EECS 16A   Designing Information Devices and Systems I
Fall 2018   Homework 11

This homework is due November 9, 2018, at 23:59.
Self-grades are due November 13, 2018, at 23:59.

Submission Format

Your homework submission should consist of **one** file.

- `hw11.pdf`: A single PDF file that contains all of your answers (any handwritten answers should be scanned).

Submit each file to its respective assignment on Gradescope.

1. **Jumpbot**

   In this problem, you will be designing circuits allowing a robot named Jumpbot to execute a set of commands that will be described below. Specifically, the output voltages produced by your circuits are interpreted by Jumpbot as setting its vertical position in meters in free space (both positive and negative values will be used). You will be generating an oscillating triangular waveform with a controllable time period.

   (a) One of the circuit blocks you will use to generate the triangular waveform is the integrator. An integrator integrates the input signal. For the circuit given below express v_1 in terms of R_1, C_1, and v_0. You may assume the capacitor C_1 has $0V$ across it at time $t = 0$.

      Hint: You will have to apply KCL, and the current flowing through a capacitor is given by $I = C\frac{dV}{dt}$.
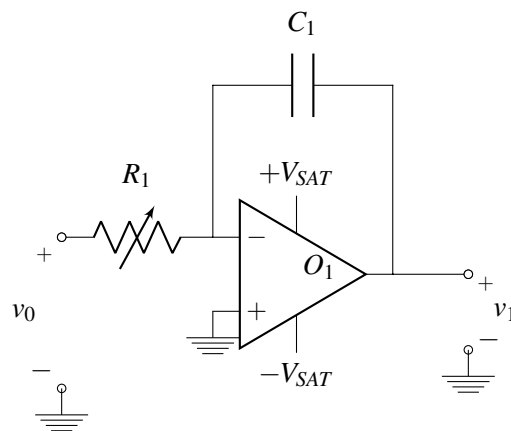

   (b) Suppose for a specific v_0, shown by the dotted orange line below, v_1 looks as shown by the blue line. Derive an expression for T_1 and T_2 as a function R_1, C_1, V_{TH}, and V_{SAT}.
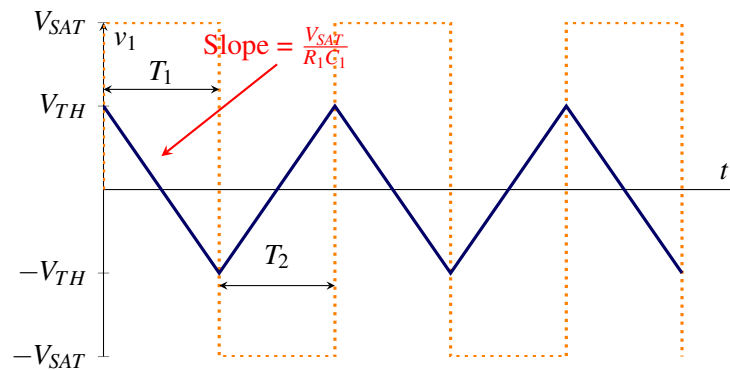
(c) We have a circuit that generates a triangle wave from a square wave. However, we need to create the initial signal (v_0) that helped us to create the triangular waveform (v_1). For the circuit below, draw the waveform (v_2) if we use v_1 from part (b) as the input. Now, draw the waveform (v_2) if we use $-v_1$. Which v_2 (v_1 as input or $-v_1$ as input) matches v_0 from part (b)?

$$+V_{TH} = \frac{R_4}{R_4 + R_5} V_{SAT}$$

$$-V_{TH} = \frac{R_4}{R_4 + R_5} (-V_{SAT})$$
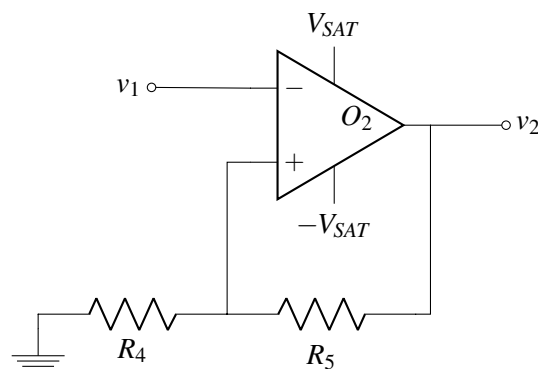
(d) Now let's put it all together. The circuit from part (a) generates a triangle wave (v_1) from a square wave (v_0). The circuit above takes an input triangle wave and creates a square wave. Connect the two circuits together so that the circuit keeps generating a triangle wave on it's own. You will use the circuits from part (a) and part (c), in addition you can use any opamps and resistors.

(e) In your circuit, if $\pm V_{SAT} = \pm 10\,\text{V}$, $C_1 = 0.01\,\text{mF}$, and $R_4 = 10\,\text{k}\Omega$, find the values for R_1 and R_5, so that the jumpbot jumps with $10\,\text{V}$ peak-to-peak amplitude ($\pm V_{TH} = \pm 5\,\text{V}$) with $1\,\text{kHz}$ frequency (period = 1 / frequency).

2. Midterm Redo

Redo the Midterm. The midterm will be posted online at 5:00PM on Monday.

3. Homework Process and Study Group

Who else did you work with on this homework? List names and student ID's. (In case of homework party, you can also just describe the group.) How did you work on this homework?

   2