Lab 1

Victoire Djuidje

In[624]:=
```
Remove["Global`*"]
```

A damped harmonic oscillator moving in one dimension with a spring attached to it has mass m, stiffness k, and a linear damping force with velocity coefficient b.

Angular frequency (w) is defined below

In[625]:=
```
w = Sqrt[w0^(2) - be^(2)]
w0 = 2 Pi
```

Out[625]= $\sqrt{-be^2 + w0^2}$

Out[626]= 2π

The position is given by x[t] where A and Q are initial conditions representative of x0 and v0.

In[627]:=
```
x[t] = A * E^(-be * t) * Cos[w * t + Q]
```

Out[627]= $A\, e^{-be\, t} \operatorname{Cos}\left[Q + \sqrt{-be^2 + 4\pi^2}\; t\right]$

In[628]:=
```
x' = D[x[t], t]
```

Out[628]= $-A\, be\, e^{-be\, t} \operatorname{Cos}\left[Q + \sqrt{-be^2 + 4\pi^2}\; t\right] - A\, e^{-be\, t} \sqrt{-be^2 + 4\pi^2} \operatorname{Sin}\left[Q + \sqrt{-be^2 + 4\pi^2}\; t\right]$

Applying the given initial conditions into the original equation yields,

In[629]:=
```
x1 = x[t] /. {A → 5, Q → 0, be → 1}
x2 = x[t] /. {A → 5, Q → 0, be → 0.1}
x3 = x[t] /. {A → 5, Q → (Pi / 2), be → 0.1}
```

Out[629]= $5\, e^{-t} \operatorname{Cos}\left[\sqrt{-1 + 4\pi^2}\; t\right]$

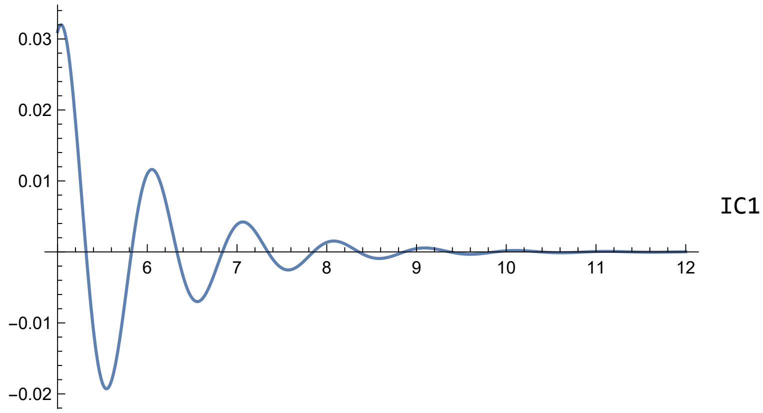
Out[630]= $5\, e^{-0.1\, t} \operatorname{Cos}[6.28239\, t]$

Out[631]= $-5\, e^{-0.1\, t} \operatorname{Sin}[6.28239\, t]$

The new equations with their IC can then be plotted as a function of position vs time.
Graph 1 shows the first IC,

In[632]:=
```
Plot[{x1}, {t, 5, 12}, PlotLegends → IC1, PlotStyle → Automatic, PlotRange → All]
```

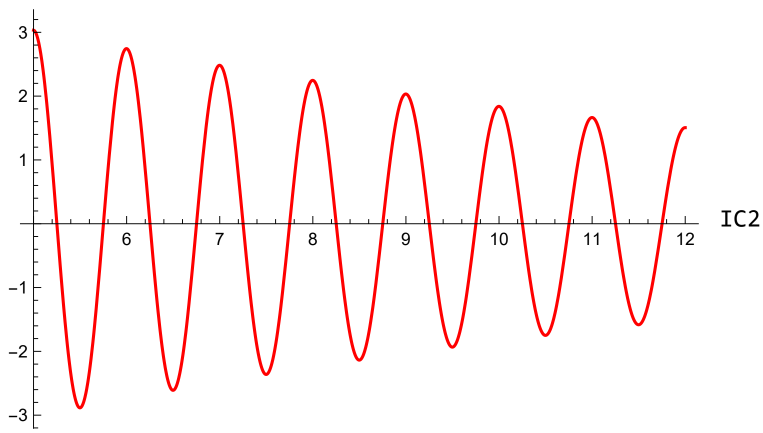
Out[632]=



This shows the second IC

In[633]:=
```
Plot[{x2}, {t, 5, 12}, PlotLegends → IC2, PlotStyle → Red, PlotRange → All]
```

Out[633]=

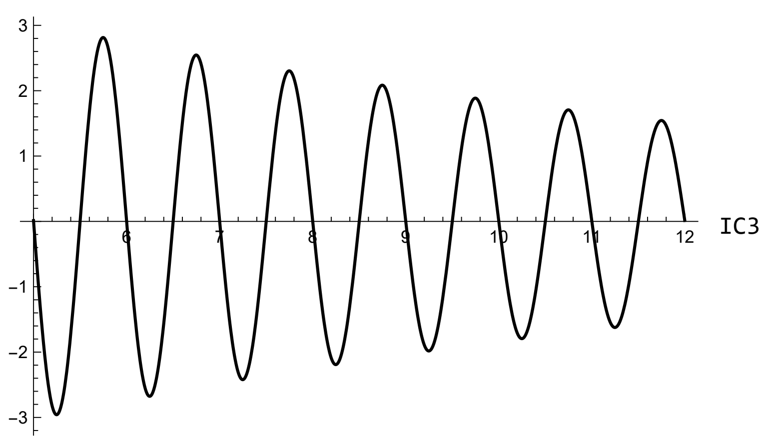


In[634]:=

This shows the third IC

In[635]:=
```
Plot[{x3}, {t, 5, 12}, PlotLegends → IC3, PlotStyle → Black, PlotRange → All]
```

Out[635]=

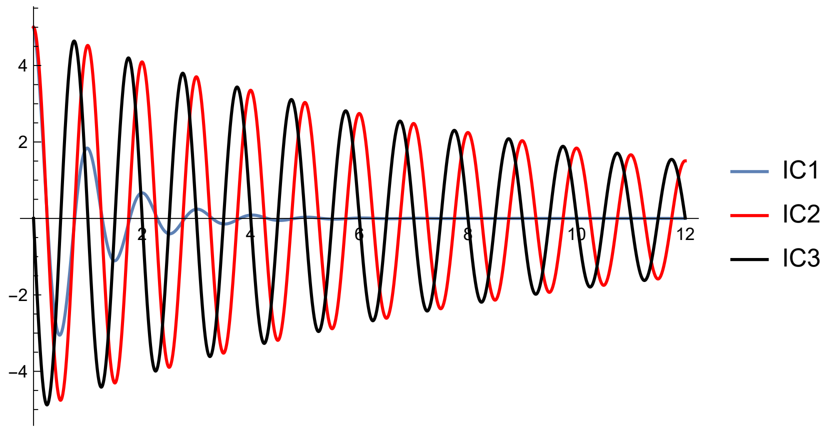


This combines all three IC in one plot. Rate of decrease of IC1 is much significant than the other two.

The main difference is beta for IC1 is 1 while for IC2 and IC3 its 0.1. IC3 also has Q= pi/2 but the effects are not as significant as the effects of beta.

In[636]:=
```
Plot[{x1, x2, x3}, {t, 0, 12}, PlotLegends → {IC1, IC2, IC3},
 PlotStyle → {Automatic, Red, Black}, PlotRange → All]
```

Out[636]=



Testing for different IC. A will be altered while Q and beta stay the same

In[637]:=
```
x4 = x[t] /. {A → 1, Q → 0, be → 1}
x5 = x[t] /. {A → 1, Q → 0, be → 0.1}
x6 = x[t] /. {A → 1, Q → (Pi / 2), be → 0.1}
```

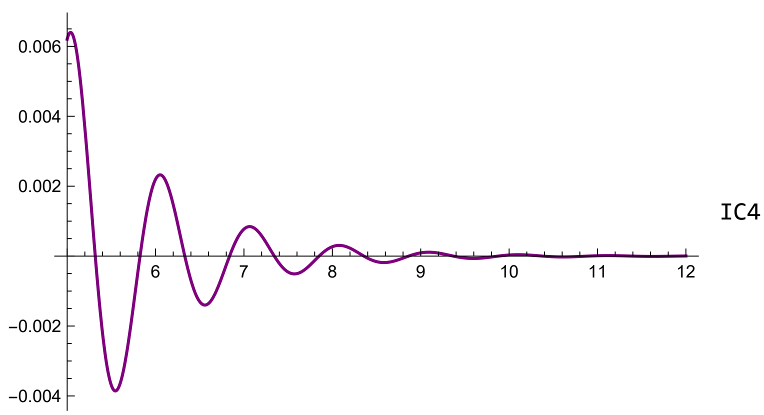
Out[637]= $e^{-t} \operatorname{Cos}\left[\sqrt{-1+4\pi^2}\ t\right]$

Out[638]= $e^{-0.1\,t} \operatorname{Cos}[6.28239\,t]$

Out[639]= $-e^{-0.1\,t} \operatorname{Sin}[6.28239\,t]$

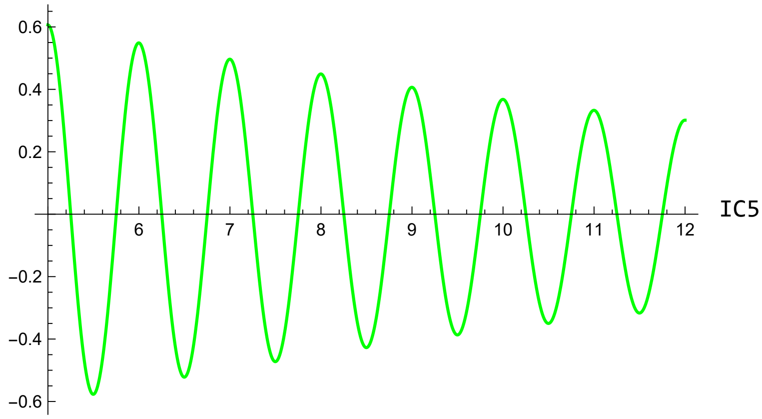
In[640]:=
```
Plot[{x4}, {t, 5, 12}, PlotLegends → IC4, PlotStyle → Purple, PlotRange → All]
```

Out[640]=



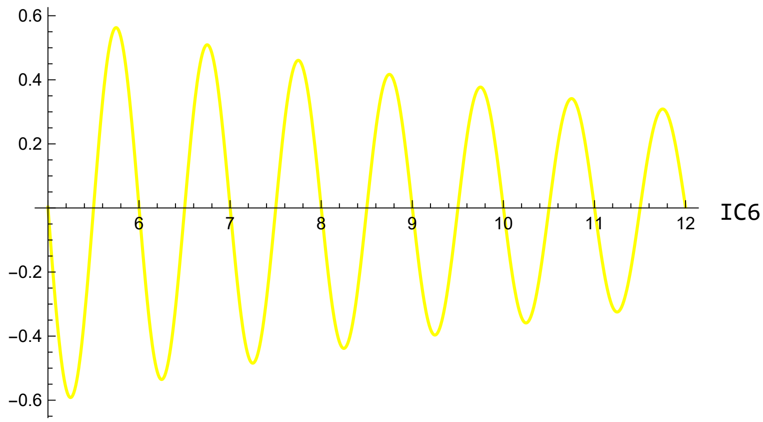
In[641]:=
```
Plot[{x5}, {t, 5, 12}, PlotLegends → IC5, PlotStyle → Green, PlotRange → All]
```

Out[641]=



In[642]:=
```
Plot[{x6}, {t, 5, 12}, PlotLegends → IC6, PlotStyle → Yellow, PlotRange → All]
```

Out[642]=



In[643]:=
```
Plot[{x4, x5, x6}, {t, 0, 12}, PlotLegends → {IC4, IC5, IC6},
 PlotStyle → {Purple, Green, Yellow}, PlotRange → All]
```

Out[643]=