PreLab6

Study the transition process of Circuits

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Part ONE Integrator

In Figure 1, the resistor R=10kΩ, Vin is a square wave, T=1ms, 50% duty cycle, the high level of the square wave is 3V, the low level of the square wave is -3V.

1. Under what conditions does an RC circuit act as an integrator? ___1.5pt

$V_{out} \ll V_{in}$

$t \leq RC$

2. Calculate the capacitance of C @ τ=0.1T, τ=T, τ=10T. ___3pt

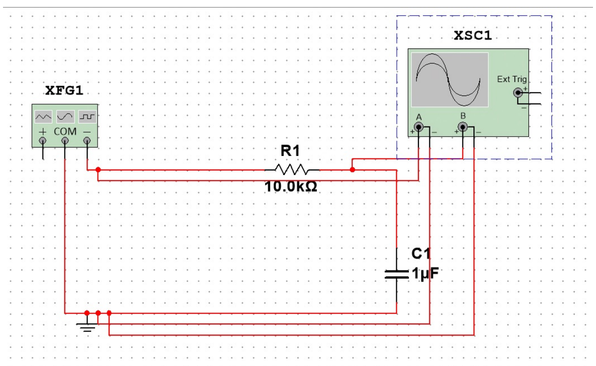
$\tau = 0.1T = 1\times10^{-4} = 10^{4}C \Rightarrow C = 1\times10^{-8}F$

$\tau = T = 1\times10^{-3} = 10^{4}C \Rightarrow C = 1\times10^{-7}F$

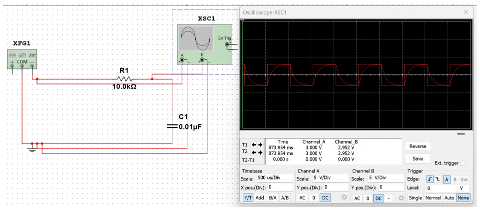
$\tau = 10T = 1\times10^{-2} = 10^{4}C \Rightarrow C = 1\times10^{-6}F$

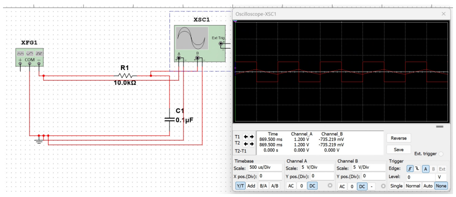
3. Simulate the four circuits using MultiSim

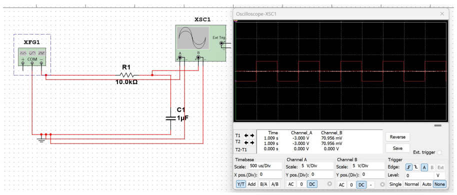
(1) take a screenshot of the circuit schematic (one case is ok). ___2pt



(2) take screenshots of the output voltage waveform (at least two cycles) @τ=0.1T, τ=T, τ=10T ___3pt







Part TWO Differentiator

In Figure 2, the resistor R=10kΩ, Vin is a square wave, T=1ms, 50% duty cycle, the high level of the square wave is 3V, the low level of the square wave is -3V.

1. Under what conditions does an RC circuit act as a differentiator? ____1.5pt

$V_{in} >> V_{out}$

$t >> RC$

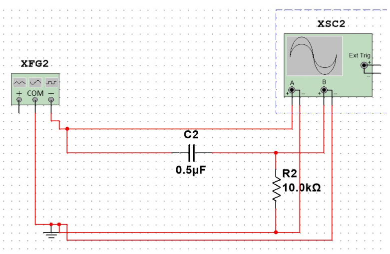
2. Calculate the capacitance of C @ τ= 5T, τ= 0.1T. ____2pt

$\tau=5T=5\times10^{3}=10^{4}C \Rightarrow C=5\times10^{-7}F$

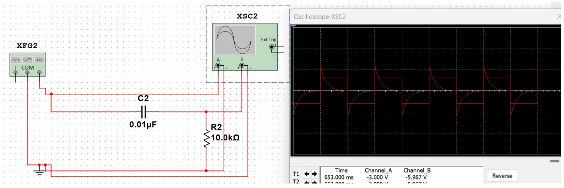
$\tau=0.1T=10^{-4}=10^{4}C \Rightarrow C=10^{-8}F$

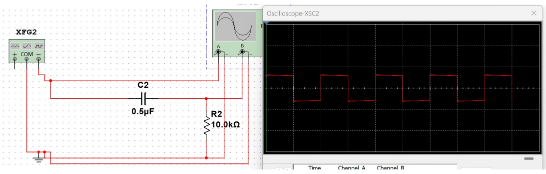
3. Simulate the two cases using MultiSim.

(1) Take a screenshot of the circuit schematic (one case is ok). ____1.5pt



(2) Take screenshots of the input and output voltage waveform (at least two cycles) @ τ=5T, τ= 0.1T respectively (input and output are in the same coordinate). ____4pt





Part THREE RLC Circuit

In the RLC series circuit shown in Figure 3, L= 0.5H, C = 0.1µF. Vin is a square wave, **T=10ms**, 50% duty cycle, the high level of the square wave is 3V, the low level of the square wave is -3V.

1. Is the circuit overdamped, underdamped or critically damped? Why? ____6pt

①R=1.3kΩ

$\alpha = \frac{R}{2L} = \frac{1.3k}{2\times 0.5} = 1.3k$ $\quad w_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{0.5\times 0.1\times 10^{-6}}} = 4.5k$ $\quad \alpha < w_0$

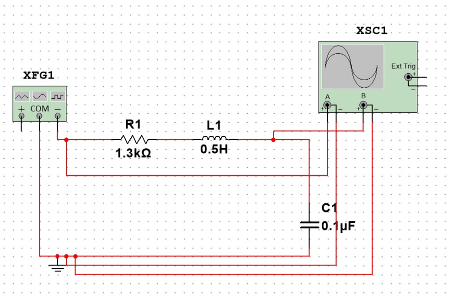
Underdamped

②R= 6.2kΩ

$\alpha = \frac{R}{2L} = 6.2k$ $\quad w_0 = \frac{1}{\sqrt{LC}} = 4.5k$ $\quad \alpha > w_0$

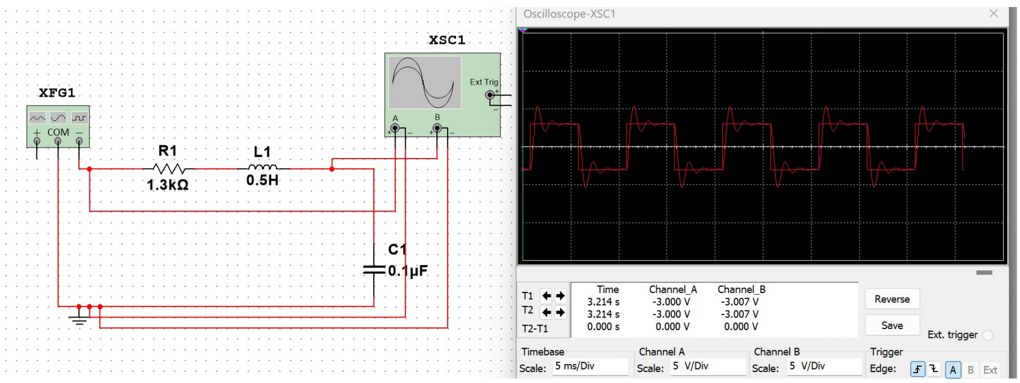
Overdamped

2. Simulate the RLC series circuit using MultiSim. Take a screenshot of the circuit schematic when R=1.3kΩ. ____1pt

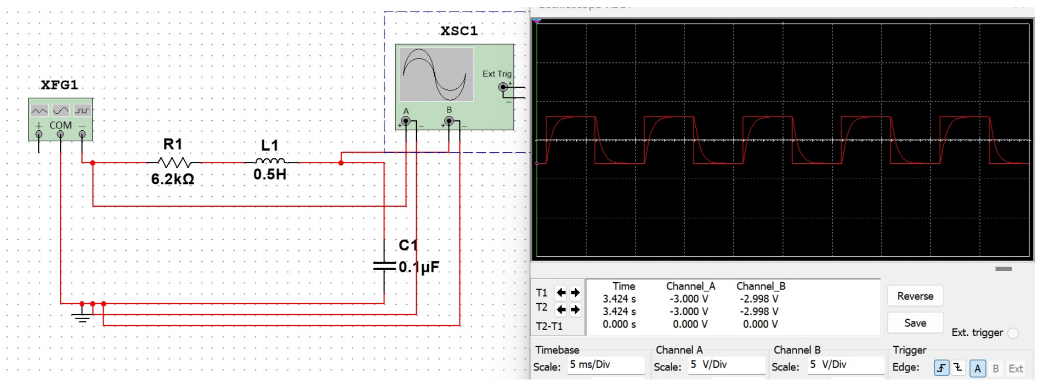


3. Take a screenshot of the input and output transient voltage waveform (input and output are in the same coordinate). ___6pt

R=1.3kΩ

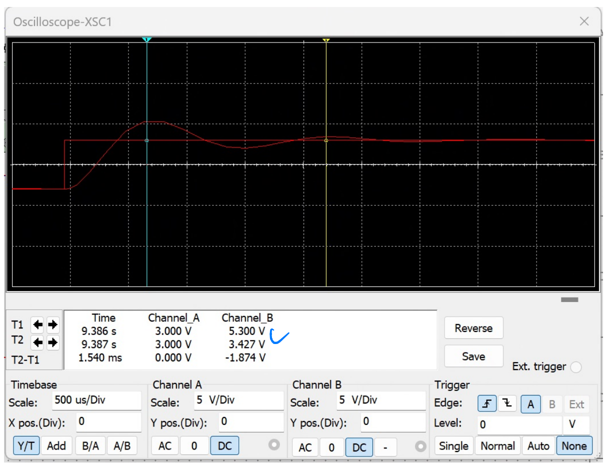


R=6.2kΩ



4. Record the necessary data, and get decay constant [s^{-1}] α and the resonant frequency. ___6pt

R=1.3kΩ



$T = 1.540\ ms = 1.54 \times 10^{-3} s = \frac{2\pi}{\omega_0}$

$\Rightarrow \omega_0 = \frac{2\pi}{T} = 4079.99\ rad/s$

$U_1 = 5.3 - 3 = 2.3V \quad U_2 = 3.427 - 3 = 0.427$

$\alpha = \frac{1}{T} \ln \frac{U_1}{U_2} = 1093.43$