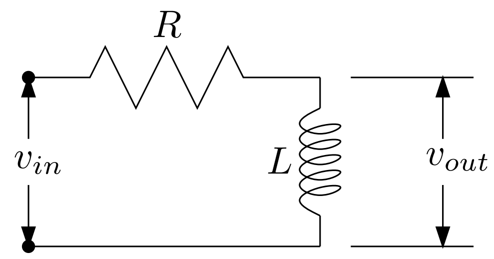


1. (4 points) Find the transfer function between v_{out} and v_{in}.

$$v_{in} - iR - L\frac{di}{dt} = 0 \tag{1}$$

$$V_{in} = IR + LsI \tag{2}$$

$$I = \frac{1}{R + Ls}V_{in} \tag{3}$$

$$v_{out} = L\frac{di}{dt} \tag{4}$$

$$V_{out} = LsI \tag{5}$$

Substituting for I from equation 3 gives

$$V_{out} = \frac{1}{R + Ls}LsV_{in} \text{ or } \frac{V_{out}}{V_{in}} = \frac{Ls}{Ls + R} = \frac{s}{s + R/L} \tag{6}$$

If $R = 100\ \Omega$, $L = 15$ mH (15e–3 H), and $v_{in} = \sin(2\pi f t)$, find the magnitude and phase of v_{out} for $f = 1$ Hz, 100 Hz, and 10,000 Hz.

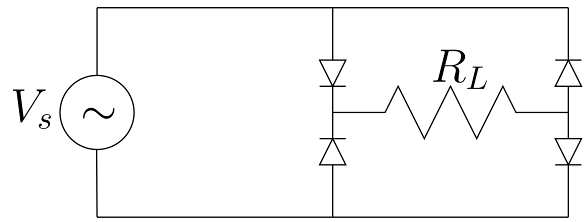
$$TF = \frac{s}{s + p} \tag{7}$$

where $p = R/L = 6666.667$ rad/sec or 1061 Hz. Evaluate TF at $s = 2.0j\pi \begin{bmatrix} 1 & 100 & 10000 \end{bmatrix}$:

f (Hz)	Mag.	Phase (deg.)
1	0.0009425	89.95
100	0.09383	84.62
10000	0.9944	6.06

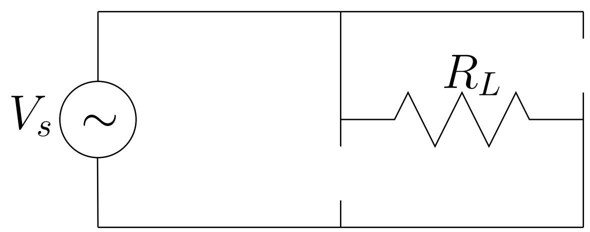
Extra credit (1 point) What is this circuit called? What does it do?

The circuit is a high-pass filter.

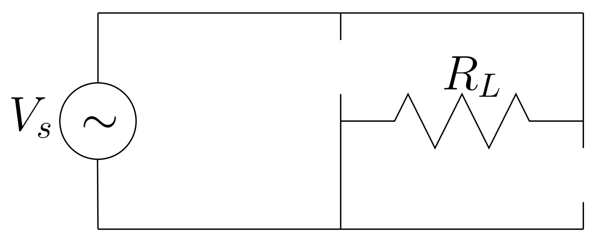


2. (3 points) Assuming ideal diodes, draw equivalent circuits for $V_s > 0$ and $V_s < 0$.

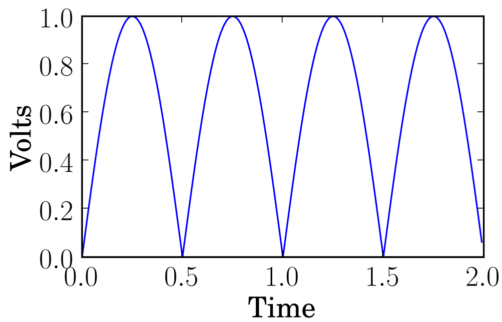
$V_s > 0$:

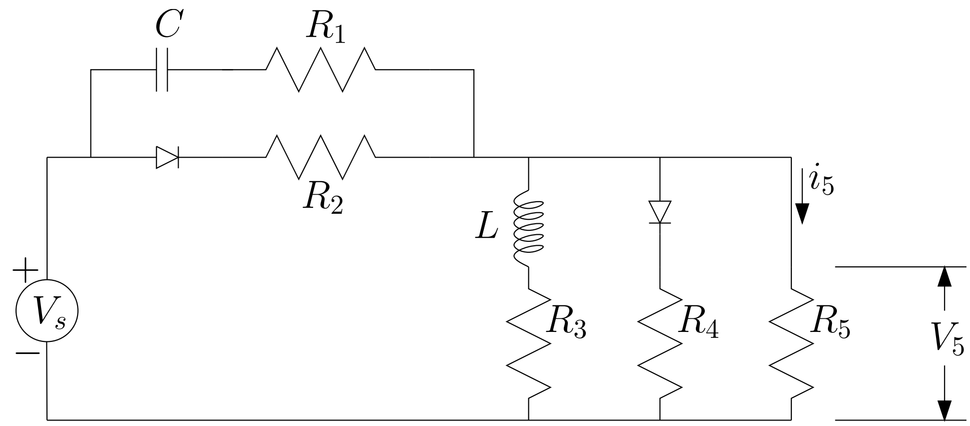


$V_s < 0$:

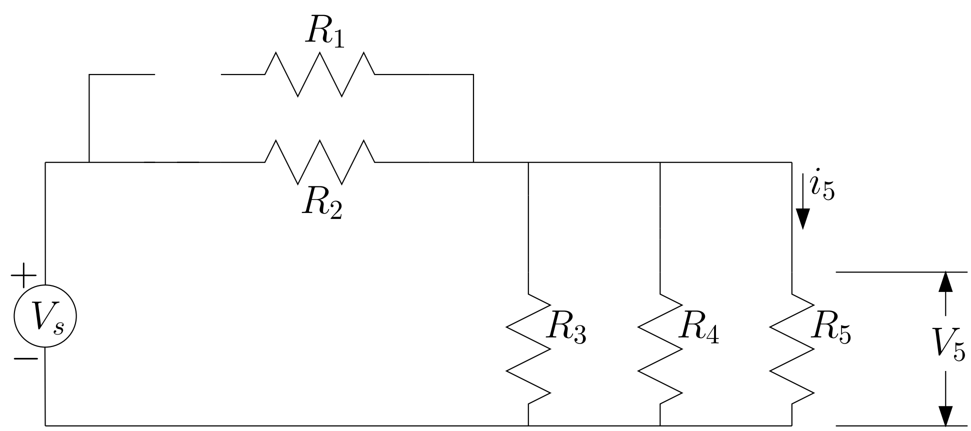


If V_s is a sine wave, sketch the voltage across R_L (assuming ideal diodes).

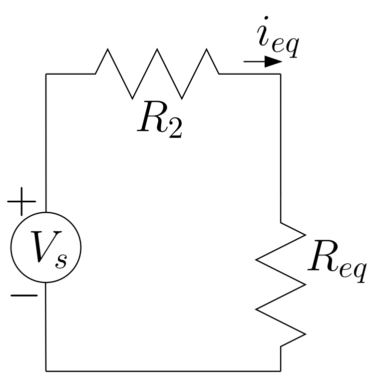




3. (3 points) If V_s is a DC voltage, draw the equivalent DC circuit.



If V_s= 5V DC, R_1=1 kΩ, R_2=2 kΩ, R_3=3 kΩ, R_4=4 kΩ, and R_5=5 kΩ, find V_5 and i_5.



$$R_{eq} = \left(\frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5}\right)^{-1} = 1276.6\ \Omega \tag{8}$$

$$V_s = R_2 i_{eq} + R_{eq} i_{eq} \tag{9}$$

$$i_{eq} = \frac{V_s}{R_2 + R_{eq}} = 0.001526\ \text{A} \tag{10}$$

$$V_{eq} = V_5 = i_{eq} R_{eq} = 1.948\ \text{V} \tag{11}$$

$$i_5 = \frac{V_5}{R_5} = 0.0003896\ \text{A} \tag{12}$$