Name PID

UNIVERSITY OF CALIFORNIA, SAN DIEGO

Electrical and Computer Engineering Department

ECE 65 – Spring 2021

Components and Circuits lab

Midterm Exam1

You should submit your handwritten solutions in a PDF format to Gradescope on Friday, 4/16, by 1:50 pm (Pacific Time).

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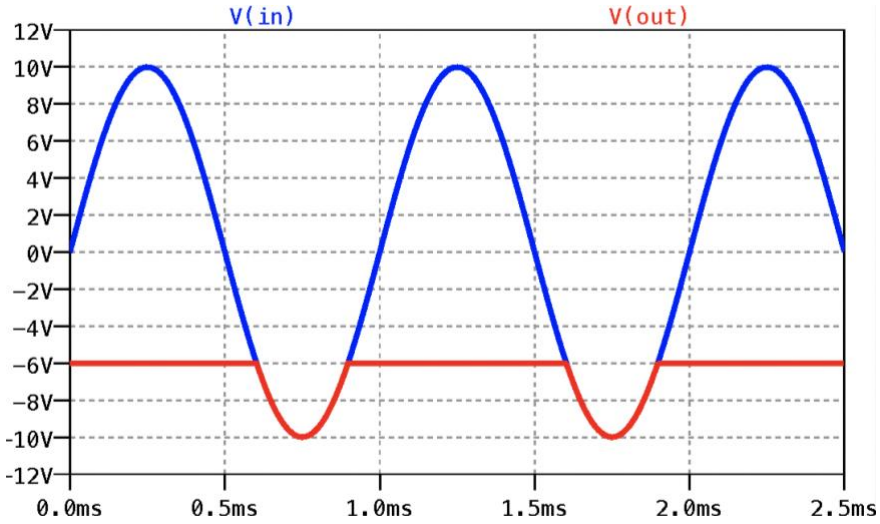
a) Design a diode circuit that would generate the output waveform shown in the below graph when the input signal $v_i = 10\sin(\omega t)$ is applied to the circuit. On the graph, $v_i(t)$ is drawn in blue color and $v_o(t)$ is drawn in red color.

You can use regular PN junction diodes ($V_{D0} = 0.7\ V$), Zener diodes (any desired V_Z), and resistor(s) in your design. Make sure to label v_i and v_o on your circuit diagram.

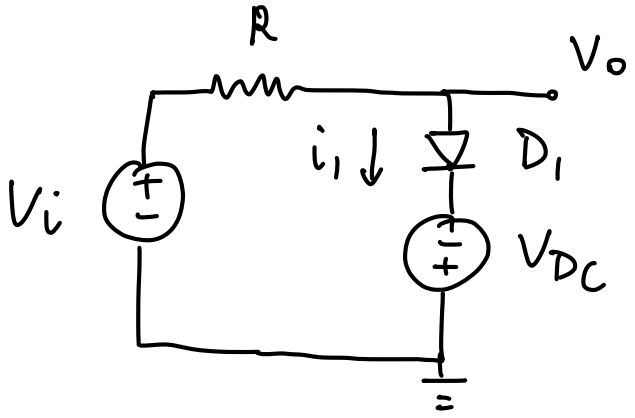


b) Parametrically solve your designed circuit to find the transfer function and draw the transfer function graph (find the relationship between v_o and v_i for different ranges of v_i and plot v_o vs v_i)

Show your work.

Solution:

(a)



KVL: $V_i - i_1 R - V_{D_1} + V_{DC} = 0.$

$$i_1 = \frac{V_i - V_{D_1} + V_{DC}}{R}$$

V_o becomes constant when $V_i \geq -6V$, meaning D_1 is on:

$$\begin{cases} i_1 = \dfrac{V_i - V_{D_1} + V_{DC}}{R} \geq 0 \\ V_i \geq -6\,V \end{cases} \Rightarrow V_{DC} = 6.7\,V$$

(b). ① D_1 is on: $V_{D_1} = V_{D_0}$. $i_1 \geq 0$

KVL: $V_i - i_1 R - V_{D_1} + V_{DC} = 0.$

$$i_1 = \frac{V_i - V_{D_1} + V_{DC}}{R} \geq 0$$

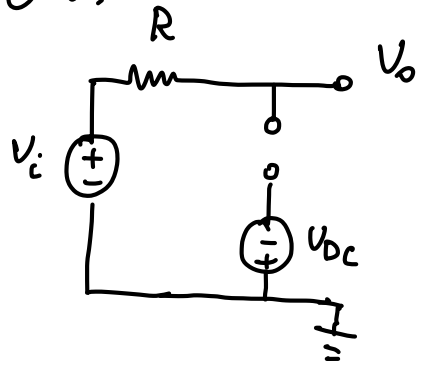
$V_i \geq -6\,V$, $V_o = V_{D_1} - V_{DC} = -6\,V$

② D_1 is off : $i_1 = 0$ $\quad V_{D1} \leq V_{D0}$

from KVL : $V_{D1} = V_i - i_1 R + V_{DC} = V_i + 6.7$

$V_{D1} \leq V_{D0}$: $V_i \leq -6\ V.$

$V_o = V_i - i_1 R = V_i.$



transfer function :