Important AC Circuit Design Formulas PDF

Formulas
Examples
with Units

List of 45
Important AC Circuit Design Formulas

1) Capacitance for Parallel RLC Circuit using Q Factor Formula

Evaluate Formula

Formula

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

Example with Units

$$349.3578\,\mu F = \frac{0.79\,mH \cdot 39.9^2}{60\,\Omega^2}$$

2) Capacitance for Series RLC Circuit given Q Factor Formula

Evaluate Formula

Formula

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

Example with Units

$$351.1111\,\mu F = \frac{0.79\,mH}{0.025^2 \cdot 60\,\Omega^2}$$

3) Capacitance given Cut off Frequency Formula

Evaluate Formula

Formula

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

Example with Units

$$350.4072\,\mu F = \frac{1}{2 \cdot 60\,\Omega \cdot 3.1416 \cdot 7.57\,Hz}$$

4) Capacitance using Time Constant Formula

Evaluate Formula

Formula

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

Example with Units

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

5) Complex Power Formula

Evaluate Formula

Formula

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

Example with Units

$$270.5199\,VA = \sqrt{235\,W^2 + 134\,VAR^2}$$

6) Complex Power given Power Factor Formula

Evaluate Formula

Formula

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

Example with Units

$$271.3546\,VA = \frac{235\,W}{\cos(30°)}$$

7) Current using Complex Power Formula

Evaluate Formula

Formula

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

Example with Units

$$2.0972\,\text{A} = \sqrt{\frac{270.5\,\text{VA}}{61.5\,\Omega}}$$

8) Current using Power Factor Formula

Evaluate Formula

Formula

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

Example with Units

$$2.102\,\text{A} = \frac{235\,\text{W}}{0.86 \cdot 130\,\text{V}}$$

9) Cut Off Frequency for RC circuit Formula

Evaluate Formula

Formula

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

Example with Units

$$7.5788\,\text{Hz} = \frac{1}{2 \cdot 3.1416 \cdot 350\,\mu\text{F} \cdot 60\,\Omega}$$

10) Electric Current using Reactive Power Formula

Evaluate Formula

Formula

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

Example with Units

$$2.0615\,\text{A} = \frac{134\,\text{VAR}}{130\,\text{V} \cdot \sin(30°)}$$

11) Electric Current using Real Power Formula

Evaluate Formula

Formula

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

Example with Units

$$2.0873\,\text{A} = \frac{235\,\text{W}}{130\,\text{V} \cdot \cos(30°)}$$

12) Electrical Angle Formula

Evaluate Formula

Formula

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

Example with Units

$$160° = \left(\frac{4}{2}\right) \cdot 80°$$

13) Frequency using Time Period Formula

Evaluate Formula

Formula

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

Example with Units

$$0.0502\,\text{Hz} = \frac{1}{2 \cdot 3.1416 \cdot 3.17}$$

14) Impedance given Complex Power and Current Formula

Evaluate Formula

Formula

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

Example with Units

$$61.3379\,\Omega = \frac{270.5\,\text{VA}}{2.1\,\text{A}^2}$$

15) Impedance given Complex Power and Voltage Formula

Evaluate Formula

Formula

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

Example with Units

$$62.4769\,\Omega = \frac{130\,\text{V}^2}{270.5\,\text{VA}}$$

16) Inductance for Parallel RLC Circuit using Q Factor Formula

Evaluate Formula

Formula

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

Example with Units

$$0.7915\,\text{mH} = \frac{350\,\mu\text{F} \cdot 60\,\Omega^2}{39.9^2}$$

17) Inductance for Series RLC Circuit given Q Factor Formula

Evaluate Formula

Formula

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

Example with Units

$$0.7875\,\text{mH} = 350\,\mu\text{F} \cdot 0.025^2 \cdot 60\,\Omega^2$$

18) Line to Neutral Current using Reactive Power Formula

Evaluate Formula

Formula

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

Example with Units

$$1.2966\,\text{A} = \frac{134\,\text{VAR}}{3 \cdot 68.9\,\text{V} \cdot \sin(30°)}$$

19) Line to Neutral Current using Real Power Formula

Evaluate Formula

Formula

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

Example with Units

$$1.3128\,\text{A} = \frac{235\,\text{W}}{3 \cdot \cos(30°) \cdot 68.9\,\text{V}}$$

20) Line to Neutral Voltage using Reactive Power Formula

Evaluate Formula

Formula

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

Example with Units

$$68.7179\,\text{V} = \frac{134\,\text{VAR}}{3 \cdot \sin(30°) \cdot 1.3\,\text{A}}$$

21) Line to Neutral Voltage using Real Power Formula

Evaluate Formula

Formula

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

Example with Units

$$69.5781\,\text{V} = \frac{235\,\text{W}}{3 \cdot \cos(30°) \cdot 1.3\,\text{A}}$$

22) Power Factor given Power Formula

Evaluate Formula

Formula

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

Example with Units

$$0.8608 = \frac{235\,\text{W}}{130\,\text{V} \cdot 2.1\,\text{A}}$$

23) Power Factor given Power Factor Angle Formula

Evaluate Formula

Formula

$$\cos\Phi = \cos(\Phi)$$

Example with Units

$$0.866 = \cos(30°)$$

24) Power in Single-Phase AC Circuits Formula

Evaluate Formula

Formula

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

Example with Units

$$236.4249\,\text{W} = 130\,\text{V} \cdot 2.1\,\text{A} \cdot \cos(30°)$$

25) Power in Single-Phase AC Circuits using Current Formula

Evaluate Formula

Formula

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

Example with Units

$$229.1503\,\text{W} = 2.1\,\text{A}^2 \cdot 60\,\Omega \cdot \cos(30°)$$

26) Q Factor for Parallel RLC Circuit Formula

Evaluate Formula

Formula

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

Example with Units

$$39.9367 = 60\,\Omega \cdot \left(\sqrt{\frac{350\,\mu\text{F}}{0.79\,\text{mH}}}\right)$$

27) Q Factor for Series RLC Circuit Formula

Evaluate Formula

Formula

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

Example with Units

$$0.025 = \frac{1}{60\,\Omega} \cdot \left(\sqrt{\frac{0.79\,\text{mH}}{350\,\mu\text{F}}}\right)$$

28) Reactive Power Formula

Evaluate Formula

Formula

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

Example with Units

$$136.5\,\text{VAR} = 2.1\,\text{A} \cdot 130\,\text{V} \cdot \sin(30°)$$

29) Reactive Power using Line-to-Neutral Current Formula

Evaluate Formula

Formula

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

Example with Units

$$134.355\,\text{VAR} = 3 \cdot 1.3\,\text{A} \cdot 68.9\,\text{V} \cdot \sin(30°)$$

30) Reactive Power using RMS Voltage and Current Formula

Evaluate Formula

Formula

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

Example with Units

$$135.125\,\text{VAR} = 57.5\,\text{V} \cdot 4.7\,\text{A} \cdot \sin(30°)$$

31) Real Power in AC Circuit Formula

Evaluate Formula

Formula

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

Example with Units

$$236.4249\,\text{W} = 130\,\text{V} \cdot 2.1\,\text{A} \cdot \cos(30°)$$

32) Real Power using Line-to-Neutral Voltage Formula

Evaluate Formula

Formula

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

Example with Units

$$232.7097\,\text{W} = 3 \cdot 1.3\,\text{A} \cdot 68.9\,\text{V} \cdot \cos(30°)$$

33) Real Power using RMS Voltage and Current Formula

Evaluate Formula

Formula

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

Example with Units

$$234.0434\,\text{W} = 4.7\,\text{A} \cdot 57.5\,\text{V} \cdot \cos(30°)$$

34) Resistance for Parallel RLC Circuit using Q Factor Formula

Evaluate Formula

Formula

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

Example with Units

$$59.9449\,\Omega = \frac{39.9}{\sqrt{\frac{350\,\mu\text{F}}{0.79\,\text{mH}}}}$$

35) Resistance for Series RLC Circuit given Q Factor Formula

Evaluate Formula

Formula

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

Example with Units

$$60.0952\,\Omega = \frac{\sqrt{0.79\,\text{mH}}}{0.025 \cdot \sqrt{350\,\mu\text{F}}}$$

36) Resistance using Time Constant Formula

Evaluate Formula

Formula

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

Example with Units

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

37) Resonant Frequency for RLC circuit Formula

Evaluate Formula

Formula

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

Example with Units

$$302.6722\,\text{Hz} = \frac{1}{2 \cdot 3.1416 \cdot \sqrt{0.79\,\text{mH} \cdot 350\,\mu\text{F}}}$$

38) RMS Current using Reactive Power Formula

Evaluate Formula

Formula

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

Example with Units

$$4.6609\,\text{A} = \frac{134\,\text{VAR}}{57.5\,\text{V} \cdot \sin(30°)}$$

39) RMS Current using Real Power Formula

Evaluate Formula

Formula

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

Example with Units

$$4.7192\,\text{A} = \frac{235\,\text{W}}{57.5\,\text{V} \cdot \cos(30°)}$$

40) RMS Voltage using Reactive Power Formula

Evaluate Formula

Formula

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

Example with Units

$$57.0213\,\text{V} = \frac{134\,\text{VAR}}{4.7\,\text{A} \cdot \sin(30°)}$$

41) RMS Voltage using Real Power Formula

Evaluate Formula

Formula

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

Example with Units

$$57.735\,\text{V} = \frac{235\,\text{W}}{4.7\,\text{A} \cdot \cos(30°)}$$

42) Voltage using Complex Power Formula

Evaluate Formula

Formula

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

Example with Units

$$128.9796\,\text{V} = \sqrt{270.5\,\text{VA} \cdot 61.5\,\Omega}$$

43) Voltage using Power Factor Formula

Evaluate Formula

Formula

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

Example with Units

$$130.1218\,\text{V} = \frac{235\,\text{W}}{0.86 \cdot 2.1\,\text{A}}$$

44) Voltage using Reactive Power Formula

Evaluate Formula

Formula

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

Example with Units

$$127.619\,\text{V} = \frac{134\,\text{VAR}}{2.1\,\text{A} \cdot \sin(30°)}$$

45) Voltage using Real Power Formula

Evaluate Formula

Formula

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

Example with Units

$$129.2165\,\text{V} = \frac{235\,\text{W}}{2.1\,\text{A} \cdot \cos(30°)}$$

Variables used in list of AC Circuit Design Formulas above

- **C** Capacitance *(Microfarad)*
- **cosΦ** Power Factor
- f_c Cut-off Frequency *(Hertz)*
- f_o Resonant Frequency *(Hertz)*
- **I** Current *(Ampere)*
- I_{ln} 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_{ln} 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 in list of AC Circuit Design Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- Functions: **cos**, cos(Angle) *Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.*
- Functions: **sin**, sin(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.*
- Functions: **sqrt**, sqrt(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 (°) *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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