High Pass Filter

In[26]:=
```
R / (R - I / (w C))  // Simplify
```

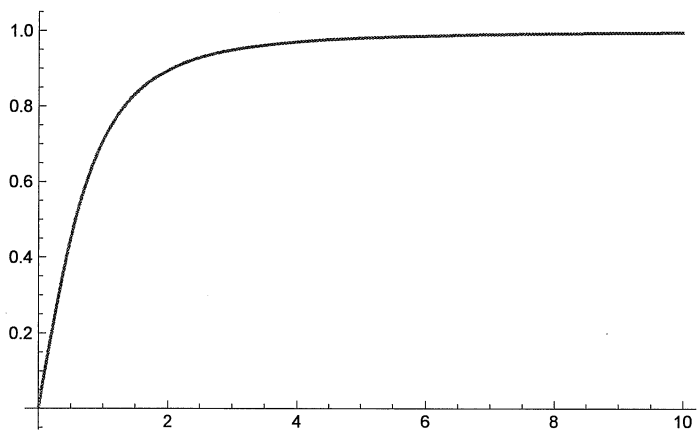
Out[26]= $\frac{C R w}{-i + C R w}$

In[27]:=
```
H[w_] = w / (w - I)  (* setting w3dB=1 for plotting *)
```

Out[27]= $\frac{w}{-i + w}$

In[28]:=
```
Plot[Abs[H[w]], {w, 0, 10}, PlotRange → All]
```

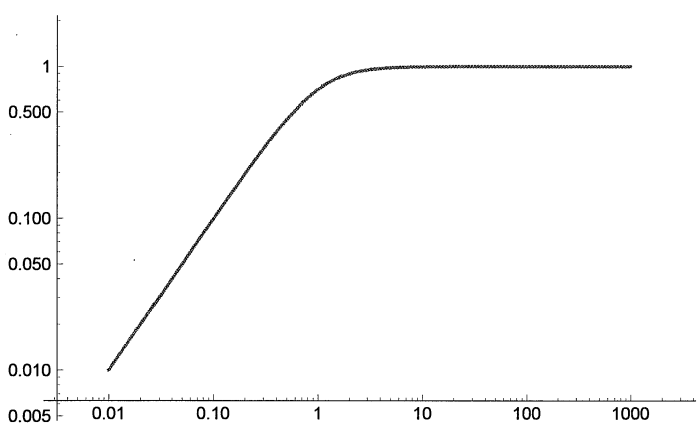
Out[28]=



Magnitude

In[29]:=
```
LogLogPlot[Abs[H[w]], {w, .01, 1000}, PlotRange → All]
```

Out[29]=



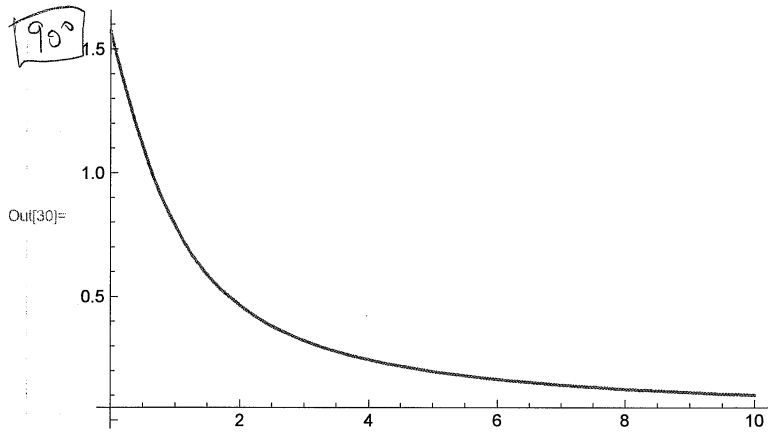
(Log-Log plot)

$w = w_{3dB} = \frac{1}{RC}$

magnitude is $\frac{1}{\sqrt{2}} \simeq 71\%$

In[30]:= **Plot[Arg[H[w]], {w, 0, 10}, PlotRange → All]**

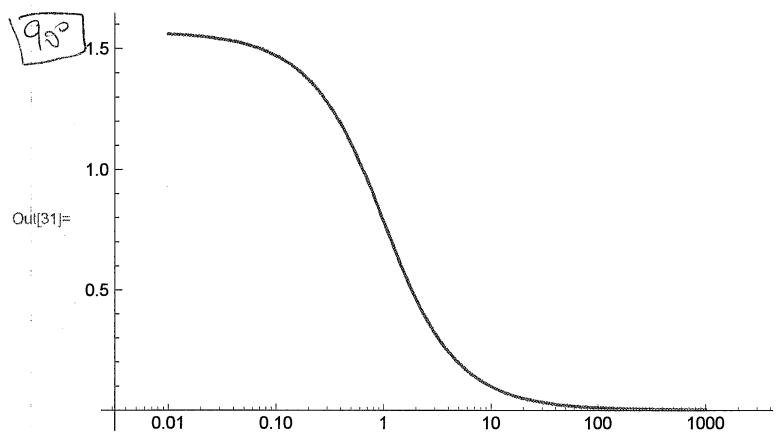
Out[30]=



phase

In[31]:= **LogLinearPlot[Arg[H[w]], {w, 0.01, 1000}, PlotRange → All]**

Out[31]=



(log x-axis plot)

$w = w_{3dB} = \frac{1}{RC}$

phase is 45°

Low Pass Filter

In[33]:=
```
(-I / (w C)) / (R - I / (w C))  // Simplify
```

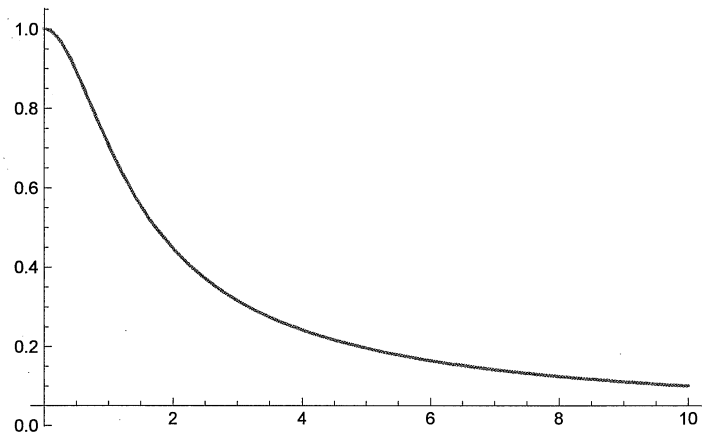
Out[33]= $\frac{i}{i - C R w}$

In[34]:=
```
H[w_] = I / (I - w)  (* setting w3dB=1 for plotting *)
```

Out[34]= $\frac{i}{i - w}$

In[35]:=
```
Plot[Abs[H[w]], {w, 0, 10}, PlotRange → All]
```

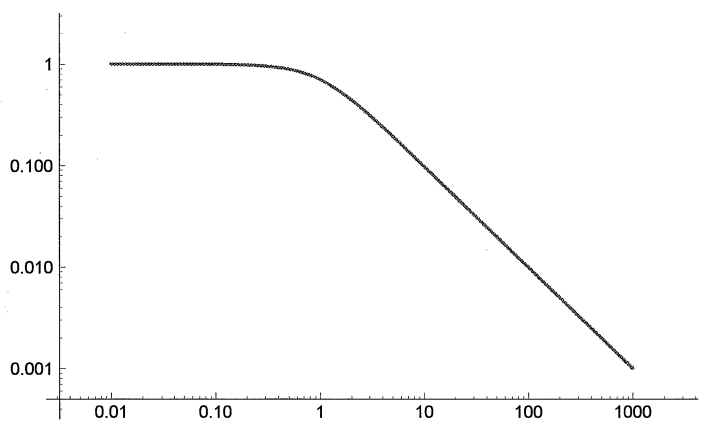
Out[35]=



Magnitude

In[36]:=
```
LogLogPlot[Abs[H[w]], {w, .01, 1000}, PlotRange → All]
```

Out[36]=



(Log-log plot)

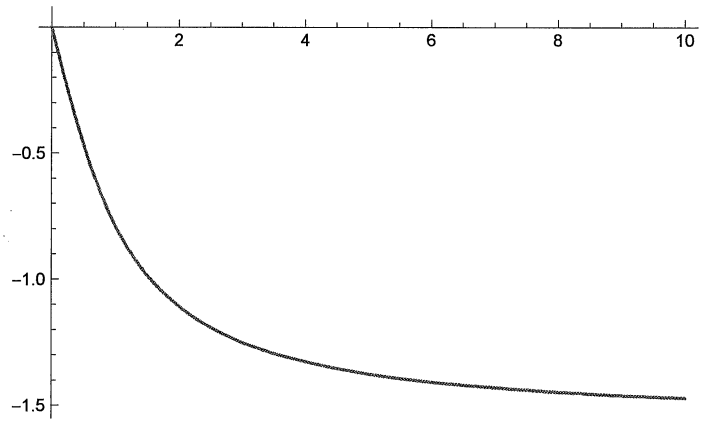
$w = w_{3dB} = \frac{1}{RC}$

magnitude $= \frac{1}{\sqrt{2}} \simeq 71\%$

In[37]:= `Plot[Arg[H[w]], {w, 0, 10}, PlotRange → All]`

Phase

Out[37]=

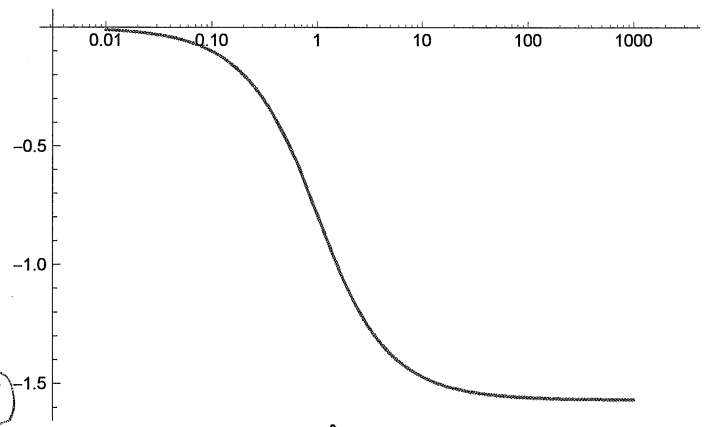


−90°

In[38]:= `LogLinearPlot[Arg[H[w]], {w, 0.01, 1000}, PlotRange → All]`

(log x-axis plot)

Out[38]=



−90°

$w = w_{3dB} = \frac{1}{RC}$

phase is −45°

Band Pass Filter

In[1]:=
```
ZC = -I / (w C);
ZL = I w L;
Ztot[w_] = R + (1/ZC + 1/ZL)^-1;
Z2[w_] = (1/ZC + 1/ZL)^-1;
H[w_] = Z2[w] / Ztot[w] // Simplify
```

Out[5]= $\frac{i L w}{R + i L w - C L R w^2}$

In[6]:=
```
1/Sqrt[L C] /. {C → 10*^-9, L → 10*^-3}
```

Out[6]= 100 000

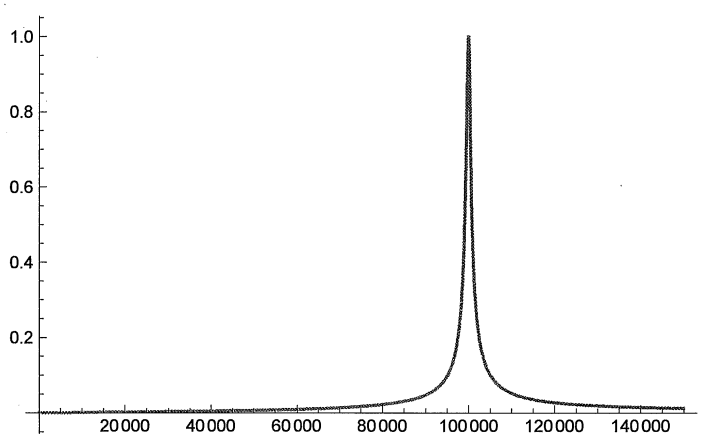
Plots for
R = 100kΩ
C = 10nF
L = 10mH

$\omega_0 = \frac{1}{\sqrt{LC}}$

$= 100000 \frac{rad}{s}$

In[7]:=
```
Plot[Abs[H[w] /. {R → 100*^3, C → 10*^-9, L → 10*^-3}],
 {w, 0, 150 000}, PlotRange → All]
```

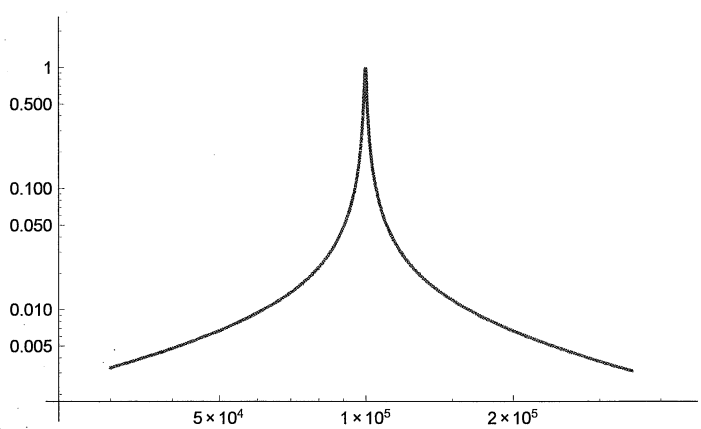
Out[7]=



Magnitude

In[8]:=
```
LogLogPlot[Abs[H[w] /. {R → 100*^3, C → 10*^-9, L → 10*^-3}],
 {w, 30 000, 350 000}, PlotRange → All]
```

Out[8]=



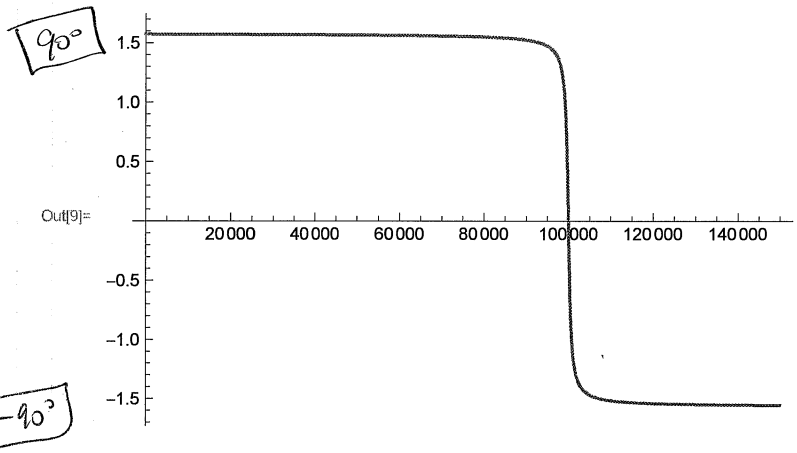
(log-log plot)

$\omega_0 = \frac{1}{\sqrt{LC}}$

magnitude is 1

In[9]:=
```
Plot[Arg[ H[w] /. {R → 100*^3, C → 10*^-9, L → 10*^-3}],
  {w, 0, 150 000}, PlotRange → All]
```

Out[9]=

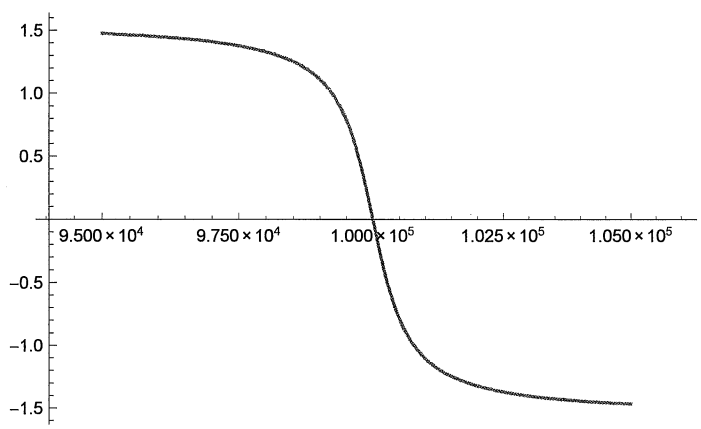


Phase

rapid phase shift right at w_0!

In[10]:=
```
LogLinearPlot[Arg[ H[w] /. {R → 100*^3, C → 10*^-9, L → 10*^-3}],
  {w, 95 000, 105 000}, PlotRange → All]
```

Out[10]=



(log scale x-axis)

$w_0 = \frac{1}{\sqrt{LC}}$

phase is 0°