

Second-Order Circuit

```

> restart;
> alias(I='I',j=sqrt(-1));
> eq1:=ic(t)=4*10^(-6)*diff(vc(t),t);
    eq1 := ic(t) = \frac{1}{250000} \left( \frac{\partial}{\partial t} vc(t) \right)
> eq2:=v1(t)=2*10^3*i1(t);
    eq2 := v1(t) = 2000 i1(t)
> eq3:=vL(t)=20*10^(-3)*diff(iL(t),t);
    eq3 := vL(t) = \frac{1}{50} \left( \frac{\partial}{\partial t} iL(t) \right)
> eq4:=ic(t)+i1(t)+iL(t)=0;
    eq4 := ic(t) + i1(t) + iL(t) = 0
> eq5:=-vc(t)-10+v1(t)=0;
    eq5 := -vc(t) - 10 + v1(t) = 0
> eq6:=-v1(t)+10+vL(t)=0;
    eq6 := -v1(t) + 10 + vL(t) = 0

```

demerit  
eq  
KCL  
KVL

Solving

```

> soln:=dsolve({eq1,eq2,eq3,eq4,eq5,eq6,vc(0)=0,iL(0)=-3/1000},{ic(t),vc(t),i1(t),v1(t),iL(t),vL(t)},method=laplace);

```

soln := {

$$iL(t) = -\frac{1}{200} + \frac{1}{500} e^{(-125/2)t} \cos\left(\frac{125}{2} \sqrt{3199} t\right) + \frac{1}{1599500} e^{(-125/2)t} \sqrt{3199} \sin\left(\frac{125}{2} \sqrt{3199} t\right),$$

$$i1(t) = \frac{1}{200} - \frac{1}{799750} e^{(-125/2)t} \sqrt{3199} \sin\left(\frac{125}{2} \sqrt{3199} t\right),$$

$$vL(t) = \frac{4}{399875} \sqrt{-49984375} \left( e^{((-125/2 + 1/2 \sqrt{-49984375})t)} - e^{((-125/2 - 1/2 \sqrt{-49984375})t)} \right),$$

$$vc(t) = \frac{4}{399875} \sqrt{-49984375} \left( e^{((-125/2 + 1/2 \sqrt{-49984375})t)} - e^{((-125/2 - 1/2 \sqrt{-49984375})t)} \right),$$

$$v1(t) = 10 - \frac{8}{3199} e^{(-125/2)t} \sqrt{3199} \sin\left(\frac{125}{2} \sqrt{3199} t\right),$$

$$ic(t) = \frac{1}{1599500} e^{(-125/2)t} \sqrt{3199} \sin\left(\frac{125}{2} \sqrt{3199} t\right) - \frac{1}{500} e^{(-125/2)t} \cos\left(\frac{125}{2} \sqrt{3199} t\right) \}$$

```

> assign(soln);
> evalf(vc(t),3);

```

$$.0707j \left( e^{((-62.5 + 3540.j)t)} - 1 \right) - 1. e^{((-62.5 - 3540.j)t)}$$

```

> evalf(iL(t),3);

```

$$-0.00500 + 0.00200 e^{(-62.5 t)} \cos(3540. t) + 0.0000354 e^{(-62.5 t)} \sin(3540. t)$$

```
[ > plot(vc(t), t=0..5/62.5, numpoints=100, color=black, title=`Capacitor  
Voltage`, labels=[`Time (s)`, `vc(t) (V)`]);  
[ > plot(1000*iL(t), t=0..5/62.5, -7..0, numpoints=100, color=black, title=  
`Inductor Current`, labels=[`Time (s)`, `iL(t) (mA)`]);  
[ >
```