

```

> # Ideal inductor
> eq := abs(V__R/R) = abs(V__S/(R+2*Pi*I*f*L));

```

$$eq := \left| \frac{V_R}{R} \right| = \left| \frac{V_S}{R + 2I\pi fL} \right| \quad (1)$$

```

> sol := solve(eq, L) assuming V__R>0, V__S>0, R>0, L>0, f>0;

```

$$sol := \frac{\sqrt{-V_R^2 + V_S^2} R}{2\pi f V_R}, -\frac{\sqrt{-V_R^2 + V_S^2} R}{2\pi f V_R} \quad (2)$$

```

> inductor_ideal := L=simplify(sol[1]); latex(%); CodeGeneration[R]
(rhs(inductor_ideal), resultname="RCode");

```

$$inductor\_ideal := L = \frac{\sqrt{-V_R^2 + V_S^2} R}{2\pi f V_R}$$

```

L = \frac{\sqrt{-V_{R}^{2}+V_{S}^{2}}\, R}{2 \pi f V_{R}}
RCode <- 0.1e1 / pi * sqrt(-V__R ^ 2 + V__S ^ 2) * R / f / V__R / 2

```

```
> # Ideal capacitor
> eq := abs(V__R/R) = abs(V__S/(R+1/(2*Pi*I*f*C)));
```

$$eq := \left| \frac{V_R}{R} \right| = \left| \frac{V_S}{R - \frac{1}{2\pi f C}} \right| \quad (3)$$

```
> sol := solve(eq, C) assuming V__R>0, V__S>0, R>0, C>0, f>0;
```

$$sol := -\frac{V_R}{2\sqrt{-\pi^2 V_R^2 + \pi^2 V_S^2 f R}}, \frac{V_R}{2\sqrt{-\pi^2 V_R^2 + \pi^2 V_S^2 f R}} \quad (4)$$

```
> capacitor_ideal := C=simplify(sol[2]); latex(%); CodeGeneration
[R](rhs(capacitor_ideal), resultname="RCode");
```

$$capacitor\_ideal := C = \frac{V_R}{2\pi\sqrt{-V_R^2 + V_S^2 f R}}$$

```
C = \frac{V_{R}}{2 \pi \sqrt{-V_{R}^2 + V_{S}^2}} \backslash, f R}
RCode <- 0.1e1 / pi * (-V__R ^ 2 + V__S ^ 2) ^ (-0.1e1 / 0.2e1) *
V__R / f / R / 2
```

```
> # Inductor with series resistance
> eq := abs(V__R/R) = abs(V__S/(R+R__L+2*Pi*I*f*L));
```

$$eq := \left| \frac{V_R}{R} \right| = \left| \frac{V_S}{R + R_L + 2I\pi fL} \right| \quad (5)$$

```
> sol := solve(eq, L) assuming V__R>0, V__S>0, R>0, L>0, f>0,
R__L>0;
```

$$sol := \frac{\sqrt{-R^2 V_R^2 + R^2 V_S^2 - 2 R R_L V_R^2 - R_L^2 V_R^2}}{2 \pi f V_R}, \quad (6)$$

$$-\frac{\sqrt{-R^2 V_R^2 + R^2 V_S^2 - 2 R R_L V_R^2 - R_L^2 V_R^2}}{2 \pi f V_R}$$

```
> inductor_series_resistance := L=simplify(sol[1]); latex(%);
CodeGeneration[R](rhs(inductor_series_resistance), resultname=
"RCode");
```

$$inductor\_series\_resistance := L = \frac{\sqrt{-(R + R_L)^2 V_R^2 + R^2 V_S^2}}{2 \pi f V_R}$$

```
L =
\frac{\sqrt{-\left(R + R_L\right)^2 V_R^2 + R^2 V_S^2}}{2 \pi f V_R}
RCode <- 0.1e1 / pi * sqrt(-(R + R__L) ^ 2 * V__R ^ 2 + R ^ 2 * V__S
^ 2) / f / V__R / 2
```

```
> # capacitor with series resistance
> eq := abs(V__R/R) = abs(V__S/(R+R__CS+1/(2*Pi*I*f*C))); eq :=
evalc(eq) :
```

$$eq := \left| \frac{V_R}{R} \right| = \left| \frac{V_S}{R + R_{CS} - \frac{I}{2\pi f C}} \right| \quad (7)$$

```
> sol := solve(eq, C) assuming V__R>0, V__S>0, R>0, L>0, f>0,
R__CS>0;
```

$$sol := - \frac{V_R}{2 \sqrt{-\pi^2 R^2 V_R^2 + \pi^2 R^2 V_S^2 - 2 \pi^2 R R_{CS} V_R^2 - \pi^2 R_{CS}^2 V_R^2 f}}, \quad (8)$$

$$\frac{V_R}{2 \sqrt{-\pi^2 R^2 V_R^2 + \pi^2 R^2 V_S^2 - 2 \pi^2 R R_{CS} V_R^2 - \pi^2 R_{CS}^2 V_R^2 f}}$$

```
> capacitor_series_resistance := C=simplify(sol[2]); latex(%);
CodeGeneration[R](rhs(capacitor_series_resistance), resultname=
"RCode");
```

$$capacitor\_series\_resistance := C = \frac{V_R}{2 \pi \sqrt{-(R + R_{CS})^2 V_R^2 + R^2 V_S^2} f}$$

```
C =
\frac{V_{R}}{2 \pi \sqrt{-\left(R + R_{\mathit{CS}}\right)^2 V_{R}
^2 + R^2 V_{S}^2}}, f)
RCode <- 0.1e1 / pi * (-(R + R__CS) ^ 2 * V__R ^ 2 + R ^ 2 * V__S ^
2) ^ (-0.1e1 / 0.2e1) * V__R / f / 2
```

```
> # capacitor with parallel resistance
> eq := abs(V__R/R) = abs(V__S/(R+1/(1/R__CP+2*Pi*I*f*C))); eq :=
evalc(eq) :
```

$$eq := \left| \frac{V_R}{R} \right| = \left| \frac{V_S}{R + \frac{1}{\frac{1}{R_{CP}} + 2I\pi f C}} \right| \quad (9)$$

```
> sol := solve(eq, C) assuming V__R>0, V__S>0, R>0, L>0, f>0,
R__CP>0;
```

$$sol := \frac{\sqrt{-(V_R^2 - V_S^2) (R^2 V_R^2 - R^2 V_S^2 + 2 R R_{CP} V_R^2 + R_{CP}^2 V_R^2)}}{2 \pi (V_R^2 - V_S^2) f R R_{CP}}, \quad (10)$$

$$- \frac{\sqrt{-(V_R^2 - V_S^2) (R^2 V_R^2 - R^2 V_S^2 + 2 R R_{CP} V_R^2 + R_{CP}^2 V_R^2)}}{2 \pi (V_R^2 - V_S^2) f R R_{CP}}$$

```
> capacitor_parallel_resistance := C=simplify(sol[1]); latex(%);
CodeGeneration[R](rhs(capacitor_parallel_resistance), resultname=
"RCode") ;
```

```
capacitor_parallel_resistance := C
```

$$= \frac{\sqrt{-(R + R_{CP})^2 V_R^4 + 2 V_S^2 \left( R^2 + R R_{CP} + \frac{1}{2} R_{CP}^2 \right) V_R^2 - V_S^4 R^2}}{2 \pi (V_R^2 - V_S^2) f R R_{CP}}$$

```
C =
```

```
\frac{\sqrt{-\left(R + R_{\mathit{CP}}\right)^2 V_{\mathit{R}}^4 + 2 V_{\mathit{S}}^2 \left(R^2 + R R_{\mathit{CP}} + \frac{1}{2} R_{\mathit{CP}}^2\right) V_{\mathit{R}}^2 - V_{\mathit{S}}^4 R^2}}{\left(V_{\mathit{R}}^2 - V_{\mathit{S}}^2\right) 2 \pi f R R_{\mathit{CP}}}
```

```
RCode <- 0.1e1 / pi * sqrt(-(R + R__CP) ^ 2 * V__R ^ 4 + 2 * V__S ^ 2
* (R ^ 2 + R * R__CP + R__CP ^ 2 / 2) * V__R ^ 2 - V__S ^ 4 * R ^ 2)
/ (V__R ^ 2 - V__S ^ 2) / f / R / R__CP / 2
```

```
> subs({R=993, R_L=11.64, f=10e3, V_S=6.88458, V_R=4.98893},  
inductor_series_resistance);  
L=0.01483177169 (11)
```

```
> subs({R=993, R_L=11.64, f=10e3, V_S=6.88458, V_R=4.98893},  
inductor_ideal);  
L=0.01502901814 (12)
```

```
> subs({R=10e3, R_CS=15, f=10e3, V_S=7.06624, V_R=2.11774},  
capacitor_series_resistance);  
C=5.000401340 × 10-10 (13)
```

```
> subs({R=10e3, R_CS=15, f=10e3, V_S=7.06624, V_R=2.11774},  
capacitor_ideal);  
C=4.999660552 × 10-10 (14)
```

```
> subs({R=993, R_L=11.64, f=9999, V_S=6.88, V_R=4.87},  
inductor_series_resistance);  
L=0.01558463859 (15)
```

```
> evalf(subs({V_S=10*V_R}, capacitor_ideal)): simplify(%)  
assuming V_R>0;
```

$$C = \frac{0.01599567362}{fR} \quad (16)$$

```
> evalf(subs({V_S=10*V_R}, inductor_ideal)): simplify(%)  
assuming V_R>0;
```

$$L = \frac{1.583571689 R}{f} \quad (17)$$

```
> evalf(subs({V__S=2*V__R}, capacitor_ideal)): simplify(%)  
assuming V__R>0;
```

$$C = \frac{0.09188814925}{fR} \quad (18)$$

```
> evalf(subs({V__S=2*V__R}, inductor_ideal)): simplify(%) assuming  
V__R>0;
```

$$L = \frac{0.2756644477 R}{f} \quad (19)$$

```

> eq := R*(V__S/V__R-1); latex(eq);
                                eq := R \left( \frac{V_S}{V_R} - 1 \right)
R \left(\frac{V_{S}}{V_{R}}-1\right)
> Z := subs({R=1e3, f=10e3, V__S=6.88458, V__R=4.98893*exp(-I*
42.9147/360*2*Pi)}, eq);
                                Z := 10.647102 + 939.6345587 I

```

(20)

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> # The real bit is the serial resistance
> Re(Z);
                                10.647102

```

(21)

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> # The complex bit is related to the inductance (Z=2*Pi*f*L)
> subs({R=1e3, f=10e3, V__S=6.88458, V__R=4.98893, pd=42.9147},
solve(Im(Z)=2*Pi*f*L, L));
                                0.01495474847

```

(22)