Solutions to Exercise: Noise RC

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Defaults

In[114]:=
```
$Assumptions = ω ∈ Reals && τ > 0;
```

In[115]:=
```
Clear[k, T, R, C];
```

Clear: Symbol C is Protected.

2. Gain (square of transfer function)

In[116]:=
```
H[ω_] = 1/(1 + ⅈ ω τ); (* transfer function of a low pass *)
```

In[117]:=
```
v2[ω_] = H[ω] Conjugate[H[ω]] // Simplify (* gain^2*)
```

Out[117]= $\frac{1}{1 + \tau^2 \omega^2}$

3. Noise Integral

In[118]:=
```
noise2 = Integrate[4 k T R v2[2 π ν], {ν, 0, ∞}] /. τ → R C
```

Out[118]= $\frac{k\,T}{C}$

4. Why independent of R?

Voltage noise INcreases with R, but the bandwidth of the filter DEcreases by the same factor.

5. Brick Wall Equivalent

In[119]:=
```
noise2brick = Integrate[4 k T R , {ν, 0, νbrick}] /. τ → R C
```

Out[119]= 4 k R T νbrick

In[120]:=
```
Solve[noise2 == noise2brick, νbrick] // First
```

Out[120]= $\left\{\nu\text{brick} \to \frac{1}{4\,C\,R}\right\}$

6. Comparison to Bandwidth

In[121]:= $\frac{2\,\pi\,\nu\text{brick} \,/.\, \%}{1/(R\,C)}$

Out[121]= $\frac{\pi}{2}$