ECE 2100

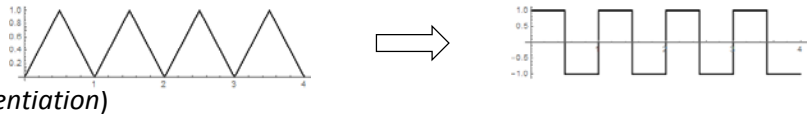
Lab. V – (100 + 30 bonus pts) Capacitor and RC Circuits

Pre-Lab

Important notes: from now on, pre-lab will count more weight. This is the pre-Lab of Lab V. You can print out, answer the questions (or type in answers) and submit at the start of the Lab. To answer the questions, you need to go to the full Lab-V description on this web page:

http://courses.egr.uh.edu/ECE/ECE3340/Class%20Notes2100/Lab_5/ECE2100_lab%20V_PID.htm

1. If you have a triangle wave input, what mathematical operation can transform it into a square wave?

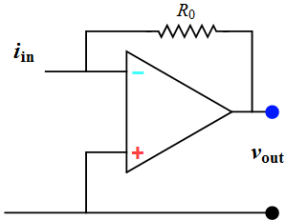


(*hint: try differentiation*)

2. If you have the reverse situation, a square wave input, what can you do to get a triangle wave output?
3. What circuit element of which the current is the time-derivative of its voltage? (i. e. $i \propto \frac{dv}{dt}$)

4. Based on Lab. 4, suggest an approach that you can convert a current signal into a voltage signal - just a few word answer (*hint: see next question*)

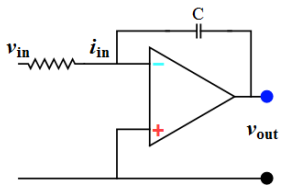
5. Based on what you learned/did in Lab 4, if you put a current source into the inverting input of a negative-feedback op amp, what do you expect to get out? Answer in plain English, not a formula.



6. What is a function (a use) of **Circuit 1**? (hint*: what "mathematical" operation does it do to the input signal v[t]*?).

7. Select the values of C, R's **that you plan to use** to build your **Circuit 1** (recommended to be in the range of the default values). Use the App to show the expected output for an input triangle wave at 5 kHz, 10 kHz, and 20 kHz. To save black ink, you can save graphics as png or jpeg files, then use the App that negates the color (like negative film, for those who know what a film is), then print out. Make sure your output is not off-scaled - It is up to you to adjust whatever necessary to do so. What is your conclusion of output amplitude vs frequency?

8. Given a signal current, what circuit element can you use to integrate it? (*hint: current is the flow rate of charge, what device can accumulate charge*?)
9. Fill in the blank: Based on Lab 4, if the op amp voltage output v_{out} is that of a capacitor, v_C, which is _____ (*a mathematical operation*) of input current i_{in}, which, in turn is proportional to input voltage v_{in}, then what is the relationship between v_{out} and v_{in}? No need for formula, just a few words.



10. What is a function (a use) of **Circuit 2**?

11. Select the values of C, R's **that you plan to use** to build your **Circuit 2** (recommended to be in the range of the default values). Use the App to show the expected output for an input square wave with zero offset (or AC coupling) at 500 Hz, 1 kHz, and 2 kHz. Make sure your output is not off-scaled - It is up to you to adjust whatever necessary to do so. What is your conclusion of the output amplitude vs frequency? Read note about saving black ink in Q. 7 above.

12. Although we won't be doing a PID circuit, watch this tutorial on youtube and write how you think you could make use of **Circuit 1** and **2** to control a mechanical system such as a robotic arm (before the current trend of digital, like the demo, PID controller used to be analog like what you will build).

13. **Circuit 3**: what is the input signal you will be using for **Circuit 3**?
14. **Circuit 3**: Is there any relationship between voltage at node A and the charge on the capacitor?

15. Can one use a typical polarity-specific (unipolar) electrolytic capacitor for **Circuit 3**, why or why not?

16. **Circuit 3**: The use of the potentiometer is to measure the potential of the op amp output. True or false?
17. What frequency from the signal generator can you apply to **Circuit 3**?

18. **Circuit 3**: What is the expected output from the op amp? (describe in a few words)

19. **Circuit 3**: If you take the output of the op amp, reduce the amplitude with a voltage divider, and input into **Circuit 2**, what do you expect to get out? (we might do this if the function generator doesn't give zero-DC offset output).

Check box if you plan to do Circuit 3 with LED ☐

Answer questions 20 -22 if the box above is checked

20. What type and value of capacitor you will need?

21. Will the LED light up with constant luminosity ("brightness") during each on-cycle? Or will its "brightness" vary during each on-cycle?

22. Suppose the LED is like the blinking light of right-turn or left-turn (never mind its luminosity variation), if you want to change its blinking rate, what will you do (what action you will take)? (in a few words)