Answer any 7 of the 8 questions. All parts of a given problem are worth the same number of points unless noted in the problem. The number of points earned on this exam will be added to your total points for determination of the final course grade. Notice that you may earn 5 bonus points above the advertised 100 points for this exam. Do your work on these pages. Use the backs of the pages for extra space if necessary.

The exam is closed book. Calculators are allowed.
Question 1

Figure 1 illustrates a typical linear, series power supply as discussed in lecture.

(15 points) 9 components make up the power supply shown in Figure 1. Identify each and briefly discuss its function in the circuit. You may add labels to the figure to assist you in your discussion. In addition, when discussing function you may group sets of the components together for simplicity.
Question 2

Figure 2 illustrates three cycles of a moderately complex periodic signal. Figure 3, Figure 4, and Figure 5 show various details of the signal.

![Signal](image)

**Figure 2**

![Signal Detail (A)](image)

**Figure 3**
The signal is to be displayed on a typical oscilloscope similar to that discussed in the lecture and used in the lab. Such an oscilloscope has a large number of operational parameters, e.g. beam intensity, trigger level, channel selection to name only three, which have to be set to appropriate values to obtain the desired display.

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**Figure 4**

**Figure 5**
a) (12 points) The details of the signal shown in Figure 3 are to be displayed on the oscilloscope. The display is to begin with the edge that occurs at about 20 milliseconds, show 10 milliseconds of the signal, and show the approximate range of 15 to 30 volts. Give the values of the oscilloscope operating parameters that you would select to achieve such a display. There are at least 5 parameters for which you must select a value. For each parameter give the name, the value selected, and the units of the value. Note: that some parameters are analog and will have units such as volts, amps, etc. However, others are digital, like trigger source, and are dimensionless.

b) (3 points) Setting the trigger level to 10 volts would be problematic. Why?
Question 3

Discuss the first order RC high pass filter. Include a sketch of the schematic for the filter. Also include a sketch of the response of the filter to sine waves as a function of frequency.
Question 4

The circuit in Figure 6 has the values: $V_1 = 6.0$ volts, $R_1 = 2 \, \text{k}\Omega$, $R_2 = 1 \, \text{k}\Omega$, $R_3 = 6 \, \text{k}\Omega$, $R_4 = 6 \, \text{k}\Omega$. What is the value of $V_2$? Show your work.
Question 5

The circuit depicted in Figure 7 is exercised by the step function depicted in Figure 8 by applying the step function signal to the input of the circuit, \( e_{in} \).

(15 points) If \( RC = 0.5 \) seconds, sketch the time behavior of \( V_C \), the voltage across the capacitor.
Question 6

Figure 9 illustrates an attempted voltage measurement of a real voltage source that can be modeled as an ideal source, $V_S$, in series with a resistance, $R_S$. The voltage reading is reported by a real voltage meter that can be modeled as an ideal voltage meter that displays the value of $e_M$ and has an input resistance, $R_M$, between the inputs. If $R_S = 100 \, \text{M} \Omega$, $R_M = 10 \, \text{M} \Omega$, $R_1 = 10 \, \text{K} \Omega$, $R_2 = 10 \, \text{K} \Omega$, $V_S = 5.0$ volts, and the operational amplifier is ideal, answer the following questions.

![Figure 9](image-url)

**a)** What is the value of the current $i_S$?

**b)** What is the value of the voltage drop across $R_S$, i.e. $(V_S - e_S)$?
c) What is the value of the voltage $e_s$?

d) What is the value of the voltage $e_{OA}$?

e) What is the value reported by the VMD?

f) What is the value of the current $i_M$?

g) Is this a good measurement? Support your answer.
Question 7

a) (5 points) Sketch the characteristic curve of a diode. Label the axes and the three regions of operation.
b) (10 points) Briefly discuss the following 5 types of diodes. Include a brief description of their typical application. Identify the region(s) of the diode characteristic in which each diode would ordinarily be operating.

1) zener

2) temperature sensing

3) power

4) LED

5) Photo detector
Question 8

Figure 10

(a) (4 points) Name the two operational amplifier circuits shown in Figure 10?

(b) (4 points) What are the transfer functions for the two circuits?

c) (7 points) If $R_1$ and $R_2$ are 10 KΩ and $V_1$ is 3.0 volts, what is $V_{out}$ for the two circuits?