ENGR-4300
Fall 2008
Test 2

Name: ________________

Section: 1(MR 8:00) 2(TF 2:00)
(circle one)

Question I (20 points): ___________

Question II (20 points): ___________

Question III (20 points): ___________

Question IV (20 points): ___________

Question V (20 points): ___________

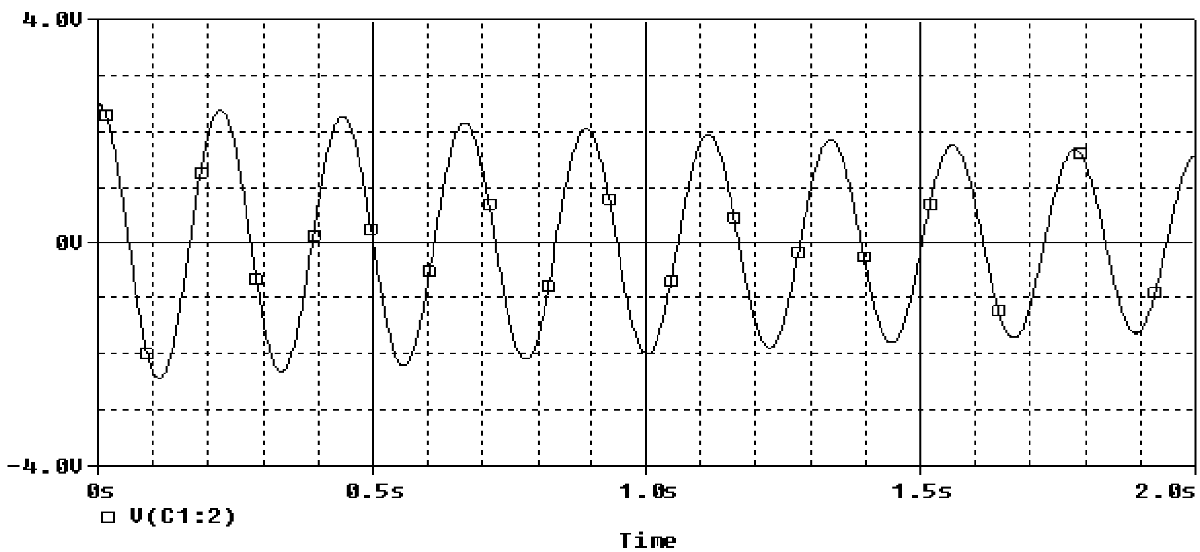
Total (100 points): ______________

On all questions: SHOW ALL WORK. BEGIN WITH FORMULAS, THEN SUBSTITUTE VALUES AND UNITS. No credit will be given for numbers that appear without justification.

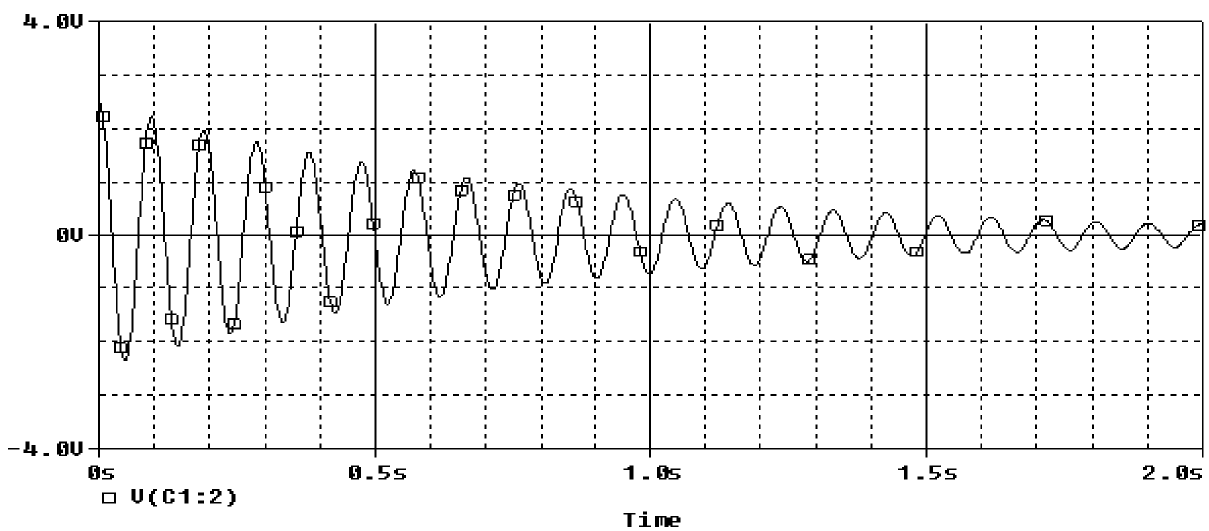
Question I – Bridges and Damped Sinusoids (20 points)

You are given a cantilever beam similar to the one you used in experiment 4. You place two weights on the end of the beam one at a time (0.1 kg and 0.7 kg) and you get the following two plots (may not be in order of mass listed).

Plot 1



Plot 2



1) (2pt) What is the frequency of plot 1? (Use at least 2 significant figures)

Question I – Bridges and Damped Sinusoids (continued)

2) (2pt) What is the frequency of plot 2? (Use at least 3 significant figures)

3) (6pt) What is the damping constant for plot 1, mark the points on the plot? (Use at least 3 significant figures)

4) (6pt) Given the following formula, $k = (m + m_n) \cdot (2 \cdot \pi \cdot f_n)^2$, and assuming that the two data points that you found are ideal, find values for k and m.

Question I – Bridges and Damped Sinusoids (continued)

5) (2pt) What is the mass of the beam?

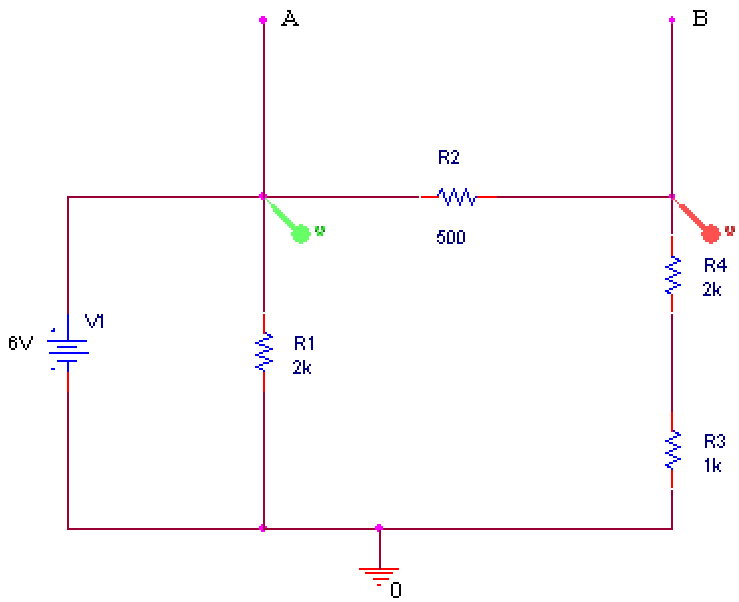
6) (2pt) Using the chart for Young's Modulus, determine the probable material that the beam is made out of given that the dimensions of the beam are: width = 1.5 cm, length=15 cm, and thickness = 2 mm.

TABLE 9.1

Young's Modulus Table of Values

Metal	Elastic modulus (N/m2)	Metal	Elastic modulus (N/m2)
aluminum, 99.3%, rolled	6.96×10^{10}	lead, rolled	1.57×10^{10}
brass	9.02×10^{10}	platinum, pure, drawn	16.7×10^{10}
copper, wire, hard drawn	11.6×10^{10}	silver, hard drawn	7.75×10^{10}
gold, pure, hard drawn	7.85×10^{10}	steel, 0.38% C, annealed	20.0×10^{10}
iron, wrought	19.3×10^{10}	tungsten, drawn	35.5×10^{10}

Question II – Thevenin Equivalents (20 points)



1) (7pt) Find the Thevenin equivalent voltage with respect to A and B for the circuit shown above)
Hint: $Vth=V_A-V_B$ so find V_A then V_B

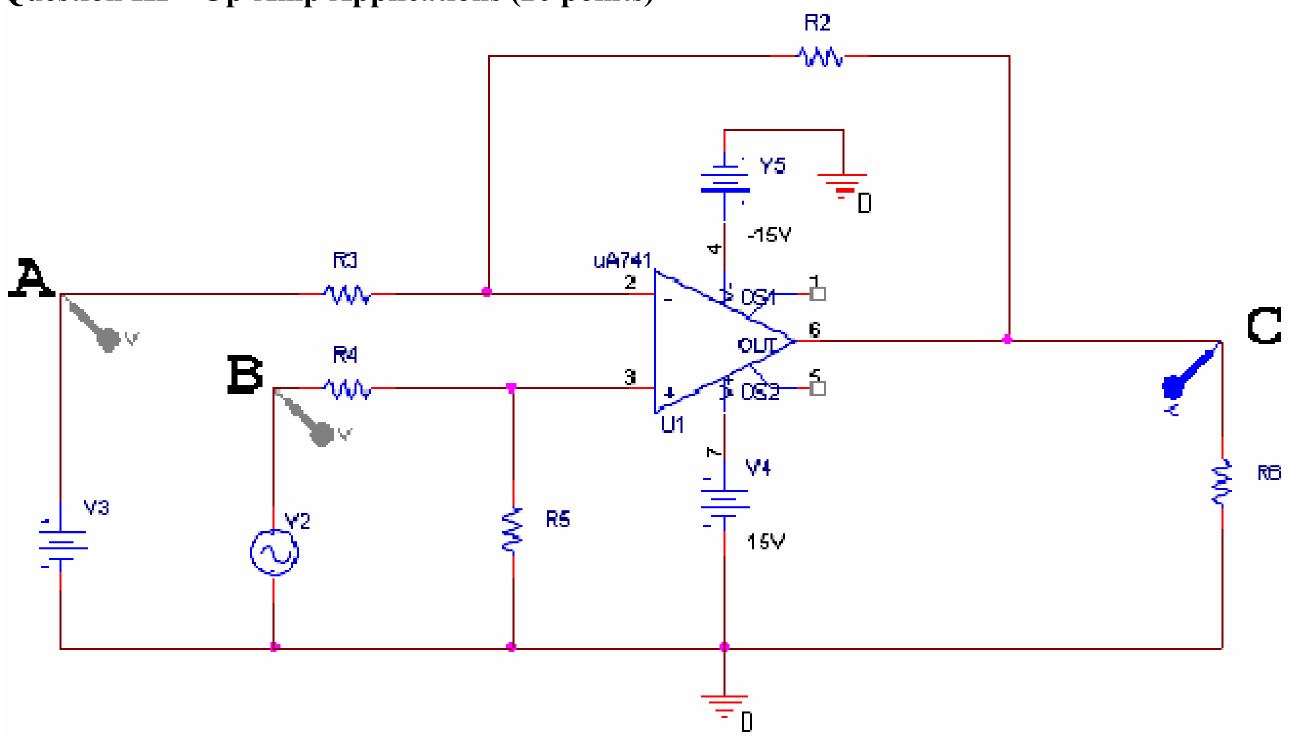
Question II – Thevenin Equivalents (continued)

2) (6pt) Find the Thevenin equivalent resistance with respect to A and B for the circuit shown above.

3) (5pt) Draw the Thevenin equivalent circuit with a load resistor RL of 3K between points A and B

4) (2pt) What is the voltage across R_L? *Hint: Also the voltage at point* V_A

Question III – Op-Amp Applications (20 points)



Assume the following components in the above circuit:

V_2 : Voff=2V, Vamp=2V, Freq=1k

$V3$:Vdc=2V

$R2 := 16k\Omega$ $R3 := 2k\Omega$ $R4 := 2k\Omega$

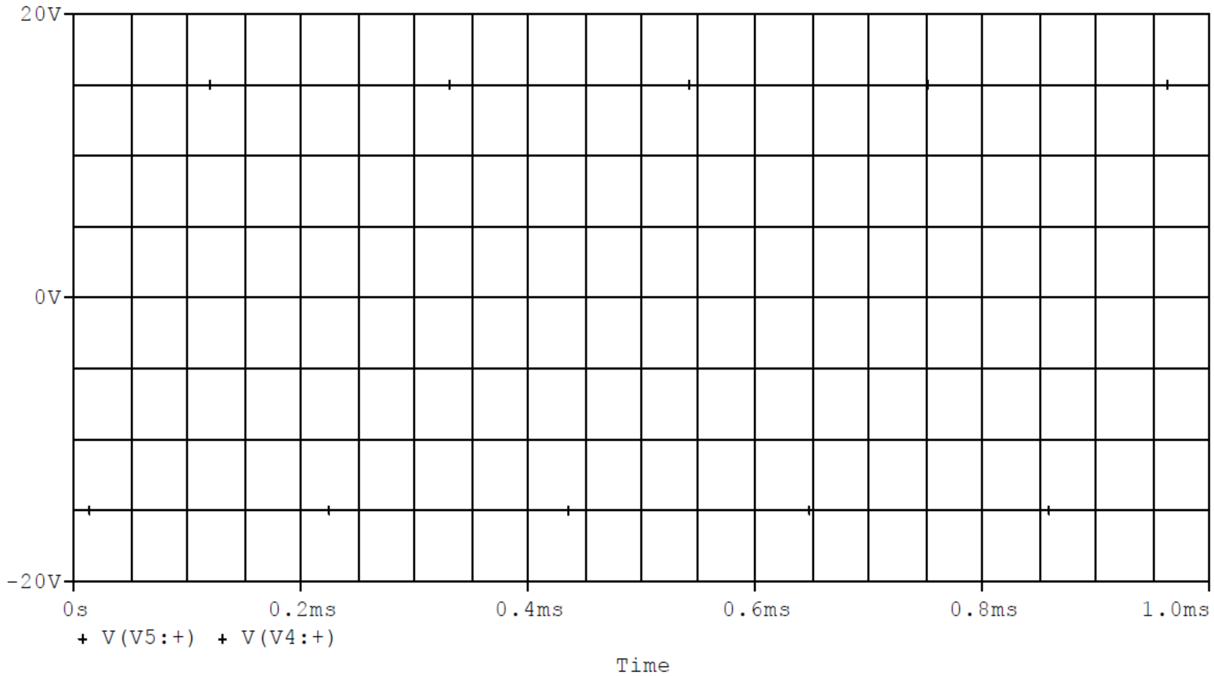
$R5 := 16k\Omega$ $R6 := 1k\Omega$

1) (1pt) The circuit above is an amplifier you've seen. What type of amplifier is it?

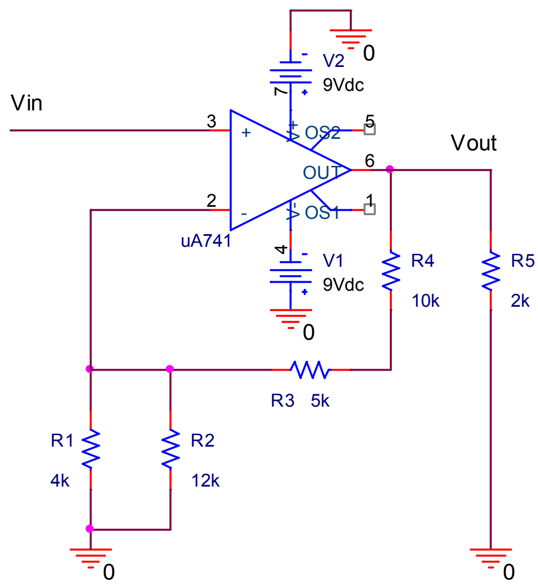
2) (3pt) Write an equation for the output C (Vc) in terms of the input voltages V2 and V3. Simplify (Do not have to enter voltage values)

Question III – Op-Amp Applications (continued)

3) (16pt) Sketch and label one cycle of the input at V2 (point B), the input at V3 (point A) and the output at C (Vc) on the plot below



Question IV – Op-Amp Analysis (20 points)



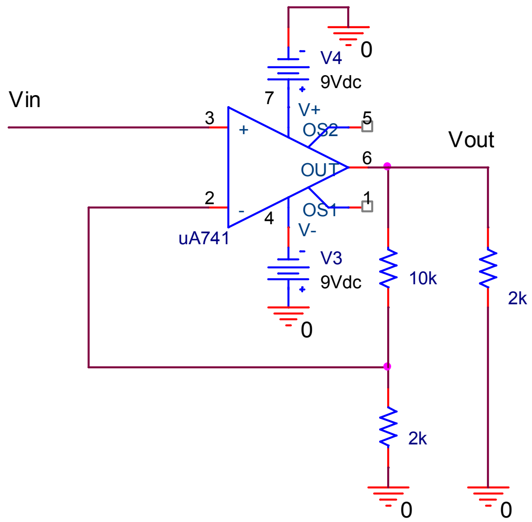
1) (2pt) What op-amp circuit given on your crib sheet does this circuit most closely represent?
a. Inverting Amplifier b. Non-inverting Amplifier c. Adder d. Differential Amplifier
e. Practical Active Differentiator

2) (2pt) Redraw the circuit combining and resistors that are in parallel or series and find the combined values.

3) (2pt) What are the two golden rules of op-amp analysis?

Question IV – Op-Amp Analysis (continued)

4) (2pt) Using a different circuit below, if Vin = 1V on the '+' input of the op-amp, what is the voltage on the '–' input?



5) (3pt) From 4), how much current is flowing through the 2k resistor to ground?

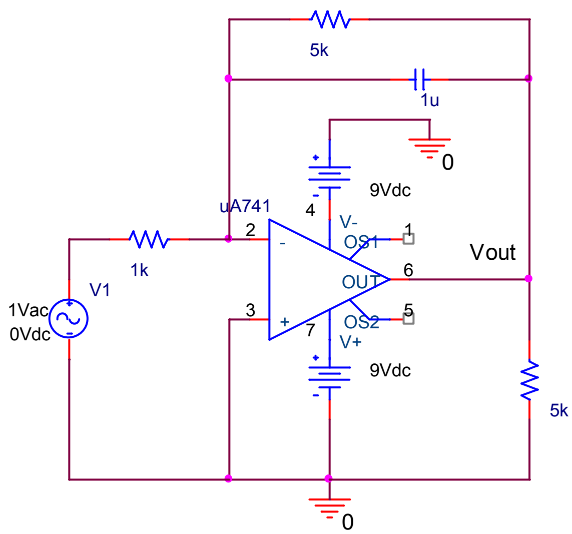
6) (3pt) By the Golden Rules, how much current in 4) is flowing through the 10k resistor from Vout to V^- (the connection point between the 2 resistors)?

7) (3pt) What is Vout for Vin = 1V?

8) (2pt) What is the gain of this op-amp circuit?

9) (1pt) For an ideal op-amp in 4), what is the maximum value the input voltage Vin can have before the output will not be able to exhibit the full amplification from 8)?

Question V – Op-Amp Integrators and Differentiators (20 points)



1) (2pt) What function is this circuit designed to perform?

2) (4pt) Write the transfer function Vout/V1 for this circuit. (Substitute in the values provided for the components.)

3) (3pt) For which frequencies will the circuit perform the desired function?

a. Low frequencies below ω_c

b. Only a mid band of frequencies around ω_c

c. High frequencies above ω_c

4) (3pt) Find the corner frequency for the circuit in Hz.

Question V – Op-Amp Integrators and Differentiators (continued)

5) (2pt) Redraw the circuit with an appropriate substitution for the capacitor as f $\rightarrow$ 0 for when the input V1 has a very low frequency.

6) (4pt) Show that simplification of the transfer function from 2) for small ω gives the same results as the analysis of the redrawn circuit in 5).

7) (2pt) Sketch the output of the original circuit in 1) to a square wave input on the axis below. Show the correct shape of the waveform but don't worry about the amplitude scaling.