

## Practice Problem Set 2.1

### CSE251 - Electronic Devices and Circuits

### OPEN LOOP ANALYSIS OF OP-AMP

Voltage Level Detector, Square Wave Design, and  
VTC Plots

[Course Description, COs,  
and Policies](#)



[Midterm and Final  
Questions](#)

# Problem 1

- I. Determine the voltage input to the inverting terminal of an ideal op amp when  $-40 \mu V$  is applied to the non-inverting terminal and the output through an open loop gain of 150,000 is 15 V.
- II. Determine the voltage across the  $10 \text{ k}\Omega$  resistor for the circuit shown below. Assume the op-amp to be ideal except with a finite gain  $A = 10^4$ .

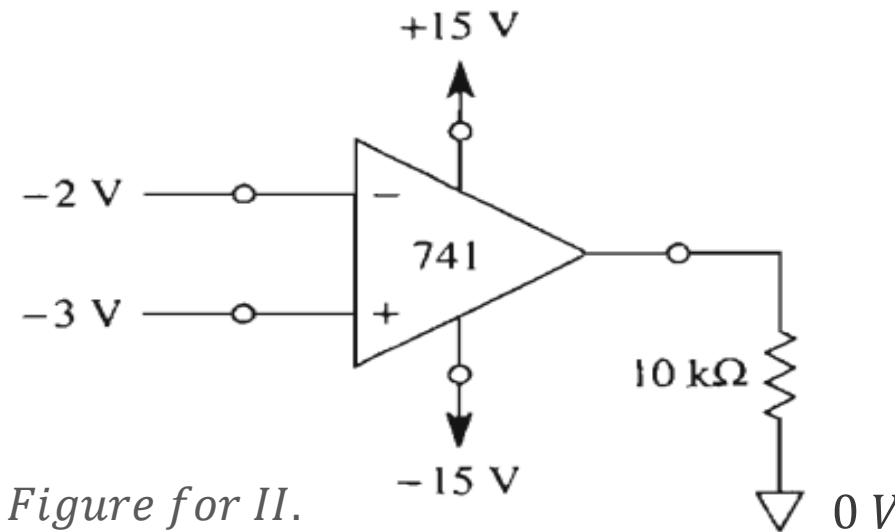
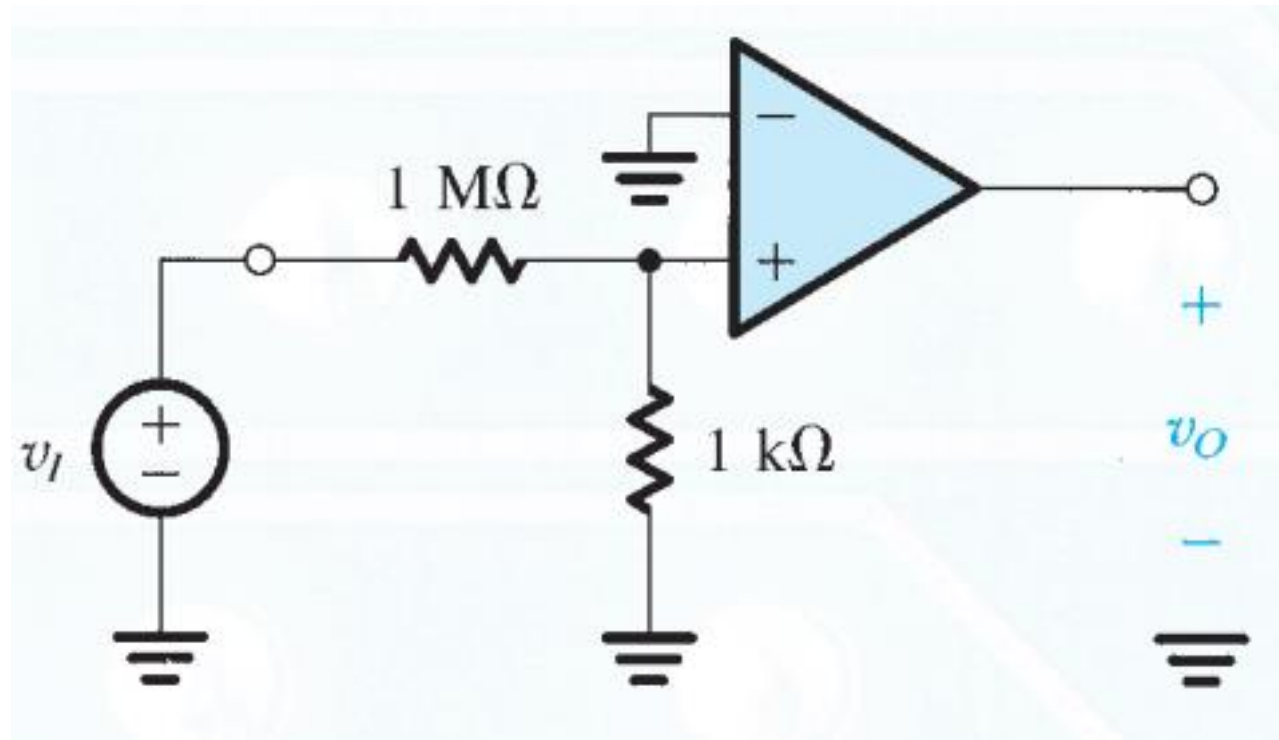


Figure for II.

Ans: I.  $-140 \mu V$ ; II.  $-15 \text{ V}$

# Problem 2

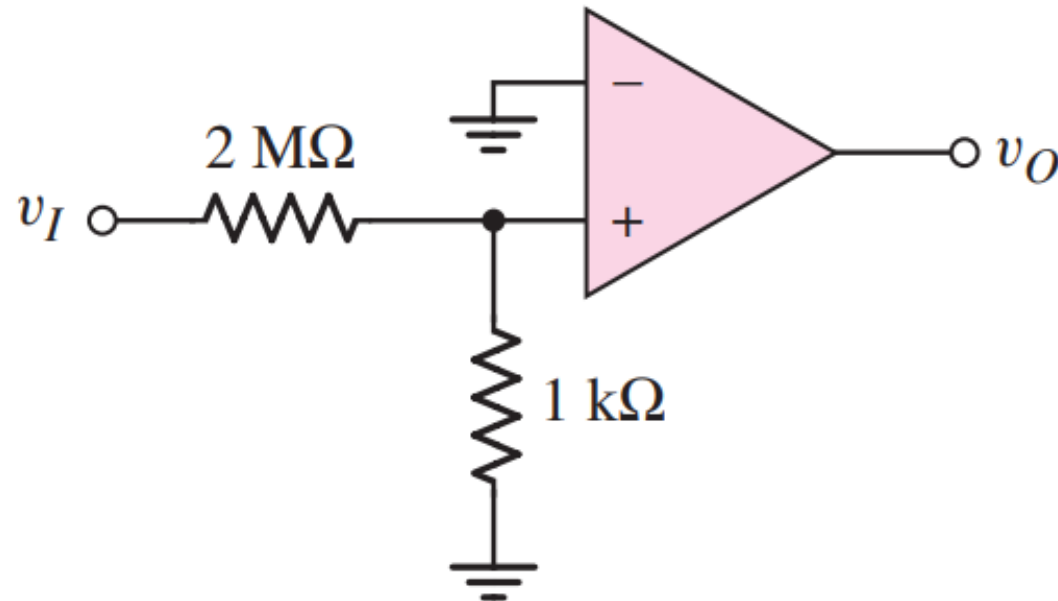
- The following circuit uses an op amp that is ideal except for having a finite gain  $A$ . Measurements indicate  $v_O = 4.0\text{ V}$  when  $v_I = 2.0\text{ V}$ . What is the op-amp gain  $A$ ?



Ans:  $A = 2002$

# Problem 3

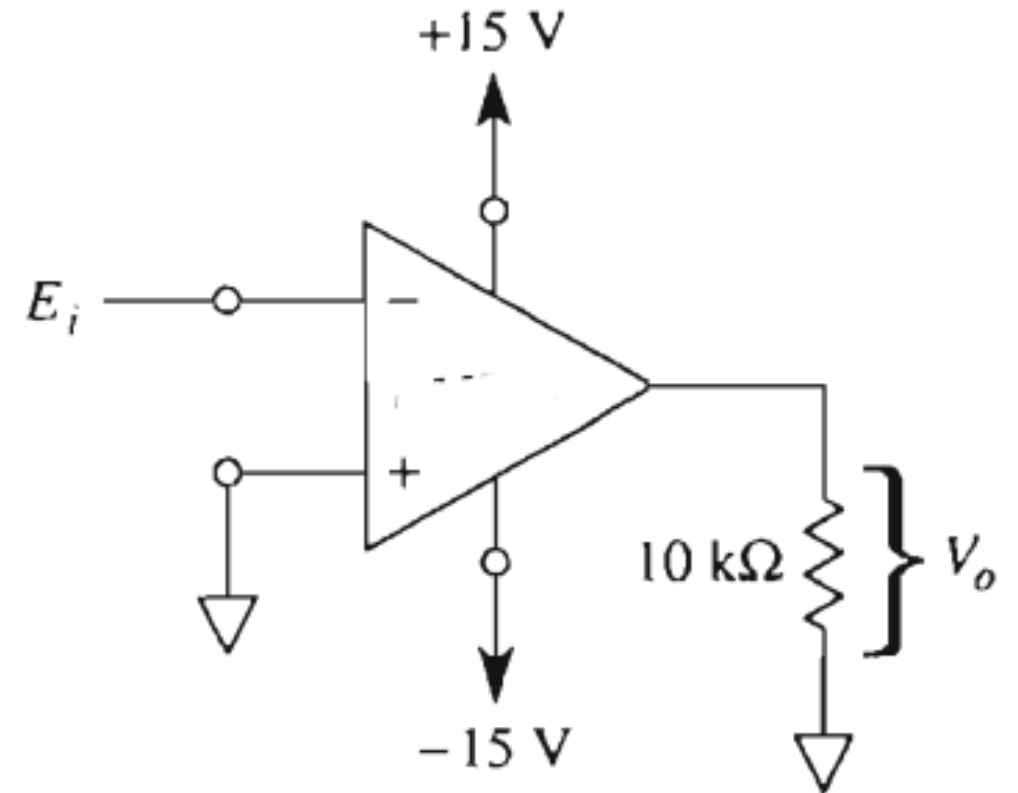
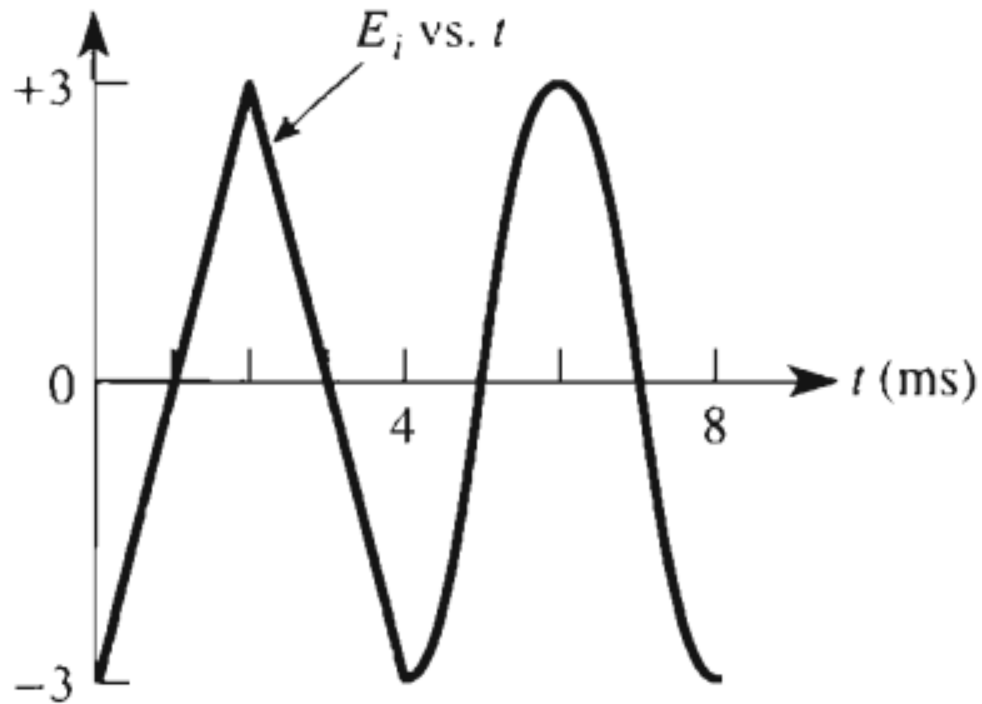
- The following circuit uses an op amp that is ideal except for having a finite gain  $A$ . If  $A = 10^4$  and  $v_O = -2.0\text{ V}$ , determine  $v_I$ .



Ans:  $v_I = -4.002\text{ V}$

# Problem 4

- Sketch  $V_o$  vs.  $t$  and  $V_o$  vs.  $E_i$ .

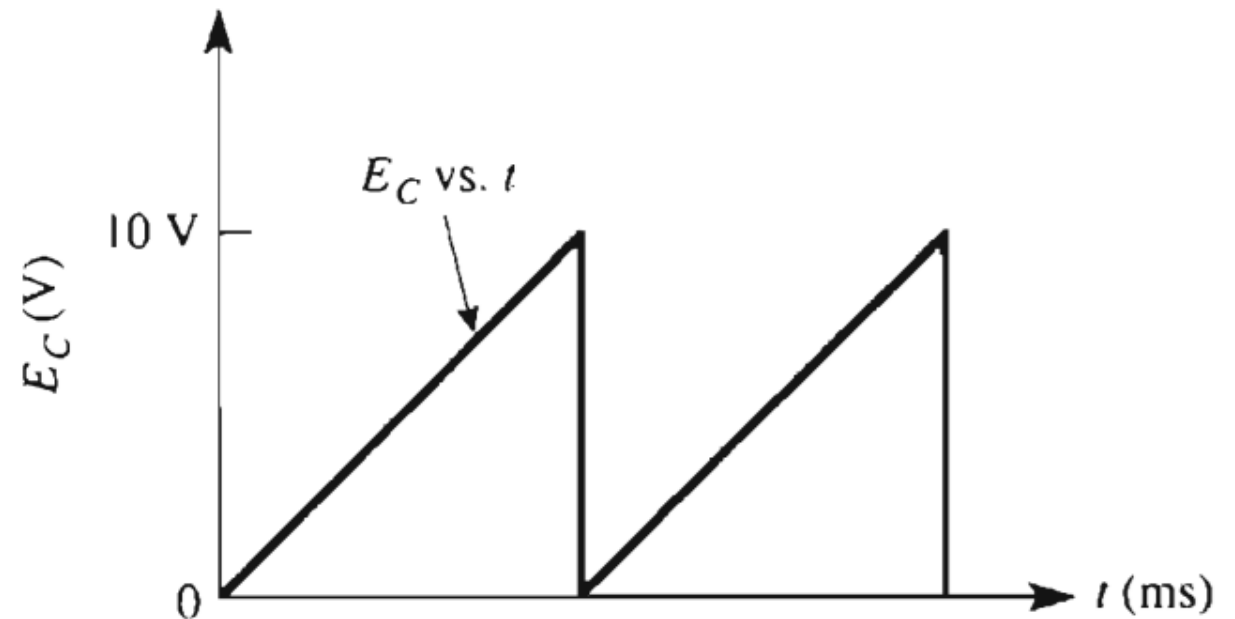
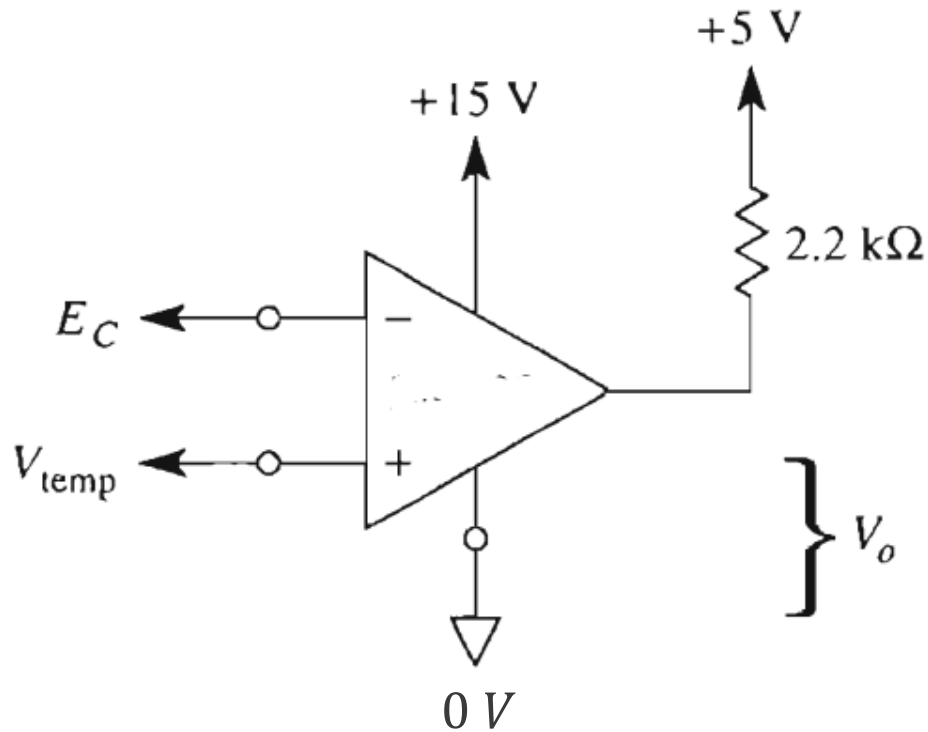


# Problem 5

- I. Draw the schematics of a circuit whose output voltage will go positive to  $+15\text{ V}$ , when the input signal crosses  $+5\text{ V}$  in the positive direction.
- II. Draw the schematics of a circuit whose output voltage will go positive to  $+15\text{ V}$ , when the input signal is below  $-4\text{ V}$ . The output should be at  $-15\text{ V}$  when the input is above  $-4\text{ V}$ .

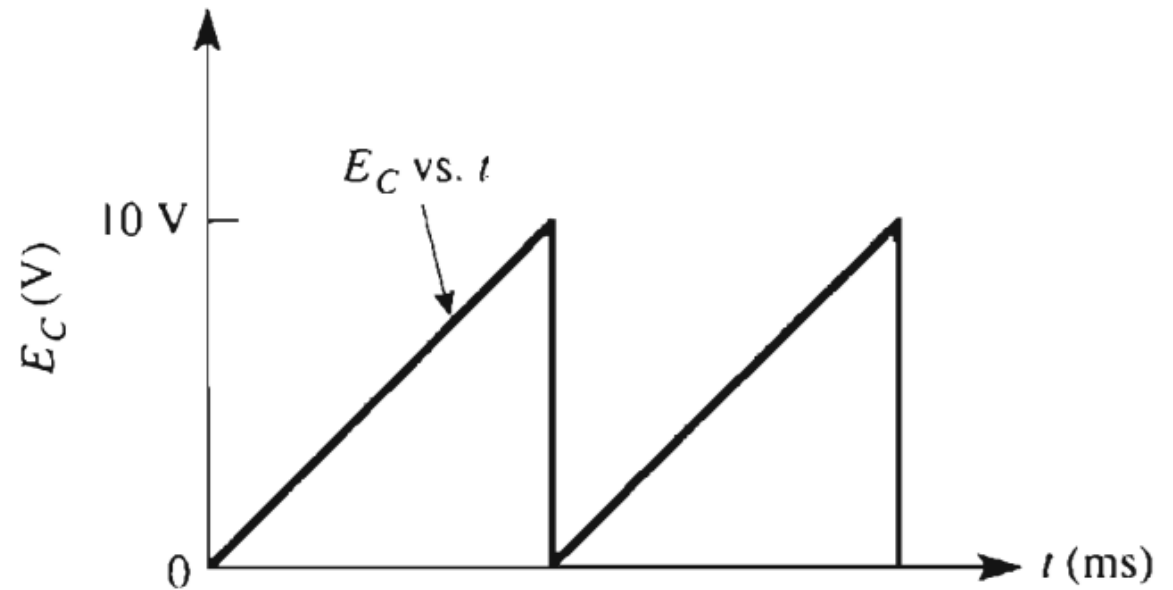
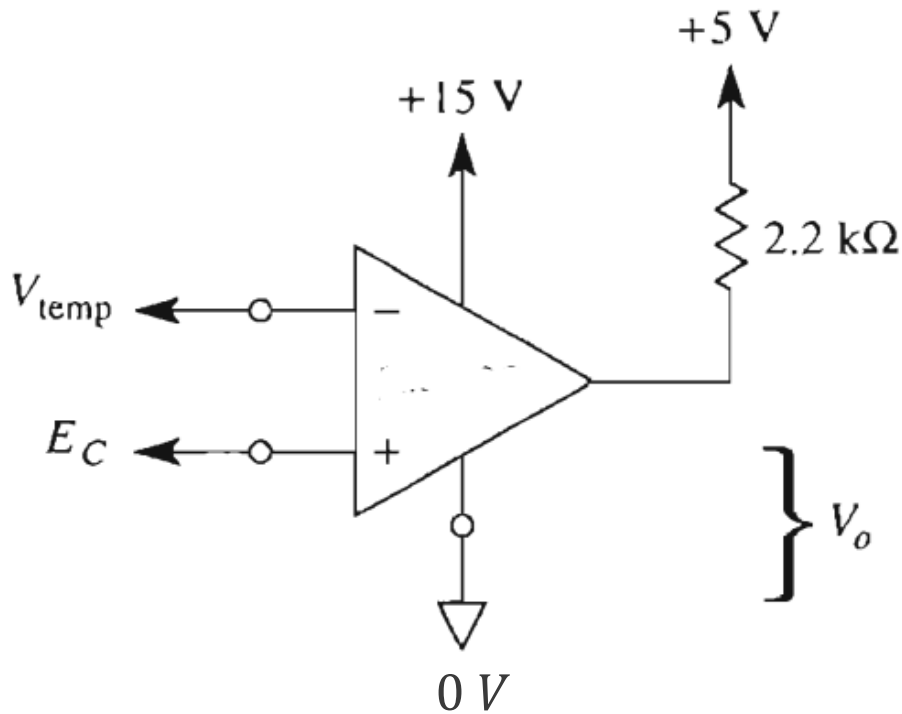
# Problem 6

- The frequency of  $E_C$  is constant at 50 Hz. If  $V_{temp} = 4\text{ V}$ , (a) plot  $V_o$  vs.  $E_C$ , (b) plot  $V_o$  vs.  $t$ , and (c)\*\* calculate the high time of  $V_o$ .



# Problem 7

- The frequency of  $E_C$  is constant at 50 Hz. If  $V_{temp} = 3\text{ V}$ , (a) plot  $V_o$  vs.  $E_C$ , (b) plot  $V_o$  vs.  $t$ , and (c)\*\* calculate the high time of  $V_o$ .

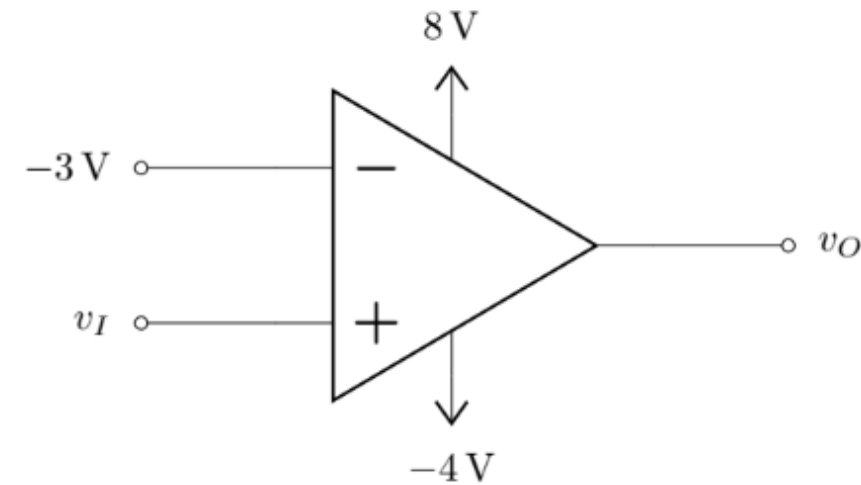
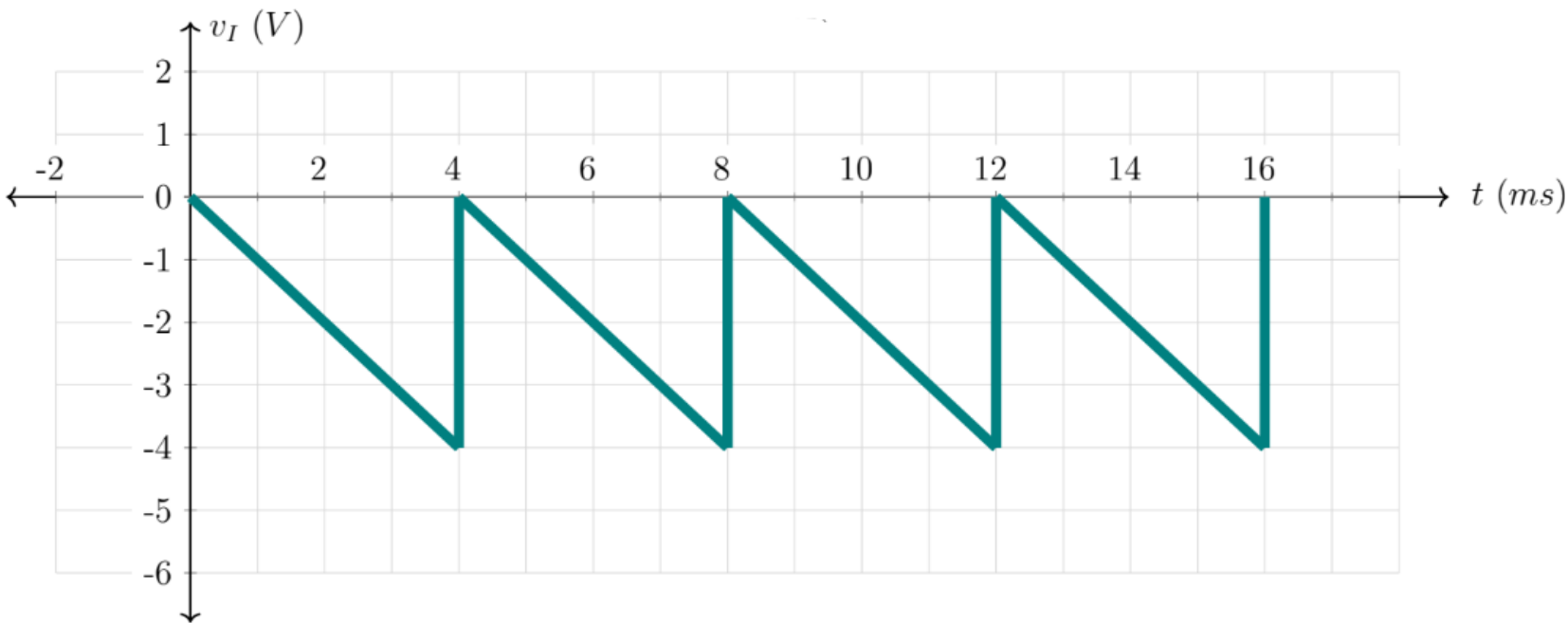


Note: Problems marked with an asterisk (\*\*) are a bit more advanced for this course. However, attempting them can help you develop a stronger grasp of the topic.



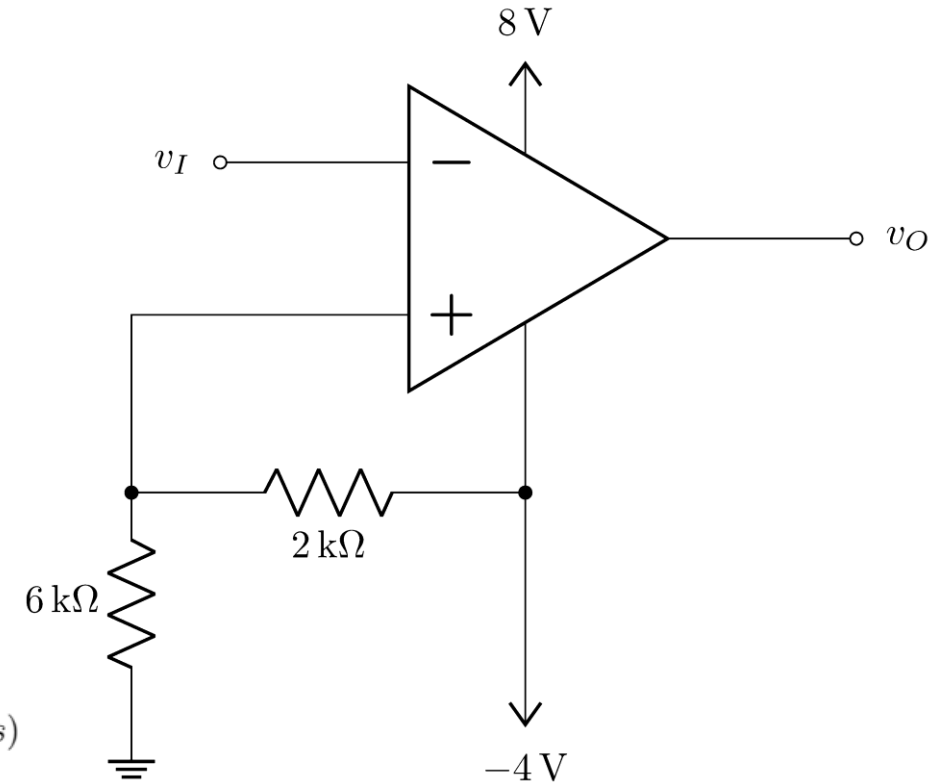
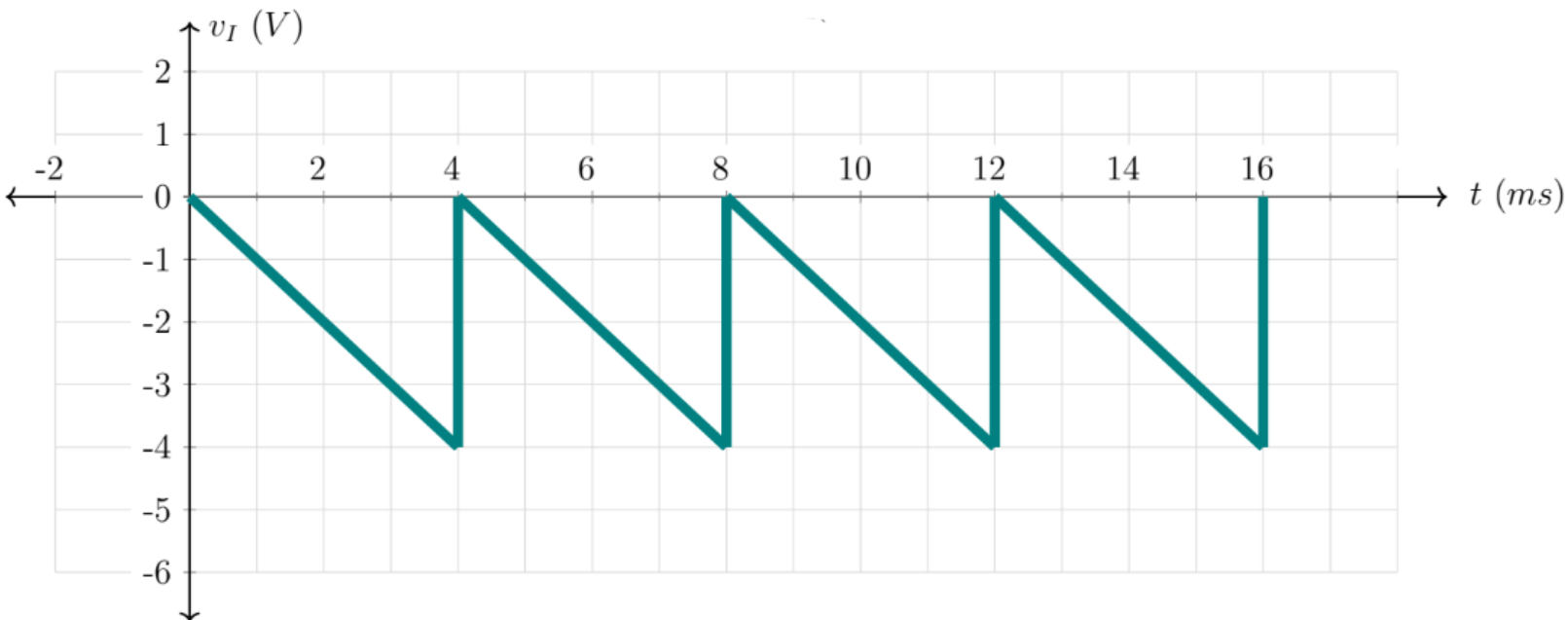
# Problem 8

- In the adjacent circuit,  $v_I$  is a time varying voltage as plotted below. Sketch the graphs of (a)  $V_o$  vs.  $t$  and (b)  $V_o$  vs.  $v_I$ .



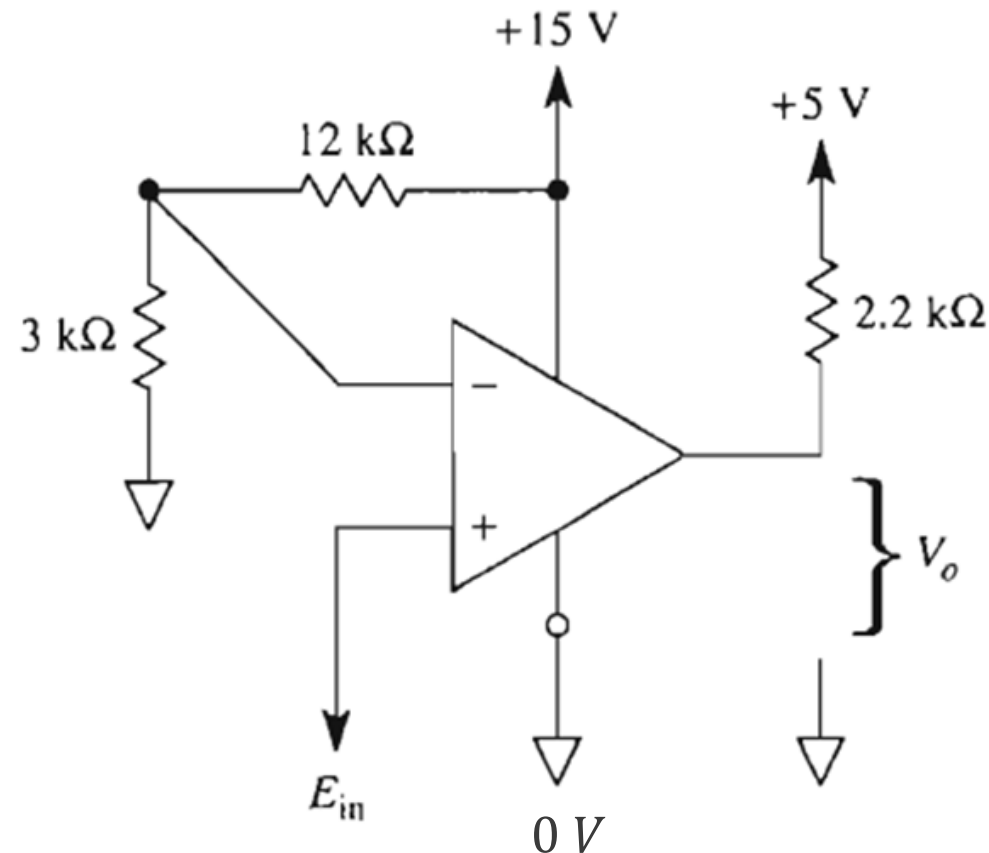
# Problem 9

- In the following circuit,  $v_I$  is a triangular wave as plotted below. Sketch the graphs of (a)  $V_o$  vs.  $E_{in}$  and (b)  $V_o$  vs.  $t$ .



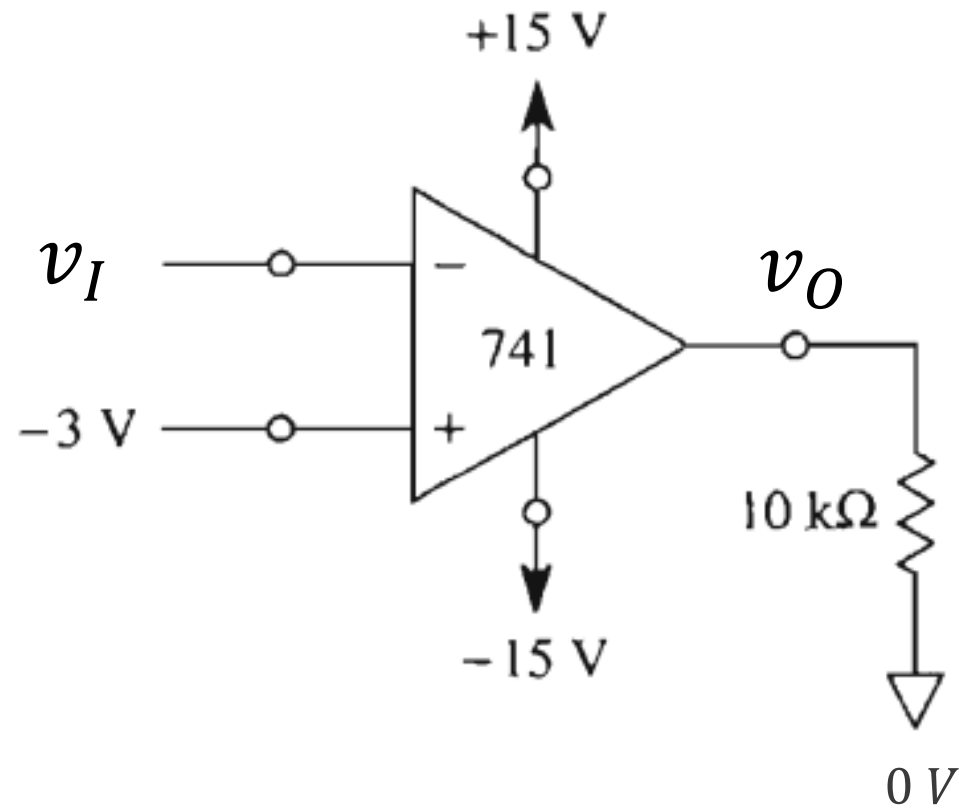
# Problem 10

- In the following circuit,  $E_{in}$  is a triangular wave of 100 Hz frequency with an amplitude of 5 V. Sketch, with appropriate levels of axes crossings, the graphs of (a)  $V_o$  vs.  $E_{in}$  and (b)  $V_o$  vs.  $t$ .



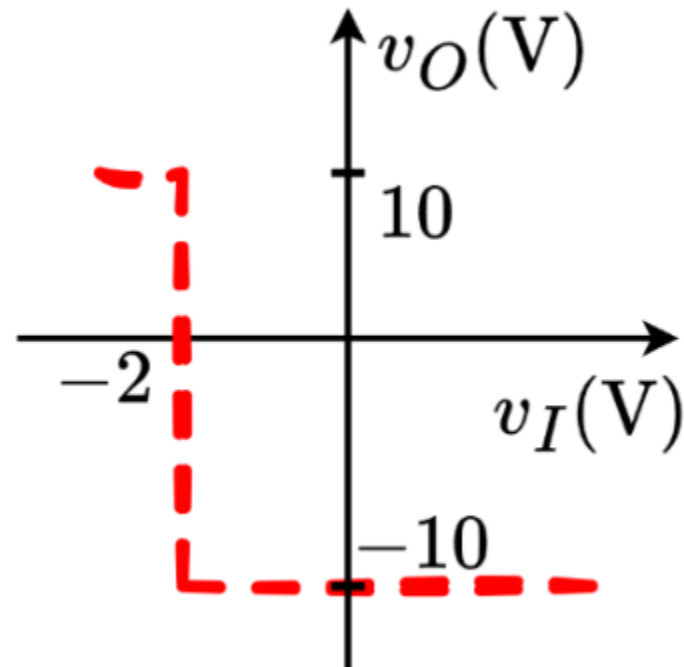
# Problem 11

- Draw the Voltage Transfer Characteristics ( $v_O$  vs.  $v_I$ ) of the following circuit.



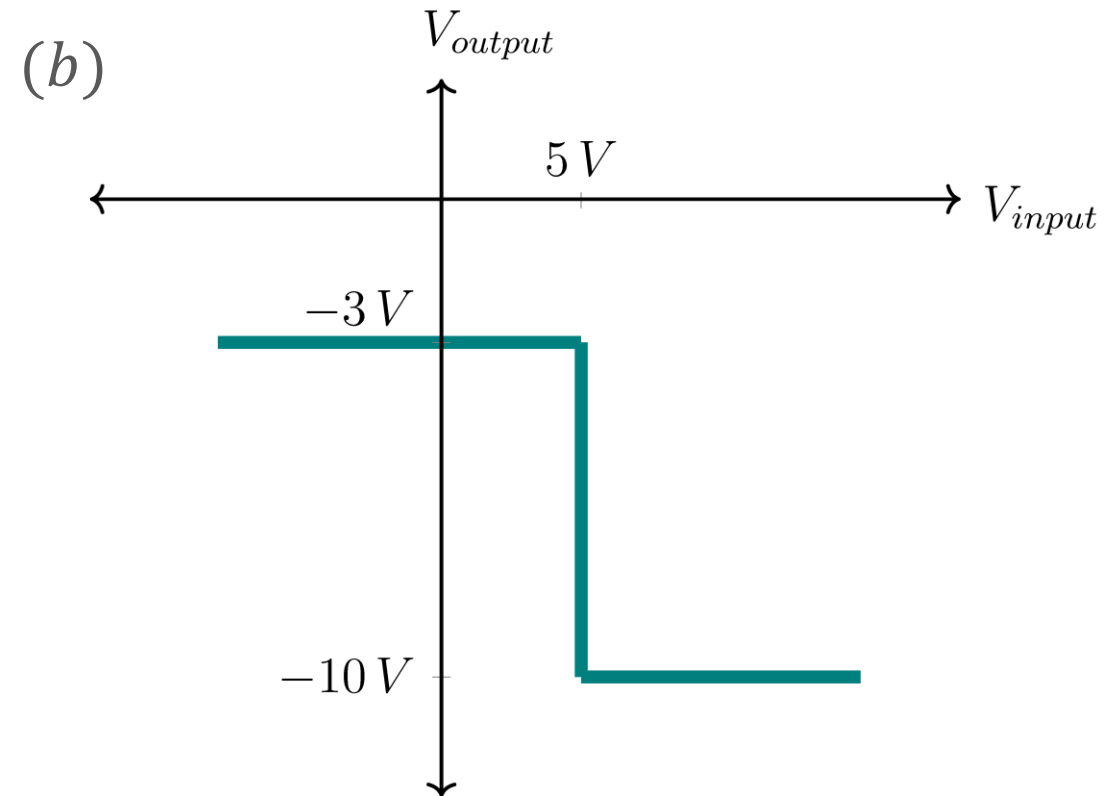
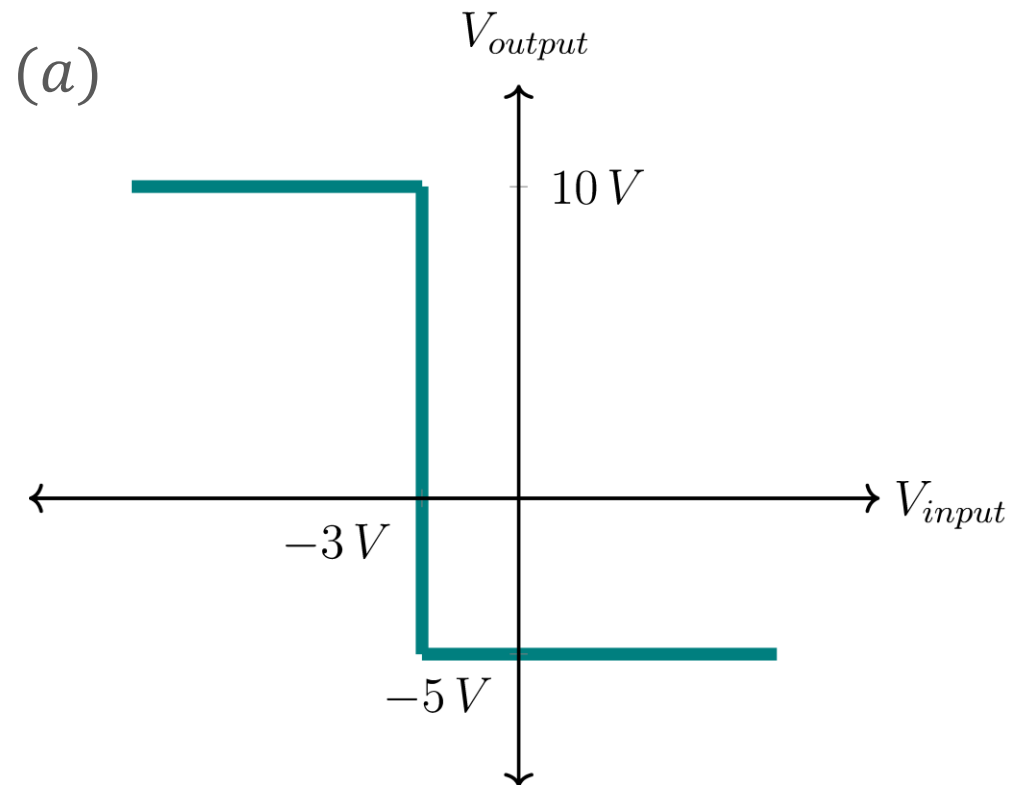
# Problem 12

- Design a circuit with a single ideal op-amp for each of the VTC plots shown below.  $v_O$  and  $v_I$  are the output voltage and the input voltage respectively.



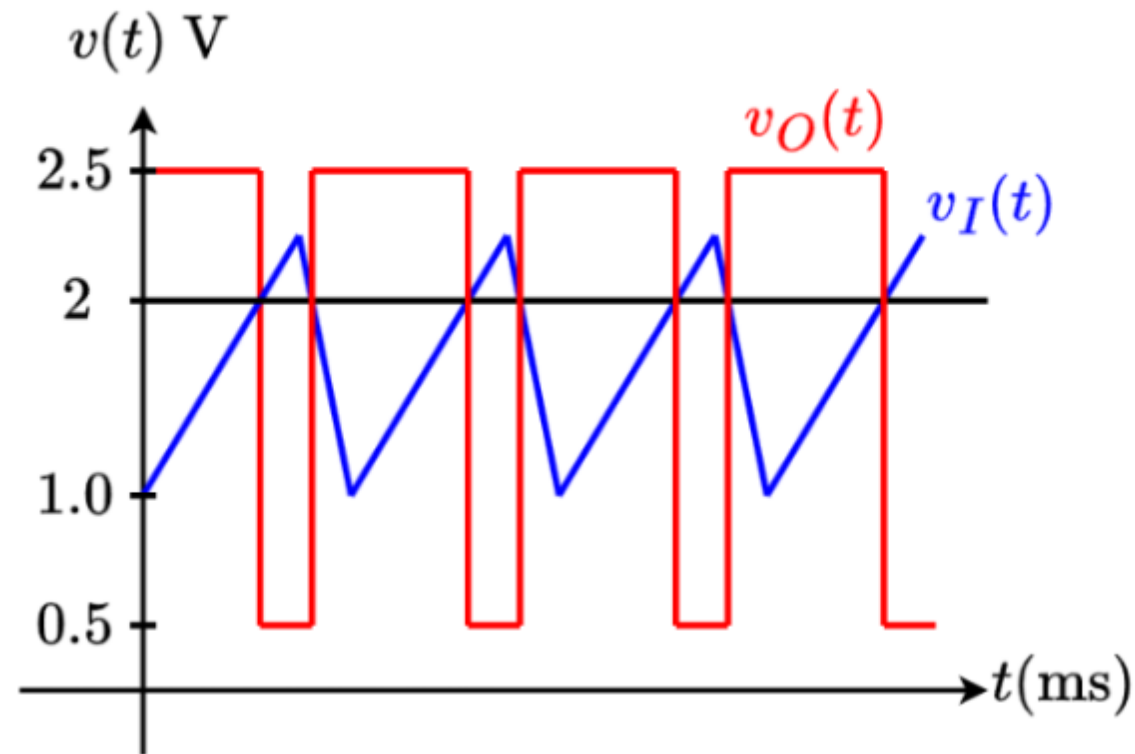
# Problem 13

- Design a circuit with a single ideal op-amp for each of the VTC plots shown below.  $V_{output}$  and  $V_{input}$  are the output voltage and the input voltage respectively.



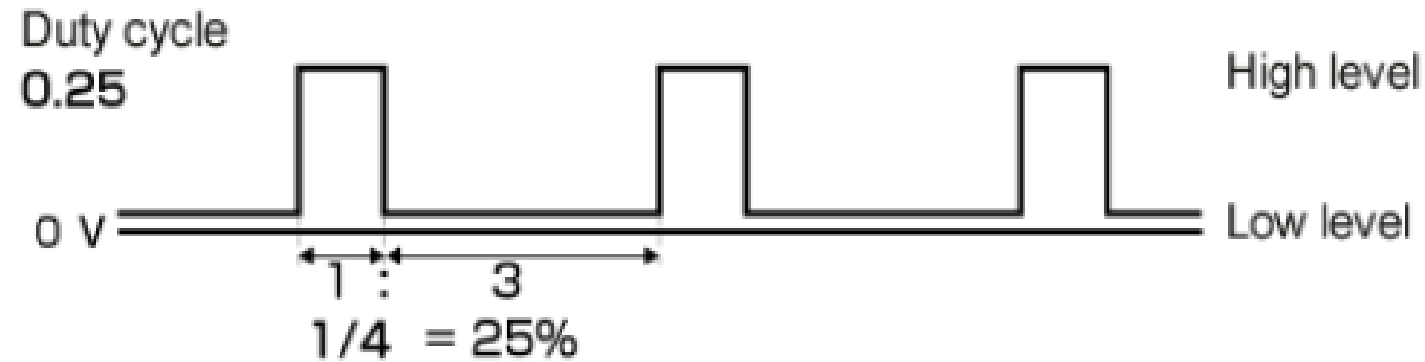
# Problem 14

- I. Draw the Voltage Transfer Characteristics ( $v_O$  vs.  $v_I$ ) of the following circuit.
- II. Also design a circuit that would give rise to the VTC you plotted in I.



# Problem 15\*\*

- Design a circuit using op-amp to transform the sinusoidal voltage  $v_I = 6 \sin(200\pi t)$  (V) into a square wave with 25% duty cycle as shown below.

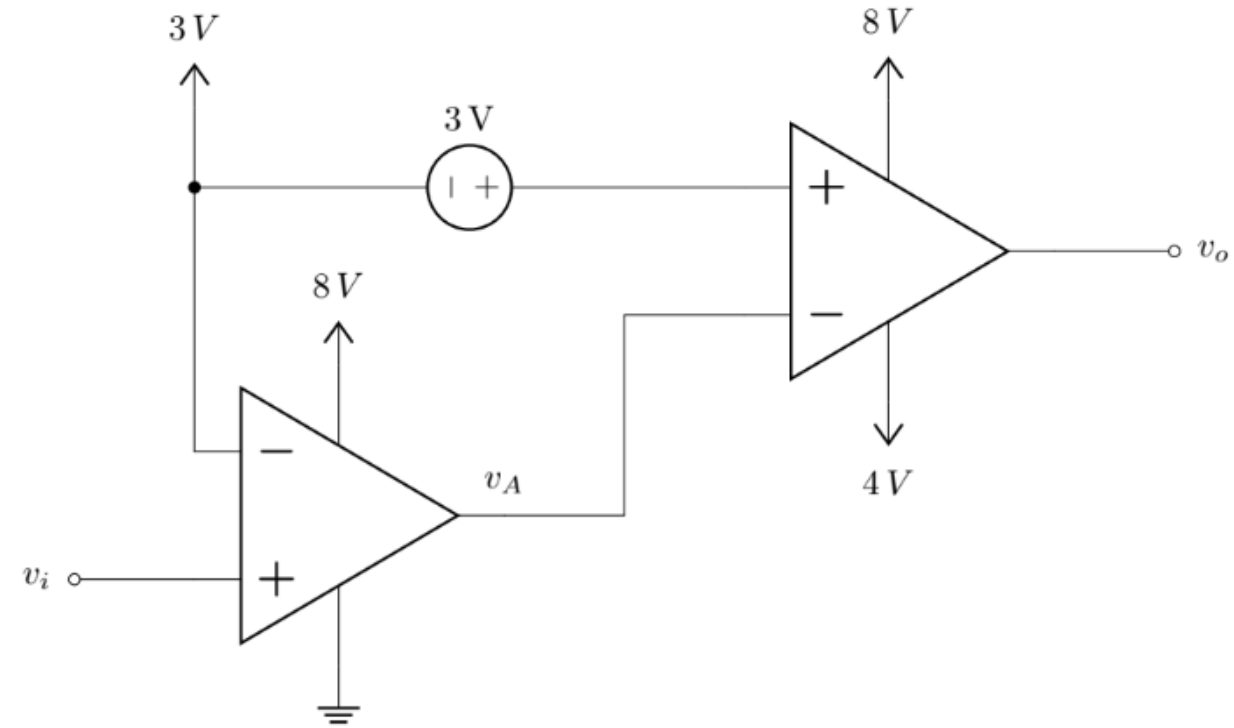
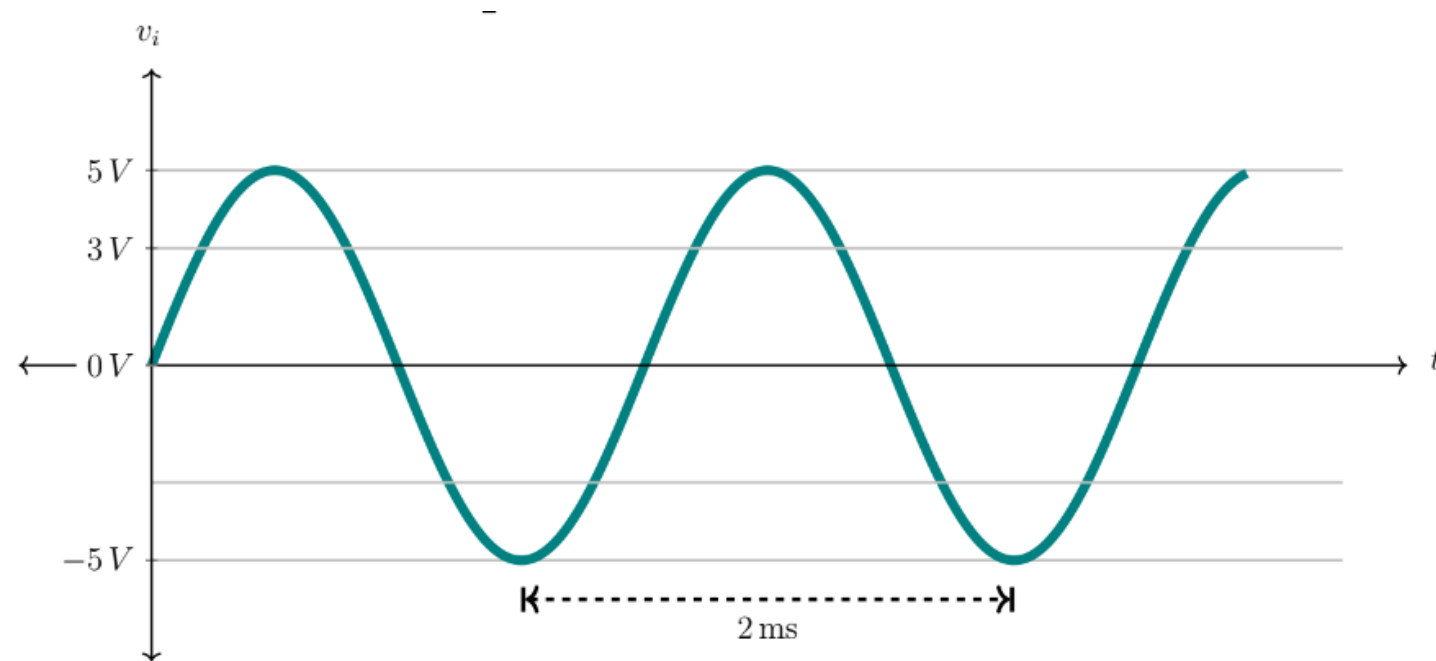


Note: Problems marked with an asterisk (\*\*) are a bit more advanced for this course. However, attempting them can help you develop a stronger grasp of the topic.



# Problem 16

- Sketch  $v_A$  vs.  $t$  and  $v_o$  vs.  $t$ .



# Acknowledgement and References

Some of the problems in this set are taken or adapted from the following sources:

1. Sedra, A. S., & Smith, K. C., Microelectronic Circuits, Oxford University Press
2. Coughlin, R. F., & Driscoll, F. F., Operational Amplifiers and Linear Integrated Circuits, Pearson
3. Neamen, D. A., Microelectronics: Circuit Analysis and Design, McGraw-Hill