In[596]:=
```
ClearAll[m, x, γ, k, t, homogeneous, value1, value2, f3response, υ]
(*simple damped undriven harmonic oscillator*)
homogeneous = m x''[t] + γ x'[t] + k x[t] == 0
```

Out[597]= $k\,x[t] + \gamma\,x'[t] + m\,x''[t] == 0$

In[598]:=
```
(*ansatz*)
x[t_] := x0 E^(υ t)


(*solving for υ and plotting υ as a funtion of γ*)
homogeneous

f3response = Solve[homogeneous, υ]
value1 = υ /. f3response[[1]]
value2 = υ /. f3response[[2]]
f1[γ_] = Arg[value1]
f2[γ_] = value1
(*Plot[{f1[γ],f2[γ]},{γ,5}]*)


(*using the ansatz...*)
```

$e^{t\upsilon}\,k\,x_0 + e^{t\upsilon}\,\gamma\,\upsilon\,x_0 + e^{t\upsilon}\,m\,\upsilon^2\,x_0 == 0$

```
(*...solving for υ*)
```

$$\left\{\left\{\upsilon \to \frac{-\gamma - \sqrt{-4\,k\,m + \gamma^2}}{2\,m}\right\}, \left\{\upsilon \to \frac{-\gamma + \sqrt{-4\,k\,m + \gamma^2}}{2\,m}\right\}\right\}$$

$\sqrt{-4\,k\,m + \gamma^2}$

```
(*if γ > Sqrt[4km]: the real part of υ will make the system return to x==
   0 without occilation see detail on understanding complex...*)
(*if γ < Sqrt[4km]: the imaginary part of υ will make the system return to x==
   0 with occilation see detail on understanding complex...*)
```

In[410]:=
```
(*understanding complex and real in υ *)
υ = -.1 + I 1 (*υ as a complex number*)
p = 0 (*phase shift*)

Plot[Re[E^(υ (t+p))], {t, 0, 50}]
```

Out[410]= $-0.1 + 1.\, i$

Out[411]= 0

Out[412]=