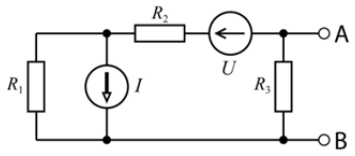
Fundamentals of electrical circuits – sample exam test

1) DC I *(10 marks)*

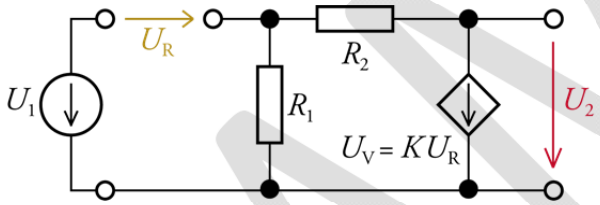
a) For the circuit in the figure calculate voltage U_{AB} between the terminals A, B.
b) From the viewpoint of terminals A, B draw the Thévenin's (or Norton's) equivalent circuit.
c) Calculate parameters of this equivalent circuit.

$U = 80\,\mathrm{V},\ I = 6\,\mathrm{mA},\ R_1 = 5\,\mathrm{k\Omega},\ R_2 = 1\,\mathrm{k\Omega},\ R_3 = 4\,\mathrm{k\Omega}.$



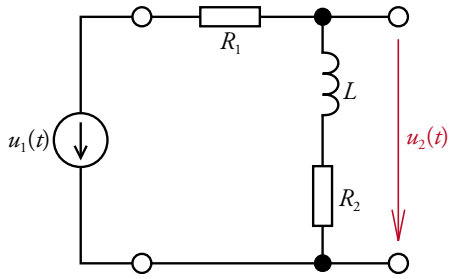
2) DC II *(10 marks)*

Circuit in the figure contains voltage controlled voltage source. Calculate voltage U_2, if $U_1 = 0.5\,\mathrm{V}$, $R_1 = 1\,\mathrm{k\Omega},\ R_2 = 4\,\mathrm{k\Omega},\ K = 20000\,[-],\ U_V = K\,U_R$.



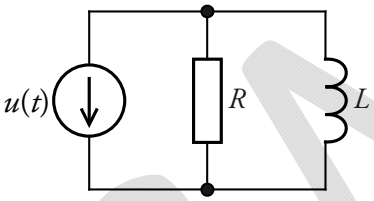
3) Frequency response *(10 marks)*

For circuit in the figure draw magnitude and phase frequency response (Bode plot) of the voltage transfer function $\mathbf{P} = \frac{\mathbf{U}_2}{\mathbf{U}_1}$. $R_1 = 18\,\mathrm{k\Omega},\ R_2 = 2\,\mathrm{k\Omega},\ L = 0.4\,\mathrm{H}$.



4) AC power *(10 marks)*

For the circuit in the figure calculate active, reactive and apparent power, drawn from the voltage source $u(t) = 100\sin(5000\,t)\,\mathrm{V}$, $R = 500\,\Omega,\ L = 100\,\mathrm{mH}$.



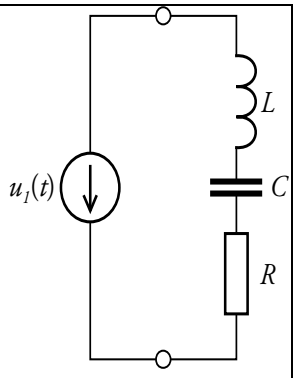
5) Resonant circuit. (10 marks)

Series RLC circuit (see figure) is supplied from sinusoidal voltage source with amplitude 1V. $C = 1\mu\text{F}$.

a) Calculate inductance of the inductor, if the resonant frequency is $\omega_r = 1000\,\text{rad s}^{-1}$.

b) Calculate the resistivity of resistor, if the amplitude of voltage across capacitor terminals in steady state in resonance is 100 V.

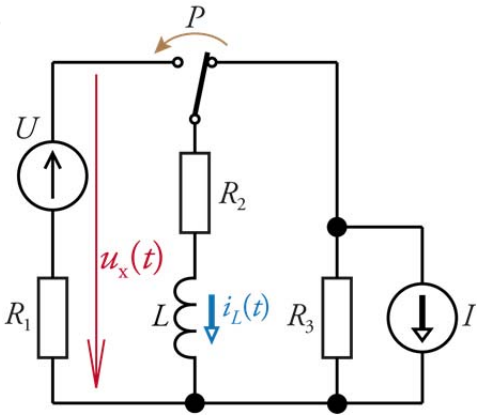
c) Find total current, which flows in the circuit.



6) 1st order transients *(10 marks)*

Circuit in the figure was at $t < 0$ in a steady state *(the switcher P was in the right-handed position at this time)*. At $t = 0$ **the switcher „P“ was switched to the left-handed position**. Calculate both the waveform of the current $i_L(t)$ passing the inductor, and the voltage $u_x(t)$.

$U = 120\,\text{V},\ I = 30\,\text{mA},$
$R_1 = 200\,\Omega,\ R_2 = 400\,\Omega,\ R_3 = 800\,\Omega,\ L = 24\,\text{mH}.$



7) 2nd order circuit *(10 marks)*

RLC circuit in the figure was in a steady state at $t < 0$. The switcher "S" was off at this time, and the capacitor was charged to the voltage $u_C(0) = 4000$ V. **At time $t = 0$ the switcher „S" was switched on.**
$R = 50\,\Omega,\ L = 0.3\,\mathrm{H},\ C = 45\,\mu\mathrm{F}.$

a) Write circuit equation, which describes current in the circuit.
You can write this equation in the time domain (integral-differential equation), or using Laplace transform, whatever you prefer.

b) Calculate roots of the equation from step a.
(characteristic equation – time domain, or polynomial in denominator – Laplace transform).

c) Write a general solution of electrical current waveform in the circuit (general solution of the transient). **Don't calculate** integration constants, or, don't perform partial fraction decomposition (in the case of Laplace transform solution).