frac{μ}{I}=0.25 and 2$. Label your curves to distinguish the two cases