

IMPEDANCE

Basic Problems

1. From the diagram on the reverse side of the page determine amplitude, initial value and period of the voltage signal (solid line). Calculate its frequency and angular frequency.
2. How long does it take for an ac signal with frequency 25 Hz to drop from the maximum to one half?
3. An ac motor runs on ac voltage with a frequency of 25 Hz and an amplitude of 12 V. Its impedance is $450\ \Omega$. The current lags behind the voltage by 7.5 ms. Calculate the current's amplitude and the phase shift.
4. Calculate the capacitance of a capacitor and the inductance of a coil with an impedance of $1\ \text{k}\Omega$ at 1 kHz.
5. Calculate the current amplitude in an ac circuit with a capacitor $22\ \mu\text{F}$ on a voltage with frequency 50 Hz and amplitude 25 V. Draw the corresponding phasor diagram.
6. Using a phasor diagram, show that a real coil (i.e. a coil whose resistance cannot be neglected) causes a phase shift between 0 and $\pi/2$.
7. A coil with inductance 13 mH and a resistor with resistance $150\ \Omega$ are connected in series to an ac voltage. Calculate the frequency for which the impedance is $250\ \Omega$.
8. A capacitor with capacitance 33 nF and a resistor with resistance $22\ \text{k}\Omega$ are connected in series to a voltage supply. The phase shift between voltage and current is $-\pi/4$. Calculate the frequency of the voltage signal.
9. A coil with inductance 220 mH, a capacitor with capacitance $150\ \mu\text{F}$ and a resistor with resistance $22\ \Omega$ are connected in parallel to a voltage signal with frequency 50 Hz. Calculate the impedance and the phase shift.
10. The sound control of a hifi system can be realised by series wiring a capacitor and a resistor. Which partial voltage favours the low frequencies?
11. A *band-pass* filter can be realised by a series wiring of a capacitor and a coil. For a radio receiver it shall be tuned to 531 kHz. The capacitance is 680 pF. Calculate the correct value for the inductance.
12. Discuss the impedance vs. frequency diagram for a parallel ac circuit. Why is this circuit often called a *band rejection filter*?

Additional Problems

13. A *light emitting diode* (LED) runs on an ac voltage with amplitude 7 V. The current can flow through the diode only in one direction and only when the voltage is greater than the threshold value 2.5 V. During what fraction of a period is the LED emitting light?
14. Using the diagram on the reverse side determine the circuit's impedance and phase shift.
15. A real coil with inductance 13 mH and resistance $15\ \Omega$ is connected in parallel to a capacitor with capacitance $6.8\ \mu\text{F}$ to an ac voltage supply with frequency 1.2 kHz and amplitude 30 V. Construct the phasor diagram and determine the total current and the phase shift between the total current and the applied voltage.
16. A real coil with inductance 3.3 mH and resistance $32\ \Omega$ and a capacitor with capacitance 68 pF are connected in series. Graph the *resonance curve* $i_{\max}(\omega)$ for a voltage amplitude of 10 V. Determine the *resonance frequency* (i.e. the frequency of maximum current amplitude) and compare it to the expected value.

Solutions to Basic Problems: 1. 5 V, 4.3 V, 6.6 ms, 150 Hz, 950 rad/s; 2. 6.7 ms; 3. 27 mA, 1.2 rad; 4. 160 nF, 160 mH; 5. 170 mA; 7. 2.4 kHz; 8. 220 Hz; 9. 18 Ω , -0.62 rad (-36°); 11. 1.3 mH

