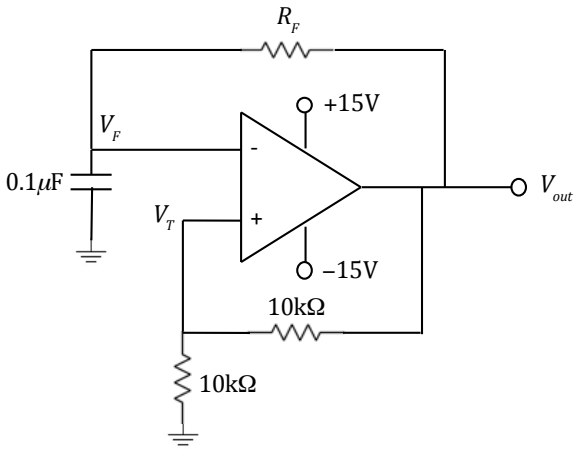
P116B Homework 1

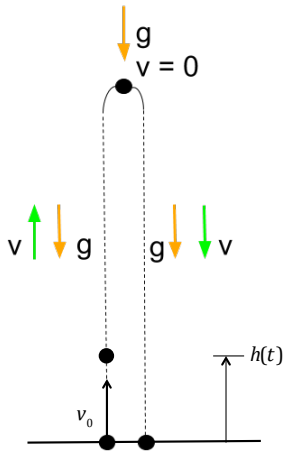
Due 1/17/2020

1. For the following relaxation oscillator, choose a value of R_F which will give a 500Hz output wave.

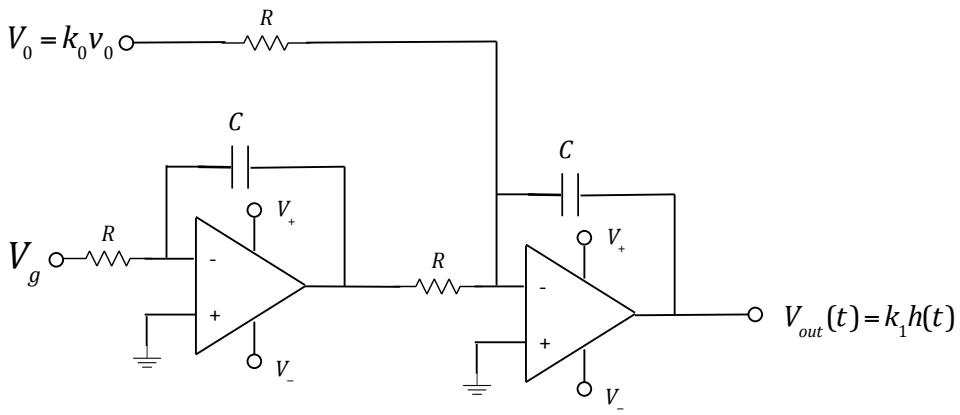


   Build an LTSpice simulation of this circuit using an AD549 Op Amp. Do a transient simulation with 10000 points for 10ms to verify that it is behaving as expected.

2. Analog Computing. Consider an object thrown straight upward with an initial vertical velocity v_0 from an initial height $h(0) = 0$



   We will use the circuit below to do an analog calculation of the altitude as a function of time.



V_0 is fixed at $V_0 = k_0 v_0$, where v_0 is the initial upward velocity. All Rs are equal and all Cs are equal. Assume all capacitors are initially discharged.

(a) Write an expression for $h(t)$ in terms of the upward initial velocity v_0, and the (positive) decelleration of gravity g.

(b) Write an expression for the output $V_{out}(t)$, in terms of k_0,V_0, R,C, V_g, and t.

(c) By equating these two expressions, write expressions for k_1 and V_g, such that $V_{out} = k_1 h(t)$, in terms of k_0, R, C, and g. Be careful with signs!

3. Resolve the following logical expressions:

(a) $A \bullet A$

(b) $A + A$

(c) $A \bullet \overline{A}$

(d) $A + \overline{A}$

(e) $A(A + B)$

(f) $A \oplus A$

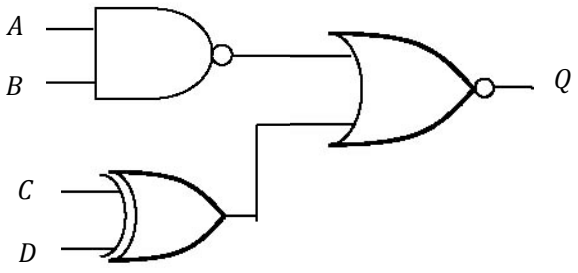
(g) $A \oplus \overline{A}$

In each case, the answer is a single logical value or symbol.

4. Construct the equivalent of an exclusive OR (XOR) gate using only NAND gates; i.e. arrange some number of NAND gates between two inputs and and output such that they will have the following truth table

A	**B**	**Q**
0	0	0
0	1	1
1	0	1
1	1	0

5. Consider the following logic circuit:



(a) Fill out a truth table for all 16 combinations of the inputs.

(b) Write a logical expression for this circuit, including a logical representation of each individual gate. Do *not* use the exclusive OR operator ($\oplus$)

(c) Use De Morgan's rule to reduce this to an expression in which any inversions operate only on individual terms.