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AC Circuit Design Formulas

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List of 45 AC Circuit Design Formulas

AC Circuit Design

1) Capacitance for Parallel RLC Circuit using Q Factor

$$\text{fx } C = \frac{L \cdot Q_{||}^2}{R^2}$$

Open Calculator 

$$\text{ex } 349.3578\mu\text{F} = \frac{0.79\text{mH} \cdot (39.9)^2}{(60\Omega)^2}$$

2) Capacitance for Series RLC Circuit given Q Factor

$$\text{fx } C = \frac{L}{Q_{se}^2 \cdot R^2}$$

Open Calculator 

$$\text{ex } 351.1111\mu\text{F} = \frac{0.79\text{mH}}{(0.025)^2 \cdot (60\Omega)^2}$$

3) Capacitance given Cut off Frequency

$$\text{fx } C = \frac{1}{2 \cdot R \cdot \pi \cdot f_c}$$

Open Calculator 

$$\text{ex } 350.4072\mu\text{F} = \frac{1}{2 \cdot 60\Omega \cdot \pi \cdot 7.57\text{Hz}}$$



4) Capacitance using Time Constant

$$\text{fx } C = \frac{\tau}{R}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$\text{ex } 350\mu\text{F} = \frac{21\text{ms}}{60\Omega}$$

5) Complex Power

$$\text{fx } S = \sqrt{P^2 + Q^2}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$\text{ex } 270.5199\text{VA} = \sqrt{(235\text{W})^2 + (134\text{VAR})^2}$$

6) Complex Power given Power Factor

$$\text{fx } S = \frac{P}{\cos(\Phi)}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

$$\text{ex } 271.3546\text{VA} = \frac{235\text{W}}{\cos(30^\circ)}$$


7) Current using Complex Power

$$\text{fx } I = \sqrt{\frac{S}{Z}}$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754_img.jpg\)](#)

$$\text{ex } 2.09723\text{A} = \sqrt{\frac{270.5\text{VA}}{61.5\Omega}}$$




8) Current using Power Factor 

$$fx \quad I = \frac{P}{\cos\Phi \cdot V}$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)


$$ex \quad 2.101968A = \frac{235W}{0.86 \cdot 130V}$$

9) Cut Off Frequency for RC circuit 

$$fx \quad f_c = \frac{1}{2 \cdot \pi \cdot C \cdot R}$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)

$$ex \quad 7.578807Hz = \frac{1}{2 \cdot \pi \cdot 350\mu F \cdot 60\Omega}$$

10) Electric Current using Reactive Power 

$$fx \quad I = \frac{Q}{V \cdot \sin(\Phi)}$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7_img.jpg\)](#)

$$ex \quad 2.061538A = \frac{134VAR}{130V \cdot \sin(30^\circ)}$$

11) Electric Current using Real Power 

$$fx \quad I = \frac{P}{V \cdot \cos(\Phi)}$$

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b_img.jpg\)](#)

$$ex \quad 2.087343A = \frac{235W}{130V \cdot \cos(30^\circ)}$$



12) Electrical Angle

$$fx \quad \theta_e = \left(\frac{N_p}{2} \right) \cdot \theta_m$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

$$ex \quad 160^\circ = \left(\frac{4}{2} \right) \cdot 80^\circ$$

13) Frequency using Time Period

$$fx \quad \omega_n = \frac{1}{2 \cdot \pi \cdot T}$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$ex \quad 0.050207\text{Hz} = \frac{1}{2 \cdot \pi \cdot 3.17}$$

14) Impedance given Complex Power and Current

$$fx \quad Z = \frac{S}{I^2}$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd_img.jpg\)](#)

$$ex \quad 61.33787\Omega = \frac{270.5\text{VA}}{(2.1\text{A})^2}$$

15) Impedance given Complex Power and Voltage

$$fx \quad Z = \frac{V^2}{S}$$

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80_img.jpg\)](#)

$$ex \quad 62.47689\Omega = \frac{(130\text{V})^2}{270.5\text{VA}}$$



16) Inductance for Parallel RLC Circuit using Q Factor 

$$fx \quad L = \frac{C \cdot R^2}{Q_{||}^2}$$

Open Calculator 


$$ex \quad 0.791452mH = \frac{350\mu F \cdot (60\Omega)^2}{(39.9)^2}$$

17) Inductance for Series RLC Circuit given Q Factor 

$$fx \quad L = C \cdot Q_{se}^2 \cdot R^2$$

Open Calculator 

$$ex \quad 0.7875mH = 350\mu F \cdot (0.025)^2 \cdot (60\Omega)^2$$

18) Line to Neutral Current using Reactive Power 

$$fx \quad I_{ln} = \frac{Q}{3 \cdot V_{ln} \cdot \sin(\Phi)}$$

Open Calculator 

$$ex \quad 1.296565A = \frac{134VAR}{3 \cdot 68.9V \cdot \sin(30^\circ)}$$


19) Line to Neutral Current using Real Power 

$$fx \quad I_{ln} = \frac{P}{3 \cdot \cos(\Phi) \cdot V_{ln}}$$

Open Calculator 

$$ex \quad 1.312795A = \frac{235W}{3 \cdot \cos(30^\circ) \cdot 68.9V}$$



20) Line to Neutral Voltage using Reactive Power 

$$fx \quad V_{ln} = \frac{Q}{3 \cdot \sin(\Phi) \cdot I_{ln}}$$

Open Calculator 


$$ex \quad 68.71795V = \frac{134VAR}{3 \cdot \sin(30^\circ) \cdot 1.3A}$$

21) Line to Neutral Voltage using Real Power 

$$fx \quad V_{ln} = \frac{P}{3 \cdot \cos(\Phi) \cdot I_{ln}}$$

Open Calculator 

$$ex \quad 69.57811V = \frac{235W}{3 \cdot \cos(30^\circ) \cdot 1.3A}$$

22) Power Factor given Power 

$$fx \quad \cos\Phi = \frac{P}{V \cdot I}$$

Open Calculator 

$$ex \quad 0.860806 = \frac{235W}{130V \cdot 2.1A}$$

23) Power Factor given Power Factor Angle 

$$fx \quad \cos\Phi = \cos(\Phi)$$

Open Calculator 

$$ex \quad 0.866025 = \cos(30^\circ)$$



24) Power in Single-Phase AC Circuits 

$$fx \quad P = V \cdot I \cdot \cos(\Phi)$$

[Open Calculator !\[\]\(6605b201d6f14d9b3bcb8ab5f274d107_img.jpg\)](#)

$$ex \quad 236.4249W = 130V \cdot 2.1A \cdot \cos(30^\circ)$$

25) Power in Single-Phase AC Circuits using Current 

$$fx \quad P = I^2 \cdot R \cdot \cos(\Phi)$$

[Open Calculator !\[\]\(e8fb589d58dad1692debababa5e928b6_img.jpg\)](#)

$$ex \quad 229.1503W = (2.1A)^2 \cdot 60\Omega \cdot \cos(30^\circ)$$

26) Q Factor for Parallel RLC Circuit 

$$fx \quad Q_{||} = R \cdot \left(\sqrt{\frac{C}{L}} \right)$$

[Open Calculator !\[\]\(4688aadfd656ded00cd6bdfae55089a9_img.jpg\)](#)

$$ex \quad 39.93666 = 60\Omega \cdot \left(\sqrt{\frac{350\mu F}{0.79mH}} \right)$$

27) Q Factor for Series RLC Circuit 

$$fx \quad Q_{se} = \frac{1}{R} \cdot \left(\sqrt{\frac{L}{C}} \right)$$

[Open Calculator !\[\]\(4146d17f71dced09c6ad789cacceaa6d_img.jpg\)](#)

$$ex \quad 0.02504 = \frac{1}{60\Omega} \cdot \left(\sqrt{\frac{0.79mH}{350\mu F}} \right)$$



28) Reactive Power

$$fx \quad Q = I \cdot V \cdot \sin(\Phi)$$

[Open Calculator !\[\]\(c3d993ca47bfe2a953c700506ce31fa0_img.jpg\)](#)

$$ex \quad 136.5\text{VAR} = 2.1\text{A} \cdot 130\text{V} \cdot \sin(30^\circ)$$

29) Reactive Power using Line-to-Neutral Current

$$fx \quad Q = 3 \cdot I_{ln} \cdot V_{ln} \cdot \sin(\Phi)$$

[Open Calculator !\[\]\(17413706fd4997a1a4bdf85c6864eee1_img.jpg\)](#)

$$ex \quad 134.355\text{VAR} = 3 \cdot 1.3\text{A} \cdot 68.9\text{V} \cdot \sin(30^\circ)$$

30) Reactive Power using RMS Voltage and Current

$$fx \quad Q = V_{rms} \cdot I_{rms} \cdot \sin(\Phi)$$

[Open Calculator !\[\]\(4b7a79268f6ba26c1471d4232fffa85a_img.jpg\)](#)

$$ex \quad 135.125\text{VAR} = 57.5\text{V} \cdot 4.7\text{A} \cdot \sin(30^\circ)$$

31) Real Power in AC Circuit

$$fx \quad P = V \cdot I \cdot \cos(\Phi)$$

[Open Calculator !\[\]\(3342c215b2a8b663596a81468d5dc314_img.jpg\)](#)

$$ex \quad 236.4249\text{W} = 130\text{V} \cdot 2.1\text{A} \cdot \cos(30^\circ)$$

32) Real Power using Line-to-Neutral Voltage

$$fx \quad P = 3 \cdot I_{ln} \cdot V_{ln} \cdot \cos(\Phi)$$

[Open Calculator !\[\]\(5a351309c3b87e4420622c1f0e57efc0_img.jpg\)](#)

$$ex \quad 232.7097\text{W} = 3 \cdot 1.3\text{A} \cdot 68.9\text{V} \cdot \cos(30^\circ)$$



33) Real Power using RMS Voltage and Current

$$fx \quad P = I_{rms} \cdot V_{rms} \cdot \cos(\Phi)$$

[Open Calculator !\[\]\(0f848bbd71cef6b345273b16f905912a_img.jpg\)](#)

$$ex \quad 234.0434W = 4.7A \cdot 57.5V \cdot \cos(30^\circ)$$

34) Resistance for Parallel RLC Circuit using Q Factor

$$fx \quad R = \frac{Q_{||}}{\sqrt{\frac{C}{L}}}$$

[Open Calculator !\[\]\(3211b5d1d968fc1665909b34f9f16010_img.jpg\)](#)

$$ex \quad 59.94492\Omega = \frac{39.9}{\sqrt{\frac{350\mu F}{0.79mH}}}$$

35) Resistance for Series RLC Circuit given Q Factor

$$fx \quad R = \frac{\sqrt{L}}{Q_{se} \cdot \sqrt{C}}$$

[Open Calculator !\[\]\(9c2e8d1b5bd77cb5c9f83b7a9cff79fd_img.jpg\)](#)

$$ex \quad 60.09516\Omega = \frac{\sqrt{0.79mH}}{0.025 \cdot \sqrt{350\mu F}}$$


36) Resistance using Time Constant

$$fx \quad R = \frac{\tau}{C}$$

[Open Calculator !\[\]\(235bfe13ebf007ce2eea9e689707fac7_img.jpg\)](#)

$$ex \quad 60\Omega = \frac{21ms}{350\mu F}$$




37) Resonant Frequency for RLC circuit 

$$fx \quad f_o = \frac{1}{2 \cdot \pi \cdot \sqrt{L \cdot C}}$$

Open Calculator 

$$ex \quad 302.6722Hz = \frac{1}{2 \cdot \pi \cdot \sqrt{0.79mH \cdot 350\mu F}}$$

38) RMS Current using Reactive Power 

$$fx \quad I_{rms} = \frac{Q}{V_{rms} \cdot \sin(\Phi)}$$

Open Calculator 

$$ex \quad 4.66087A = \frac{134VAR}{57.5V \cdot \sin(30^\circ)}$$

39) RMS Current using Real Power 

$$fx \quad I_{rms} = \frac{P}{V_{rms} \cdot \cos(\Phi)}$$

Open Calculator 

$$ex \quad 4.719211A = \frac{235W}{57.5V \cdot \cos(30^\circ)}$$


40) RMS Voltage using Reactive Power 

$$fx \quad V_{rms} = \frac{Q}{I_{rms} \cdot \sin(\Phi)}$$

Open Calculator 

$$ex \quad 57.02128V = \frac{134VAR}{4.7A \cdot \sin(30^\circ)}$$



41) RMS Voltage using Real Power 

$$fx \quad V_{\text{rms}} = \frac{P}{I_{\text{rms}} \cdot \cos(\Phi)}$$

Open Calculator 


$$ex \quad 57.73503V = \frac{235W}{4.7A \cdot \cos(30^\circ)}$$

42) Voltage using Complex Power 

$$fx \quad V = \sqrt{S \cdot Z}$$

Open Calculator 

$$ex \quad 128.9796V = \sqrt{270.5VA \cdot 61.5\Omega}$$

43) Voltage using Power Factor 

$$fx \quad V = \frac{P}{\cos\Phi \cdot I}$$

Open Calculator 

$$ex \quad 130.1218V = \frac{235W}{0.86 \cdot 2.1A}$$


44) Voltage using Reactive Power 

$$fx \quad V = \frac{Q}{I \cdot \sin(\Phi)}$$

Open Calculator 

$$ex \quad 127.619V = \frac{134VAR}{2.1A \cdot \sin(30^\circ)}$$



45) Voltage using Real Power [Open Calculator !\[\]\(bd1a142de767a21e5362c595f844a4ff_img.jpg\)](#)

$$\text{fx } V = \frac{P}{I \cdot \cos(\Phi)}$$

$$\text{ex } 129.2165V = \frac{235W}{2.1A \cdot \cos(30^\circ)}$$



Variables Used








- **C** Capacitance (*Microfarad*)
- **$\cos\Phi$** Power Factor
- **f_c** Cut-off Frequency (*Hertz*)
- **f_o** Resonant Frequency (*Hertz*)
- **I** Current (*Ampere*)
- **I_{In}** Line to Neutral Current (*Ampere*)
- **I_{rms}** Root Mean Square Current (*Ampere*)
- **L** Inductance (*Millihenry*)
- **N_p** Number of Poles
- **P** Real Power (*Watt*)
- **Q** Reactive Power (*Volt Ampere Reactive*)
- **$Q_{||}$** Parallel RLC Quality Factor
- **Q_{se}** Series RLC Quality Factor
- **R** Resistance (*Ohm*)
- **S** Complex Power (*Volt Ampere*)
- **T** Time Period
- **V** Voltage (*Volt*)
- **V_{In}** Line to Neutral Voltage (*Volt*)
- **V_{rms}** Root Mean Square Voltage (*Volt*)
- **Z** Impedance (*Ohm*)
- **θ_e** Electrical Angle (*Degree*)
- **θ_m** Mechanical Angle (*Degree*)





- τ Time Constant (Millisecond)
- Φ Phase Difference (Degree)
- ω_n Natural Frequency (Hertz)



Constants, Functions, Measurements used

- **Constant:** **pi**, 3.14159265358979323846264338327950288
Archimedes' constant
- **Function:** **cos**, $\cos(\text{Angle})$
Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- **Function:** **sin**, $\sin(\text{Angle})$
Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.
- **Function:** **sqrt**, $\text{sqrt}(\text{Number})$
A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- **Measurement:** **Time** in Millisecond (ms)
Time Unit Conversion 
- **Measurement:** **Electric Current** in Ampere (A)
Electric Current Unit Conversion 
- **Measurement:** **Power** in Volt Ampere (VA), Watt (W), Volt Ampere Reactive (VAR)
Power Unit Conversion 
- **Measurement:** **Angle** in Degree ($^{\circ}$)
Angle Unit Conversion 
- **Measurement:** **Frequency** in Hertz (Hz)
Frequency Unit Conversion 
- **Measurement:** **Capacitance** in Microfarad (μF)
Capacitance Unit Conversion 
- **Measurement:** **Electric Resistance** in Ohm (Ω)
Electric Resistance Unit Conversion 



- **Measurement: Inductance** in Millihenry (mH)
Inductance Unit Conversion 
- **Measurement: Electric Potential** in Volt (V)
Electric Potential Unit Conversion 



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