Name _____

1. _____   (6 pts)

2. _____   (15 pts)

3. _____   (8 pts)

4. _____   (8 pts)

5. _____   (8 pts)

6. _____   (10 pts)

7. _____   (5 pts)

Total _____

For partial credit on some questions, you may want to re-draw/label circuit diagrams to clarify your answers.

Show all of your work. Use the backs of pages if there is not enough room on the front.

Many problems can be solved using more than one method. Check your answers by using a second method.

At least skim through the entire quiz before you begin and then start with the problems you know best.

The proctor will only answer clarification questions where wording is unclear or where there may be errors/typos. No other questions will be responded to.
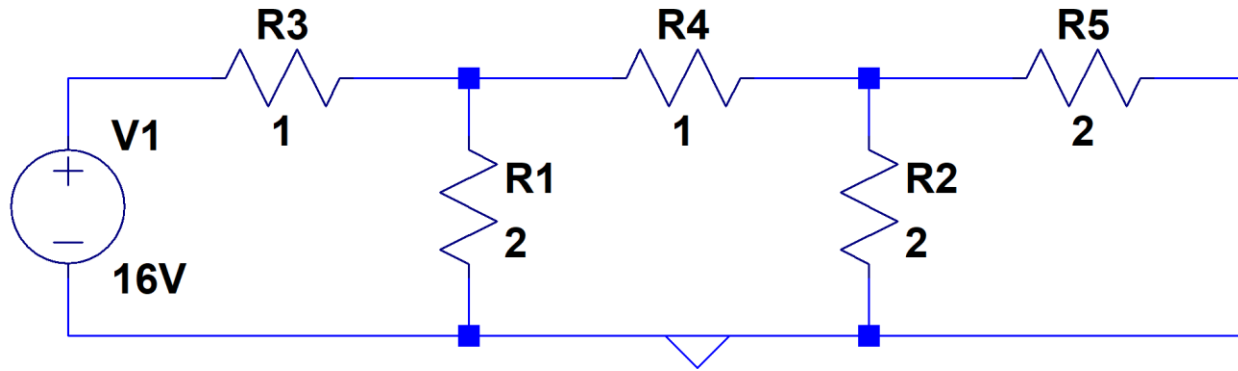
Problem 1 (6 Points) – Voltage Dividers with a Sinusoidal Source
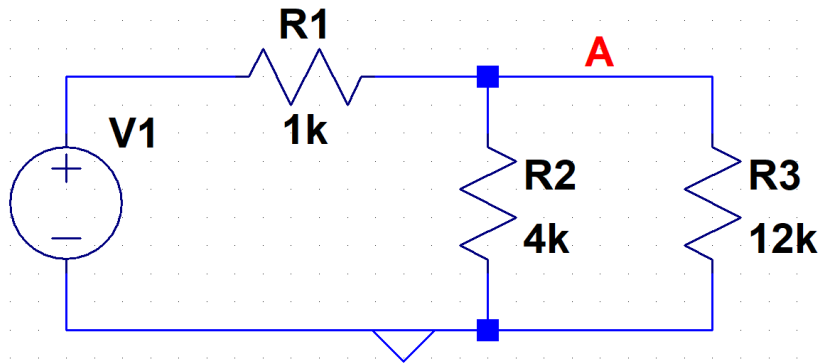
The source voltage is a sinusoidal signal, with an amplitude of 8V and a frequency of 10 Hz. On the provided plot, sketch the voltage at node A as a function of time.
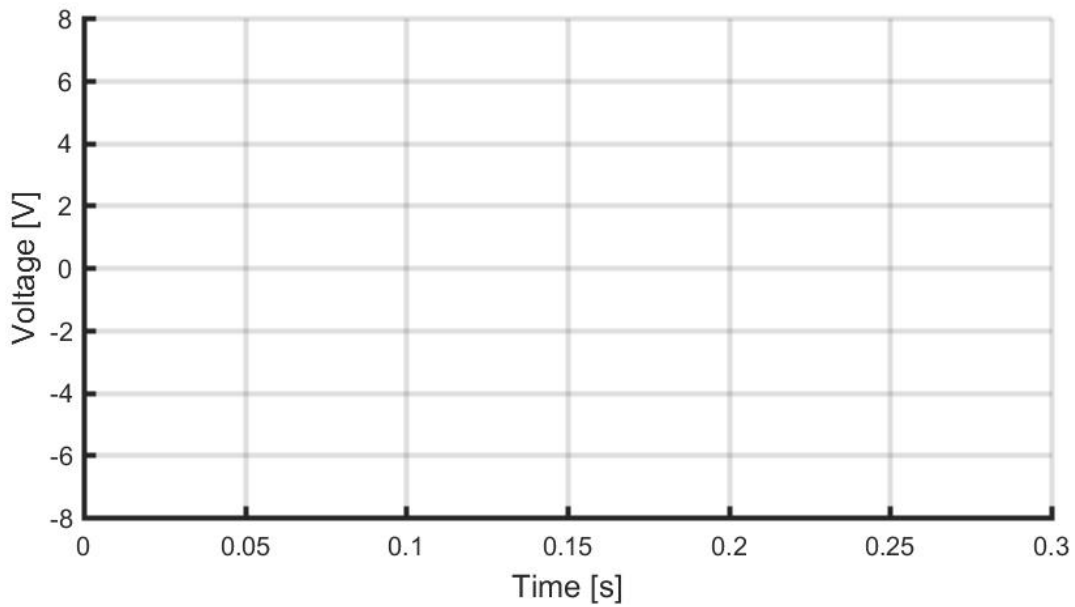
Problem 2 (15 Points) – Nodal Analysis

a) Label all the nodes in the above circuit. (2 pts)
b) Which labelled nodes have an unknown voltage? _____ (1 pt)

c) Apply KCL and determine the linear system of equations associated with the unknown nodes. (Do not simplify the circuit using parallel and series relationships for resistors.) (3 pts)

d) Based on your part c equations, build the matrix expression $Ax = b$. (2 pts)

$$\begin{bmatrix} \\ \\ \end{bmatrix} \begin{bmatrix} \\ \\ \end{bmatrix} = \begin{bmatrix} \\ \\ \end{bmatrix}$$

e) Find the determinant of the A matrix in the above expression. (1 pts)

f) Using any method, find the inverse of the A matrix in the above expression. (2 pts)

g) Use matrix mathematics to determine the voltage at the unknown nodes. Circle your voltage results. (2 pts)

h) If the source was replaced by a sinusoidal signal, $V(t) = 16\sin(20\pi t)$, sketch the voltage at the unknown nodes on the following plot. (2 pts)
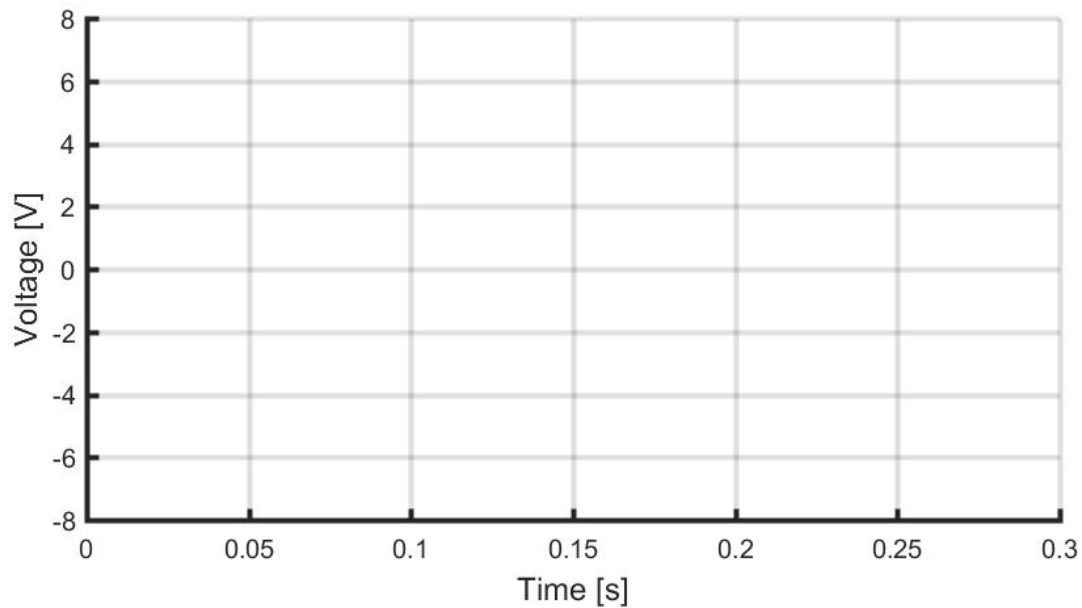
Problem 3 (8 Points) – Concept Questions

The voltage in an RC circuit when the capacitor is charging has which of the following expressions (circle one).

    i. $V(t) = V_o e^{-\frac{t}{RC}}$

    ii. $V(t) = V_o \left(1 - e^{-\frac{t}{RC}} \right)$

The current in an RL circuit when the current is decaying has which of the following expressions (circle one).

    i. $I(t) = I_o e^{-\frac{t}{L/R}}$

    ii. $I(t) = I_o \left(1 - e^{-\frac{t}{L/R}} \right)$

In an underdamped second order circuit, the relationship between the attenuation constant, α, and the oscillation frequency, β, is (circle one)

    i. $\alpha > \beta$

    ii. $\alpha = \beta$

    iii. $\alpha < \beta$

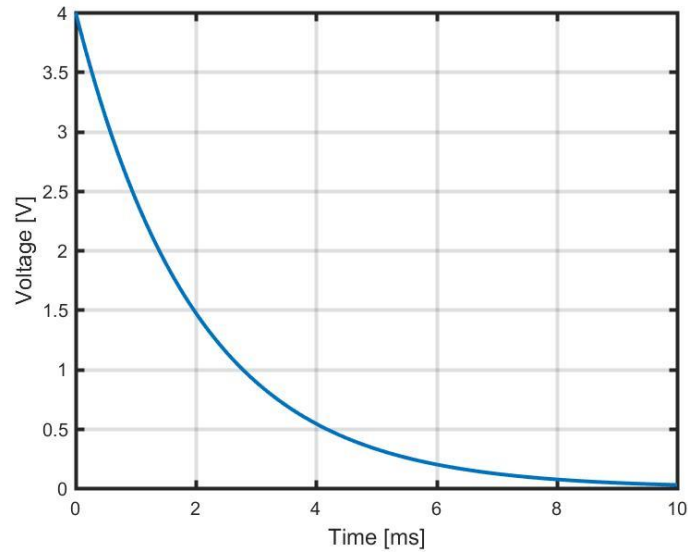We can increase the time constant in an RL circuit by (circle all correct answers)

    i.   Increasing the resistance

    ii.   Decreasing the resistance

    iii.   Increasing the inductance

    iv.   Decreasing the inductance

Problem 4 (8 Points) – First Order Circuit

a) For the above plot, determine the time constant in ms. Note, the time axis is in units **milliseconds** (0.001s). (4 pts)

τ	[ms]

b) Design any circuit that would produce the above voltage plot. Your circuit should include a source and include a brief description of how the source behaves. (4 pts)

Problem 5 (8 Points) – RC Circuits
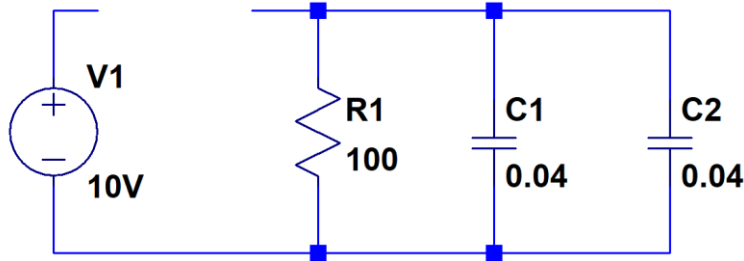
In the above circuit, the voltage source is connected to the circuit and then disconnected at t = 0s (time equals zero). Additionally, at t = 5s, capacitor C2 is disconnected from the circuit, discharged by shorting the leads and then immediately reconnected to the circuit (all happening very quickly). To the best of your artistic ability, sketch the voltage across capacitor C1 as a function of time.
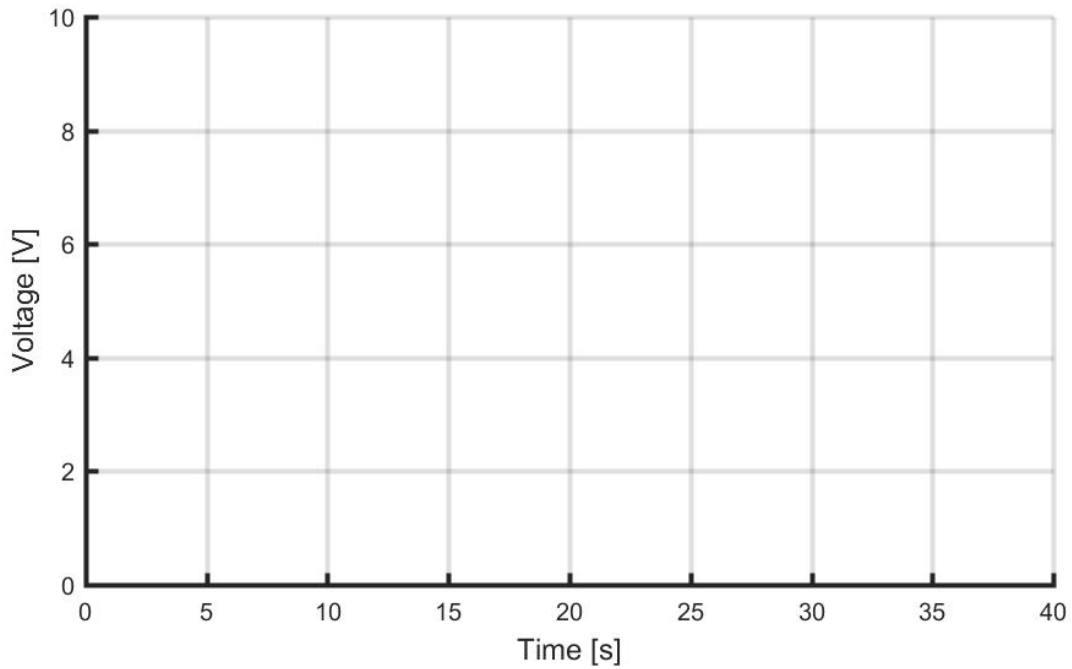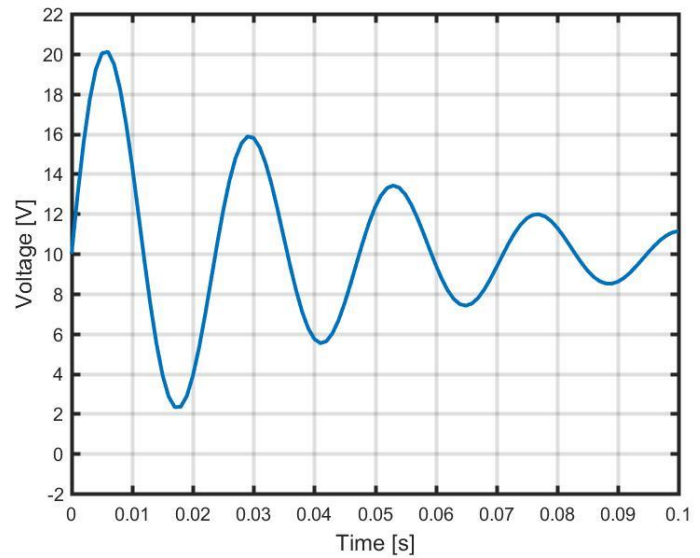
Problem 6 (10 Points) – Second Order Circuit

Note, the time axis is in units **seconds.**

a) Estimate the DC steady state value of the voltage (the value of the voltage as time becomes very large). (2 pts)
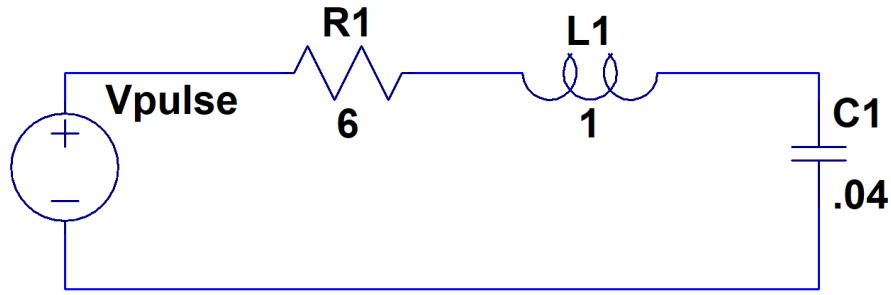

b) Estimate the period, T, of the sinusoid. (2 pts)

c) Estimate the oscillation frequency, β. (2 pts)

d) Estimate the attenuation constant, α. (2 pts)

e) Estimate the resonant frequency, ω_o. (2 pts)

Problem 7 (5 Points) – Second Order Circuit

To the best of your artistic ability, sketch the voltage across the capacitor in the above circuit for a pulsed voltage source, between Vmin = 0V and Vmax = 5V. You only need to sketch one 'section' of the decaying sinusoid during capacitor discharge (when the capacitor voltage is decaying to zero). Annotate your plot, indicating 'features of interest'.