Name PID

# UNIVERSITY OF CALIFORNIA, SAN DIEGO

Electrical and Computer Engineering Department

ECE 65 – Fall 2020

*Components and Circuits lab*

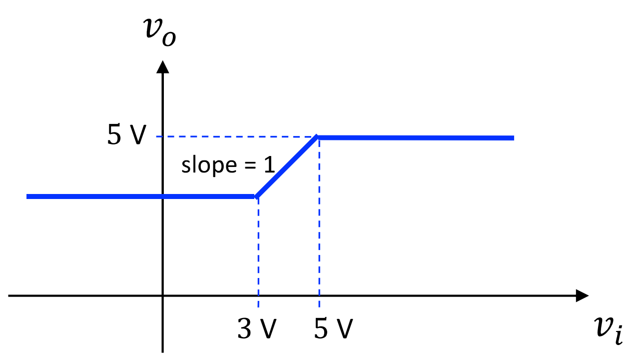
Midterm Exam1 solutions

You should submit your handwritten solutions in a PDF format to Gradescope by Wednesday, 10/21, at 11:50 am (Pacific Time).

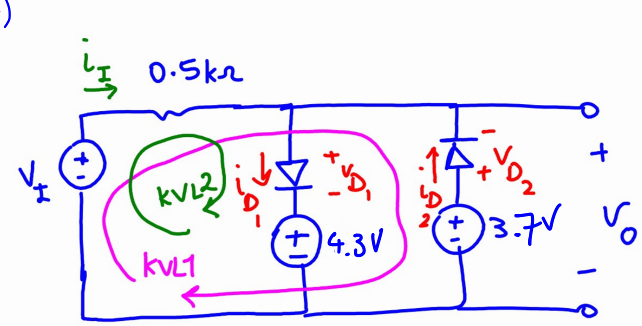
**Problem 1**. (15 points)

a) Design a diode waveform shaping circuit that would have the below transfer function. You can use PN junction diodes and Zener diodes with $V_{D0} = 0.7\ V$, $V_Z = 1.3\ V$, DC voltage sources, and resistors in your design. You can use any combination in your design.

b) Write **two possible cases** of the operation of the diode(s) in your designed circuit, and for each case, include the **calculation of finding $v_o$** and **the range of $v_i$.** Show your work.




a)




b) Case 1: $D_1$ ON and $D_2$ off : $V_{D_1} = 0.7V$ & $i_{D_1} \geq 0$ & $V_{D_2} < 0.7V$ & $i_{D_2} = 0$

KVL 2: $-V_i + 0.5\,k\Omega \times i_I + V_{D_1} + 4.3 = 0$

KCL: $i_I = i_{D_1} - i_{D_2}$

$i_{D_2} = 0 \longrightarrow i_I = i_{D_1} \Longrightarrow V_i = 0.5\,k\Omega \times i_{D_1} + V_{D_0} + 4.3V = \frac{1}{2} i_{D_1} + 5V$

$i_{D_1} = \frac{V_i - 5V}{1/2}$ $\quad i_{D_1} \geq 0 \longrightarrow \frac{V_i - 5V}{1/2} \geq 0 \longrightarrow V_i \geq 5V$

$$V_0 = V_{D_1} + 4.3V = 0.7V + 4.3V = 5V$$

Case 2: $D_1$ & $D_2$ off : $V_{D_1} < 0.7V$ & $i_{D_1} = 0$ & $V_{D_2} < 0.7V$ & $i_{D_2} = 0$

KVL 2: $-V_i + 0.5k\Omega \times i_I + V_{D_1} + 4.3 = 0$

KVL 1: $-V_i + 0.5k\Omega \times i_I - V_{D_2} + 3.7 = 0$

KCL: $i_I = i_{D_1} - i_{D_2} \longrightarrow i_I = 0$

KVL 2: $V_{D_1} = V_i - 4.3$, $V_{D_1} < 0.7V \longrightarrow V_i < 5V$

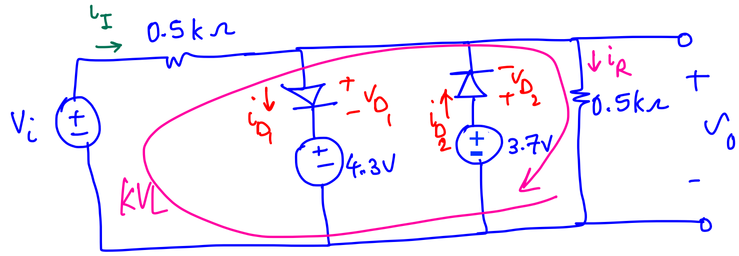
$\Rightarrow 3V < V_i < 5V$

KVL 1: $V_{D_2} = -V_i + 3.7$, $V_{D_2} < 0.7V \longrightarrow V_i > 3V$

$$V_0 = 0.5k\Omega \times (-i_I) + V_i = 0.5k\Omega \times 0 + V_i \longrightarrow V_0 = V_i$$

**Problem 2**. (3 points)

Modify the circuit that you designed in problem 1 such that the voltage gain in the nonlimiting range is 0.5 V/V. Sketch the modified circuit.




$D_1$ & $D_2$ off

$i_{D_1} = 0$ & $i_{D_2} = 0$

$i_I = i_R$

KVL: $-V_i + 0.5k\Omega \times i_I + 0.5k\Omega \times i_R = 0$

$V_i = 1k\Omega \times i_R$

$V_0 = 0.5k\Omega \times i_R = \frac{1}{2} V_i$

The ranges of vi will be different from the ones included in the original transfer function graph.