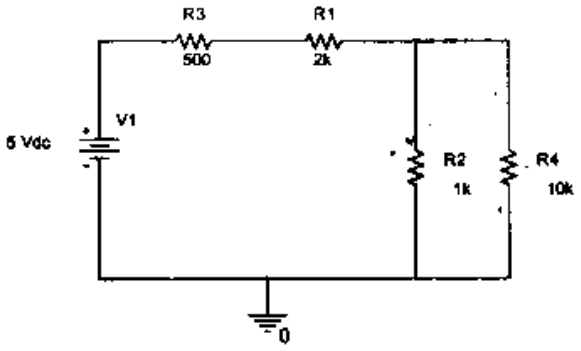
ENGR4300 Test 1A
Spring 2002

Name answer key
Section _____

1. Resistive circuits (20 points)



In the circuit above, V1=5 volts. R1= 2000Ω, R2= 1000Ω, R3= 500Ω, R4= 10,000Ω

a) (10 points) Find the amplitude of the voltage across R1.

$R_{24} = \frac{1K \cdot 10K}{1K+10K} = .909\,K\Omega$

$R_{eq} = R_3 + R_1 + R_{24}$

$= 500 + 2000 + 909$

$= 3409\,\Omega$

$I_T = \frac{V_T}{R_{eq}} = \frac{5}{3409} = 1.4667\,mA$

$V_1 = I_T R_1$

$= (1.4667m)(2K)$

$\boxed{V_1 = 2.9\,V}$

b) (10 points) Find the current through R4.

$V_{24} = I_T R_{24} = (1.4667m)(.909K)$

$= 1.33V$

$V_4 = I_4 R_4$

$1.33 = I_4 (10{,}000)$

$\boxed{I_4 = .133\,mA}$

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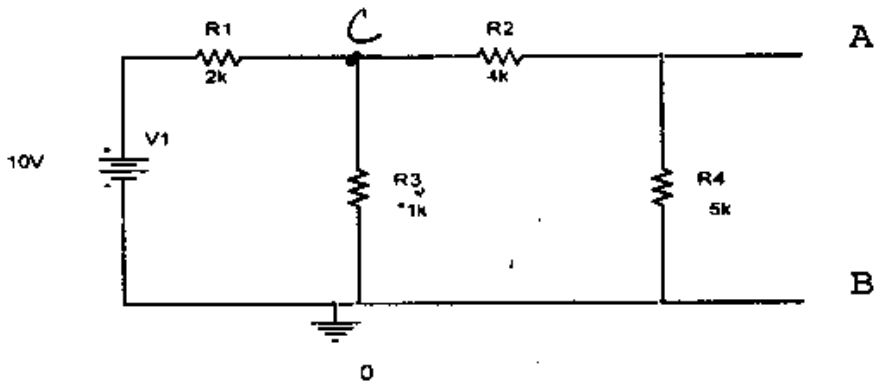
2. Thevenin circuits (20 points)



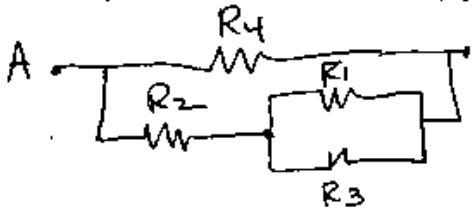
a) Find the Thevenin Voltage (Voc) of the Circuit (8 points)

$R_{24} = 4K+5K = 9K \quad R_{324} = \frac{9K \cdot 1K}{9K+1K} = 0.9K$

$V_C = 10\left(\frac{0.9K}{2K+0.9K}\right) = 3.103V \quad V_A = 3.103\left(\frac{5K}{4K+5K}\right) = 1.72V$

$V_B = 0$ $\quad V_{AB} = V_{OC} = V_{TH} = 1.724V$

b) Find the Thevenin Resistance (8 points)



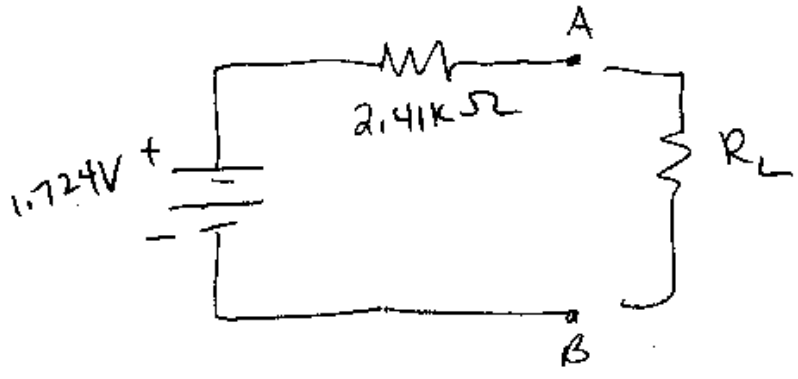
$R_{13} = \frac{2K \cdot 1K}{2K+1K} = \frac{2}{3}K$

$\therefore R_{213} = 4K + \frac{2}{3}K = \frac{14}{3}K$

$R_{4213} = \frac{5K \cdot \frac{14}{3}K}{5K + \frac{14}{3}K} = 2.41K\Omega$

$R_{TH} = 2.41K\Omega$

c) Draw the Standard Thevenin Circuit, including a load Resistor (4 points)



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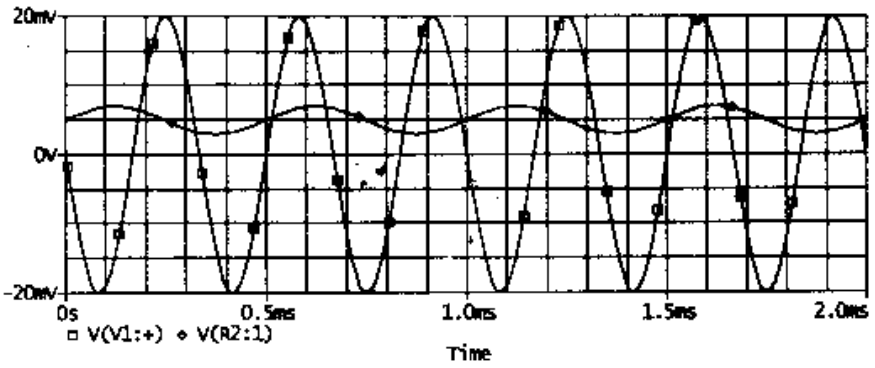
3. Sine Waves (20 points)



a) Consider trace A in the plot above and give the following values (6 points):
(Do not forget the units.)
frequency: 2K Hz
amplitude: 2mV
rms value: (see next page)
peak-to-peak voltage: 4mV
phase shift: ϕ rad
offset voltage: 5mV

$T = 0.5mS \quad f = \frac{1}{T} = 2K$

b) Write down the mathematical expression for A in the form $v(t) = V_{dc} + A \sin(\omega t + \phi)$.
(4 points)

$v(t) = .005 + .002 \sin(4000\pi t)$

$\omega = 2\pi f = (2\pi)(2K)$
$= 4K\pi$
$= 12566.37 \text{ rad/s}$

c) Consider trace B in the plot above and give the following values (6 points):
(Do not forget the units.)
frequency: 3K Hz
amplitude: 20mV
rms value: 14.1mV
peak-to-peak voltage: 40mV
phase shift: $-\pi$ rad/sec or $+\pi$ rad/sec
offset voltage: 0 volts

$T = 0.33mS \quad f = 3K$

$\phi = -\omega t_0 = -2\pi\left(\frac{.165}{.33}\right)$
$= -\pi \text{ (or } +\pi)$

d) Write down the mathematical expression for B in the form $v(t) = V_{dc} + A \sin(\omega t + \phi)$.
(4 points)

$v(t) = .02 \sin(6000\pi t \pm \pi)$

$\omega = 2\pi f = (2\pi)(3K)$
$= 6K\pi$
$= 18879.55 \text{ rad/sec}$

V_{rms}

1] No DC offset

$$V_{rms} = \frac{V_{AMP}}{\sqrt{2}}$$

2] With DC offset

$$V_{rms} = \sqrt{(V_{DC})^2 + \frac{(V_{AMP})^2}{2}}$$

Test B

$$V_{rms_B} = \sqrt{(10m)^2 + \frac{(2m)^2}{2}}$$

$V_{rms} = 10.1mV$

Test A

$$V_{rms_A} = \sqrt{(5m)^2 + \frac{(2m)^2}{2}}$$

$V_{rms} = 5.2mV$

Since we did not cover this equation, you were all given the point. (Thank you, AC for clarification)

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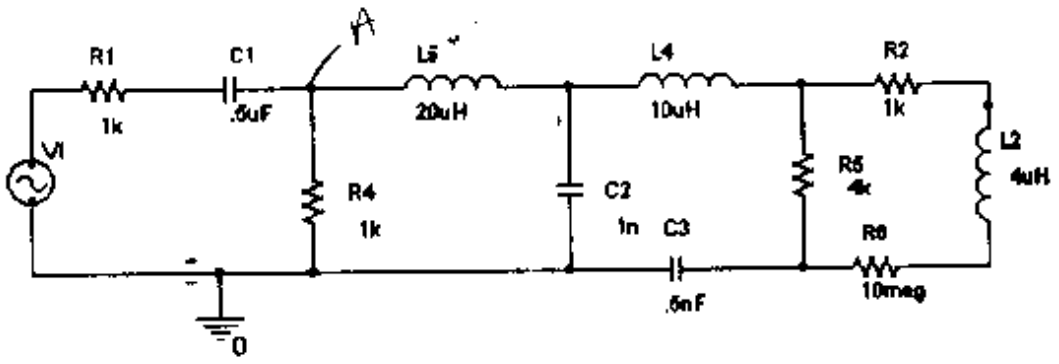
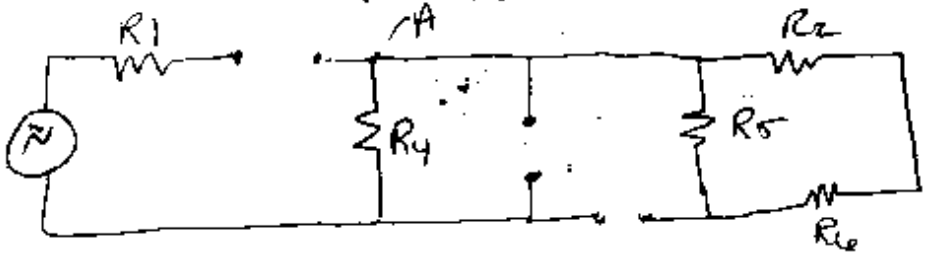
4. Inductance and Capacitance at very high and very low frequencies (20 points).



Given that you know that inductors and capacitors can behave like short and open circuits at very high and low frequencies, we want to redraw the above circuit by replacing components that look like open circuits by open circuits and components that look like short circuits by short circuits.

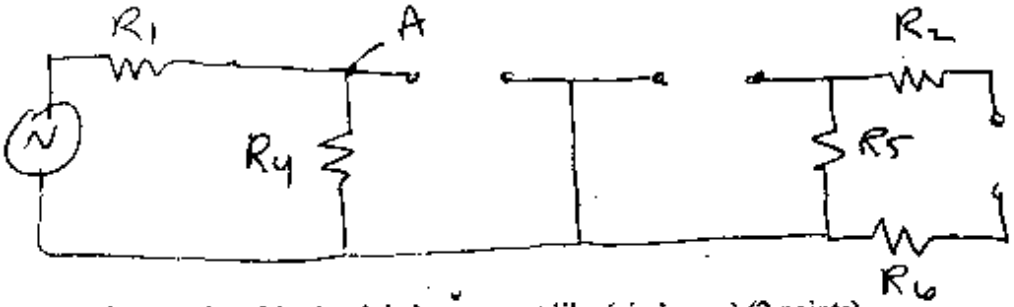
a) Redraw this circuit at low frequencies (8 points).



b) At low frequencies, this circuit behaves most like (circle one) (2 points)

a voltage divider (an open circuit) a short an op amp

c) Redraw this circuit at high frequencies (8 points).



d) At high frequencies, this circuit behaves most like (circle one) (2 points).

(a voltage divider) an open circuit a short an op amp

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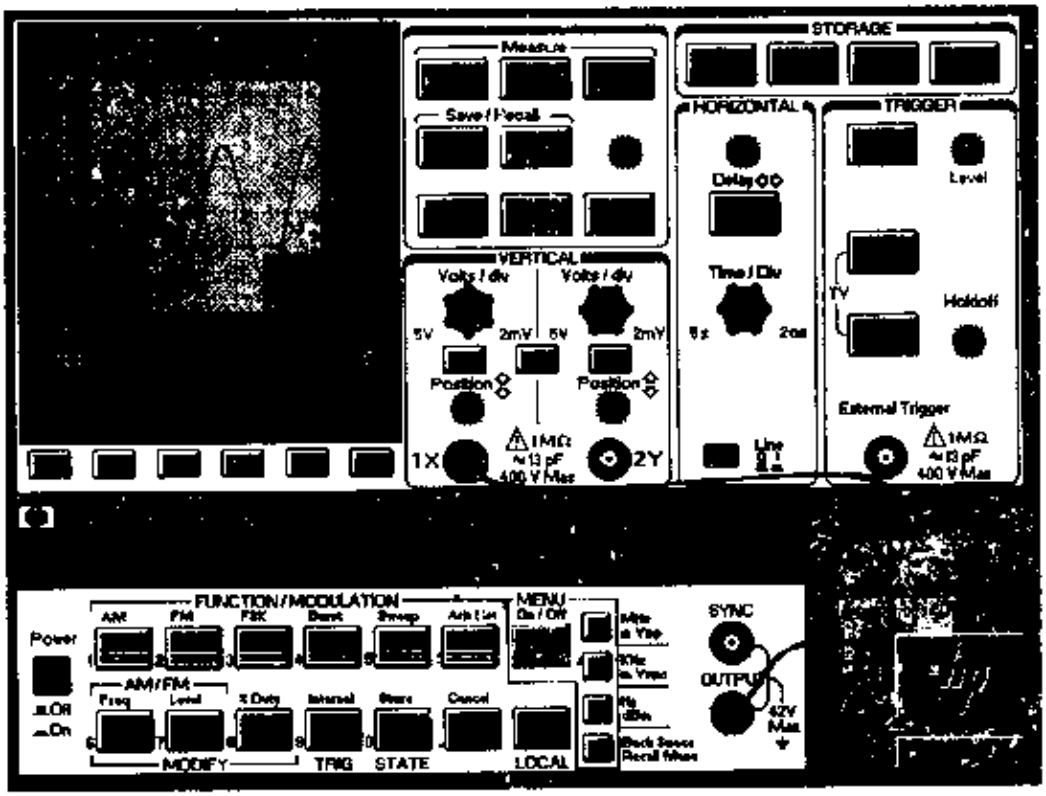
5. Instrumentation (20 points)



a) List two ways to obtain the frequency of the signal using the oscilliscope (4 points)

1) Use TIME button to display frequency of signal.

2) Use scale (20 µs per division) to find the period (50 µs) and take inverse (20 KHz)

b) When the function generator is connected to the scope you should notice a discrepancy between the reading on the display panel of the function generator, and the signal displayed on the scope. What discrepancy do you see and which device is correct? (2 points) Why? (6 points)

The scope shows the peak-to-peak voltage as 800mV and the function generator shows 400mV. The 'scope is right. The function generator expects a 50Ω load, but the load of the scope is 1MΩ. This very large load is so far from the expected load, that the scope ends up showing twice the amount on the generator.

c) Explain as simply as possible how to set up the function generator and scope to display the signal shown. (Use of Autoscale is NOT allowed). **Give specific values.** (8 points)

1) Set FG to 20KHz
2) set FG Amp to 400mVp-p
3) turn off FG offset)
4) set volts/div on 'scope channel 1 to 200mV
5) set time/div on 'scope to 20µS.
6) move position of trace to 0 on channel 1