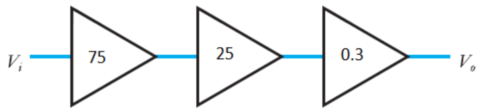
TUTORIAL 8 FREQUENCY CHARACTERISTICS OF AC CIRCUITS

8.1 What is meant by a 'two-port network', and what are the two ports?

8.2 Derive expressions for the voltage gain, current gain and power gain of a two-port network in terms of the input and output voltages, and the input and output currents.

8.3 Determine the voltage gain, current gain and power gain of the following arrangement.

8.4 Calculate the overall power gain of the following arrangement if the power gain of each stage is a shown in the diagram.



8.5 For the arrangement shown in Exercise 8.4, determine the gain of each stage in decibels, and then compute the gain of the overall arrangement in decibels.

8.6 A circuit has a gain of 25 dB. What is its power gain (expressed as a simple ratio)?

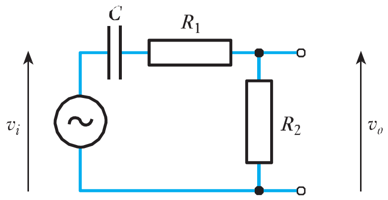
8.7 A circuit has a gain of 25 dB. What is its voltage gain?

8.8 Calculate the reactance of a 1 μF capacitor at a frequency of 10 kHz, and the reactance of a 20 mH inductor at a frequency of 100 rad/s. In each case include the units in your answer.

8.9 Express an angular frequency of 250 rad/s as a cyclic frequency (in Hz).

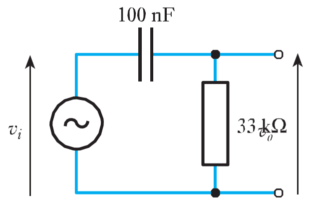
8.10 Express a cyclic frequency of 250 Hz as an angular frequency (in rad/s).

8.11 Determine the transfer function of the following circuit.



8.12 A series *RC* circuit is formed from a resistor of 33 kΩ and a capacitor or 15 nF. What is the time constant of this circuit?

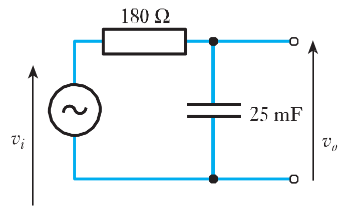
8.13 Calculate the time constant T, the angular cut-off frequency ω_c and the cyclic cut-off frequency f_c of the following arrangement. Is this a high- or a low-frequency cut-off?



8.14 Determine the frequencies that correspond to:

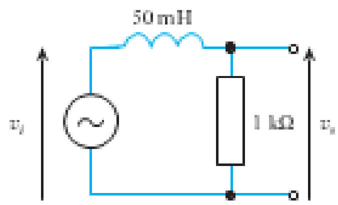
a) an octave below 30 Hz;
b) two octaves above 25 kHz;
c) three octaves above 1 kHz;
d) a decade above 1 MHz;
e) two decades below 300 Hz;
f) three decades above 50 Hz.

8.15 Calculate the time constant T, the angular cut-off frequency ω_c and the cyclic cut-off frequency f_c of the following arrangement. Is this a high- or a low-frequency cut-off?

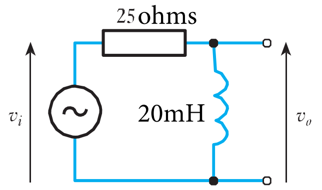


8.16 A parallel *RL* circuit is formed from a resistor of 150 Ω and an inductor of 30 mH. What is the time constant of this circuit?

8.17 Calculate the time constant T, the angular cut-off frequency ω_c and the cyclic cut-off frequency f_c of the following arrangement. Is this a high- or a low-frequency cut-off?



8.18 Calculate the time constant T, the angular cut-off frequency ω_c and the cyclic cut-off frequency f_c of the following arrangement. Is this a high- or a low-frequency cut-off?



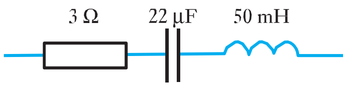
8.19 Sketch a straight-line approximation to the Bode diagram of the circuit of Exercise 8.18. Use this approximation to produce a more realistic plot of the gain and phase responses of the circuit.

8.20 A circuit contains three high-frequency cut-offs and two low-frequency cut-offs. What are the rates of change of gain of this circuit at very high and very low frequencies?

8.21 In the arrangement described in Exercise 8.20, what phase shift is produced at very high and very low frequencies?

8.22 Explain what is meant by the term 'resonance'.

8.23 Calculate the resonant frequency f_0, the quality factor Q and the bandwidth B of the following circuit.



8.24 Calculate the resonant frequency f_0, the quality factor Q and the bandwidth B of a parallel circuit with a resistor of 1 kΩ, an inductor of 50 mH and a capacitor of 22 µF.

8.25 Why is it more common to construct first order filters using combinations of resistors and capacitors, rather than resistors and inductors.

8.26 Explain the difference between a passive and an active filter.

8.27 Why are inductors often avoided in the construction of filters?

8.28 What form of active filter is optimised to produce a flat response within its pass band?

8.29 What form of active filter is optimised to produce a sharp transition from the pass band to the stop band?

8.30 What form of filter is optimised for a linear phase response?

8.31 Explain why stray capacitance and stray inductance affect the frequency response of electronic circuits.