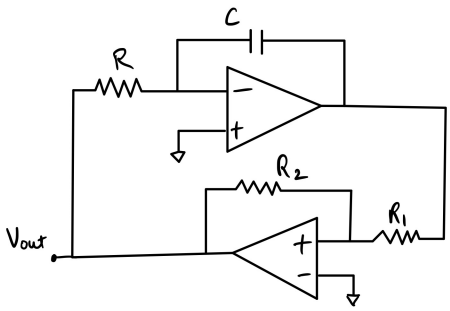
Analog Lab 2022

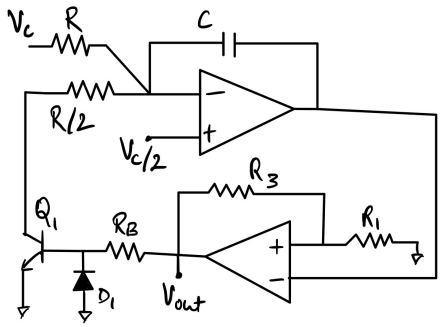
EE2401

Experiment 5: Voltage controlled oscillator

1. Design a schmitt trigger based oscillator with the following specifications:
   - Oscillation frequency: 10 kHz
   - Hysteresis width for schmitt trigger: Around 20% of the opamp peak-to-peak output swing
   - LF347 opamp with +5V/-5V dual supply



2. Below is a modified oscillator with a control voltage (V_C) input to vary the oscillation frequency. Here, V_C decides the rate of integration and hence controls the output frequency. Transistor Q_1 introduces an inversion, therefore the schmitt trigger is also inverting. R_B is for controlling the base current of Q_1 and D_1 protects the transistor from breakdown during negative swing. :
   - Analyze and calculate component values assuming Q_1 to act like an ideal switch
   - Output frequency 10-15 kHz for V_C ranging from 4-6 V
   - Generate $V_C/2$ from V_C using a voltage divider
   - Q_1: 2N3904, D_1: 1N4148
   - Plot frequency vs V_C characteristics. Is it expected?



3. Change R or C to obtain new frequency range of 100-150 kHz for the same V_C range as above. Plot frequency vs V_C. Is it linear? Explain. In reality Q_1 doesn't act like an ideal switch. It has a saturation voltage of around 0.2 V. This can cause deviation in the expected duty cycle. Modify the circuit in Problem 2 to compensate this effect. You can assume a matched transistor is available.

   CAD info:

   - LF347 https://www.ti.com/product/LF347#product-details
   - PSPICE models can be used in LTspice using this procedure: https://www.analog.com/en/technical-articles/ltspice-simple-steps-to-import-third-party-models.html

   Submit the following:

   - Testbench snapshot, output plots
   - Hand calculation
   - Any unusual observation along-with comments