Department of Computer Science and Engineering (CSE)
BRAC University

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

Inspiring Excellence

Midterm and Final Questions

For any error or issues, contact purbayan.das@bracu.ac.bd

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 $10\ k\Omega$ resistor for the circuit shown below. Assume the op-amp to be ideal except with a finite gain $A = 10^4$.

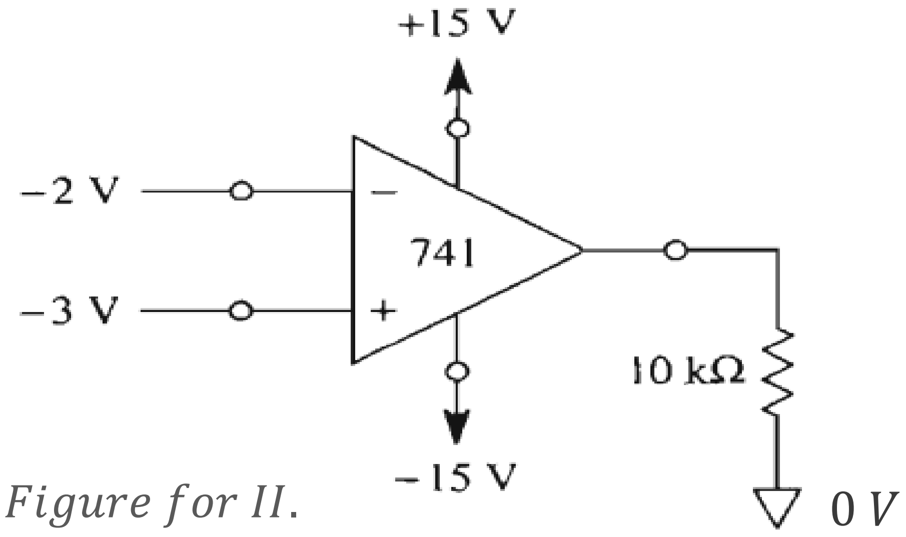
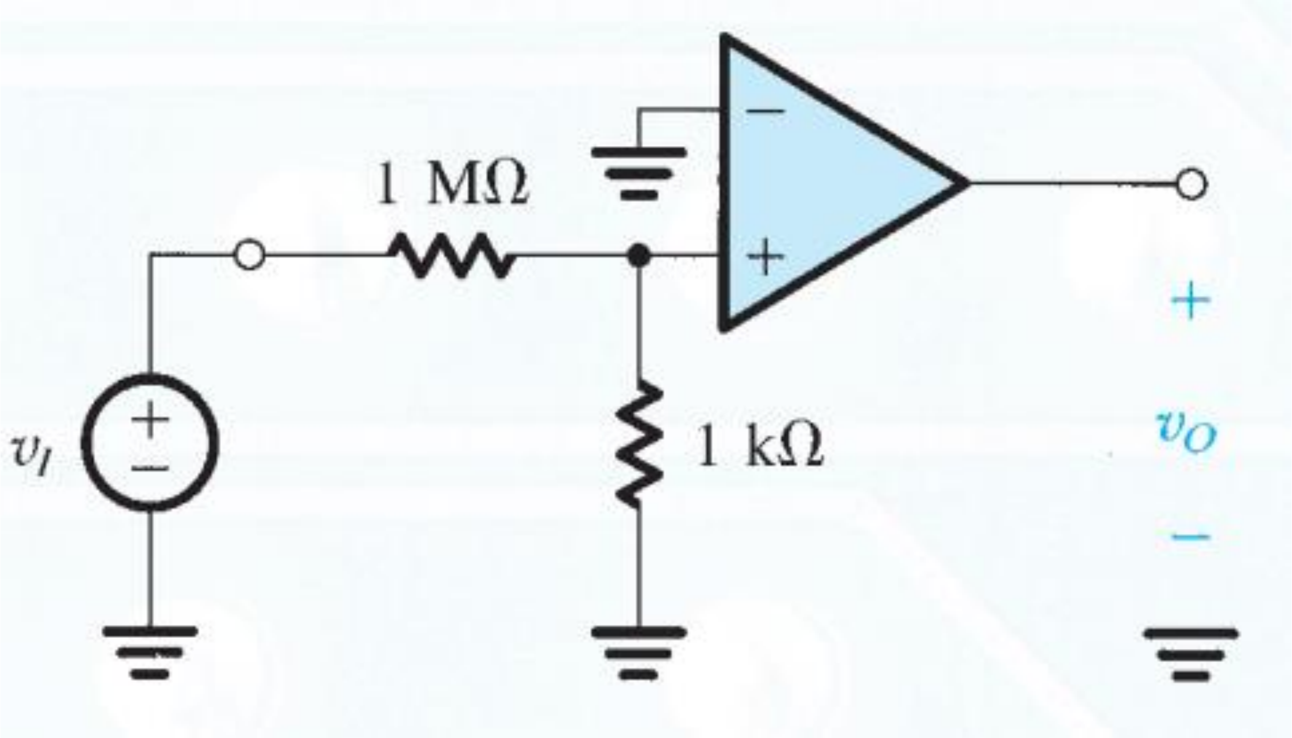


Figure for II.

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

Problem 2

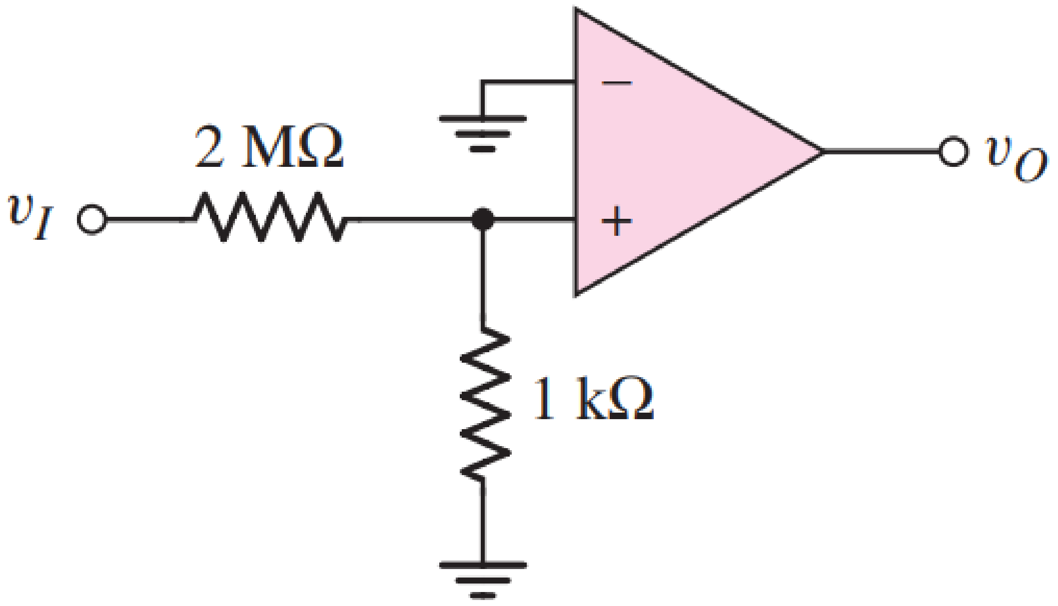
- The following circuit uses an op amp that is ideal except for having a finite gain A. Measurements indicate $v_O = 4.0\,V$ when $v_I = 2.0\,V$. What is the op-amp gain A?



Ans: $\boldsymbol{A = 2002}$

Problem 3

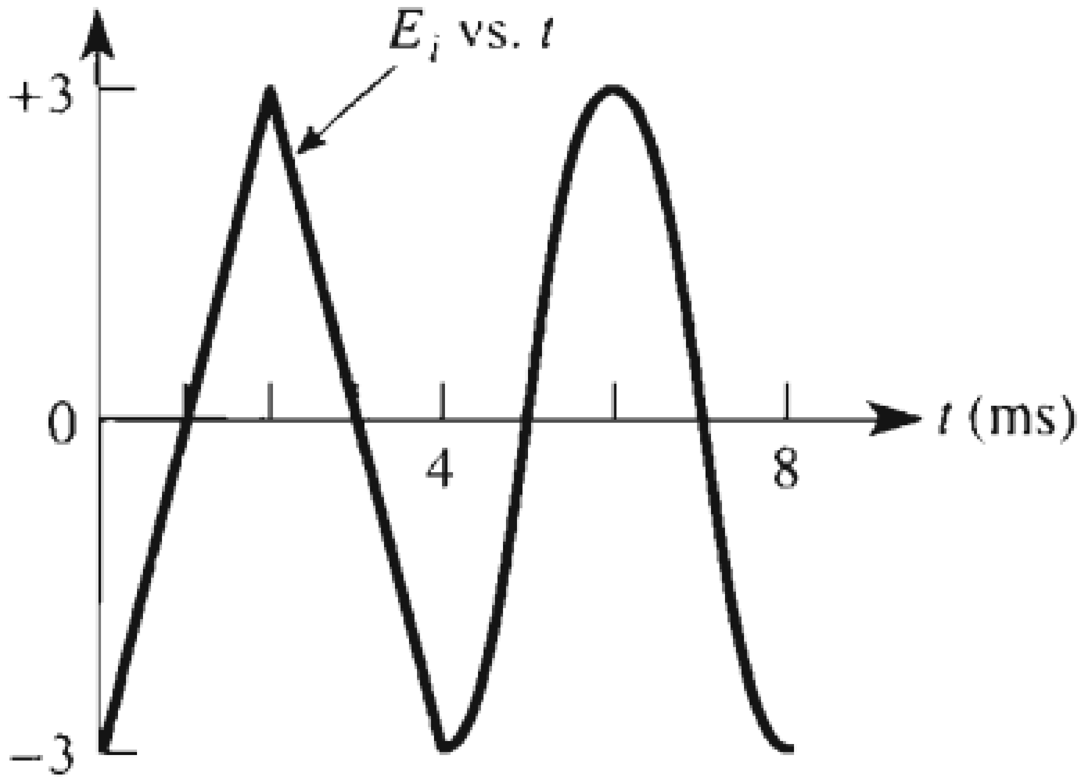
- The following circuit uses an op amp that is ideal except for having a finite gain A. If $A = 10^4$ and $v_O = -2.0\ V$, determine v_I.

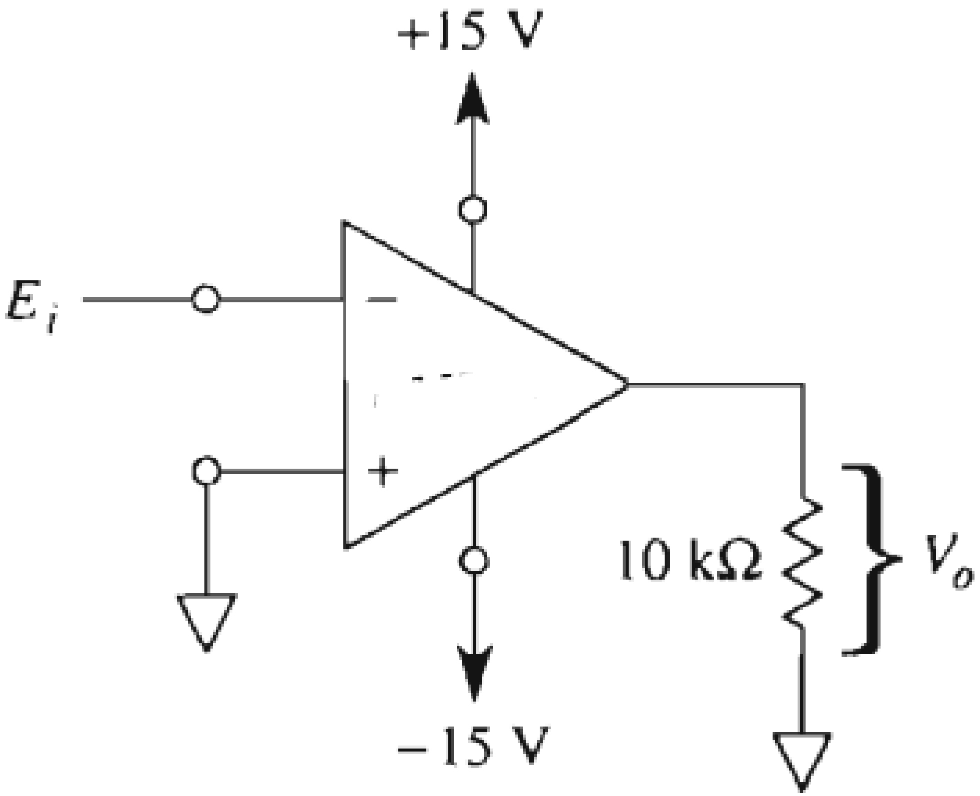


Ans: $\boldsymbol{v_I = -4.002\ V}$

Problem 4

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





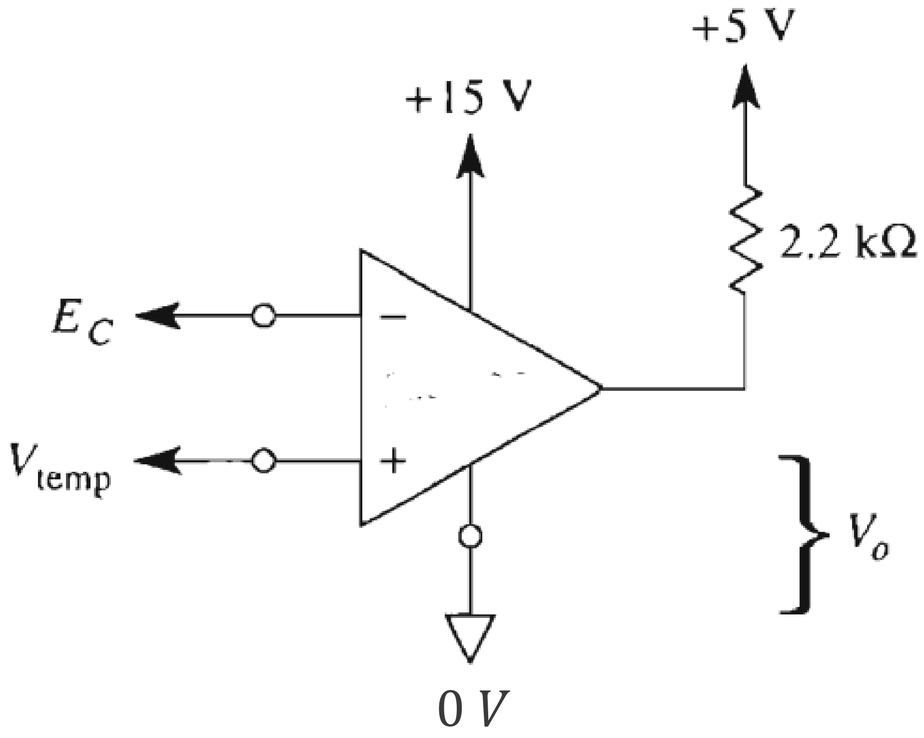
Problem 5

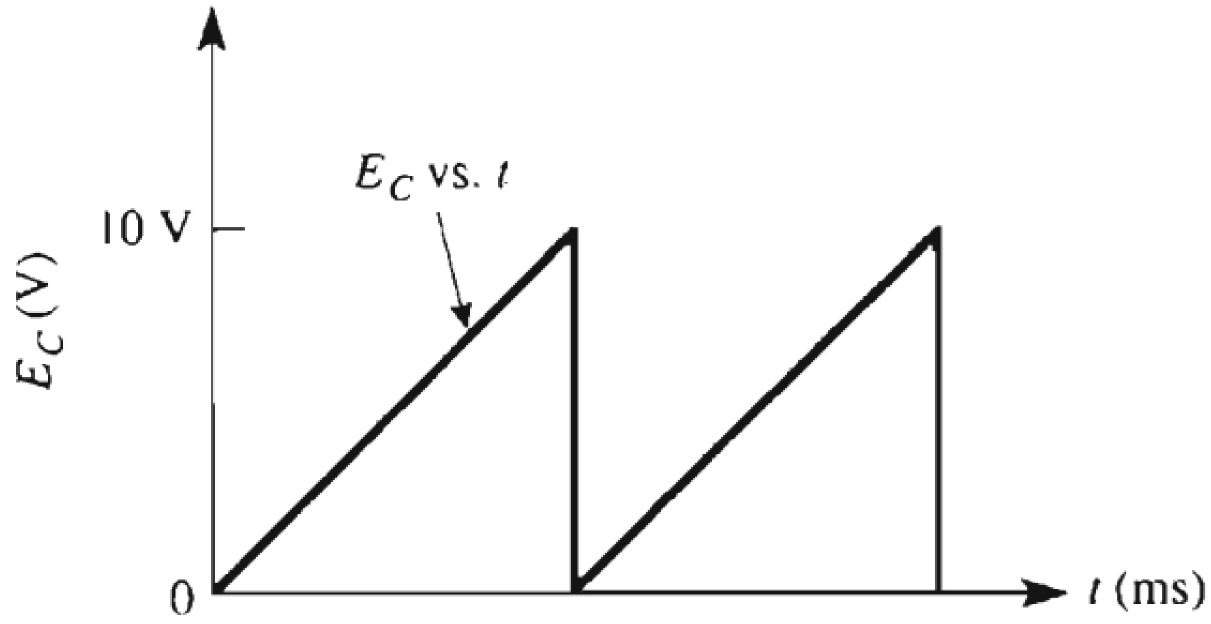
I. Draw the schematics of a circuit whose output voltage will go positive to $+15\ V$, when the input signal crosses $+5\ V$ in the positive direction.

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

Problem 6

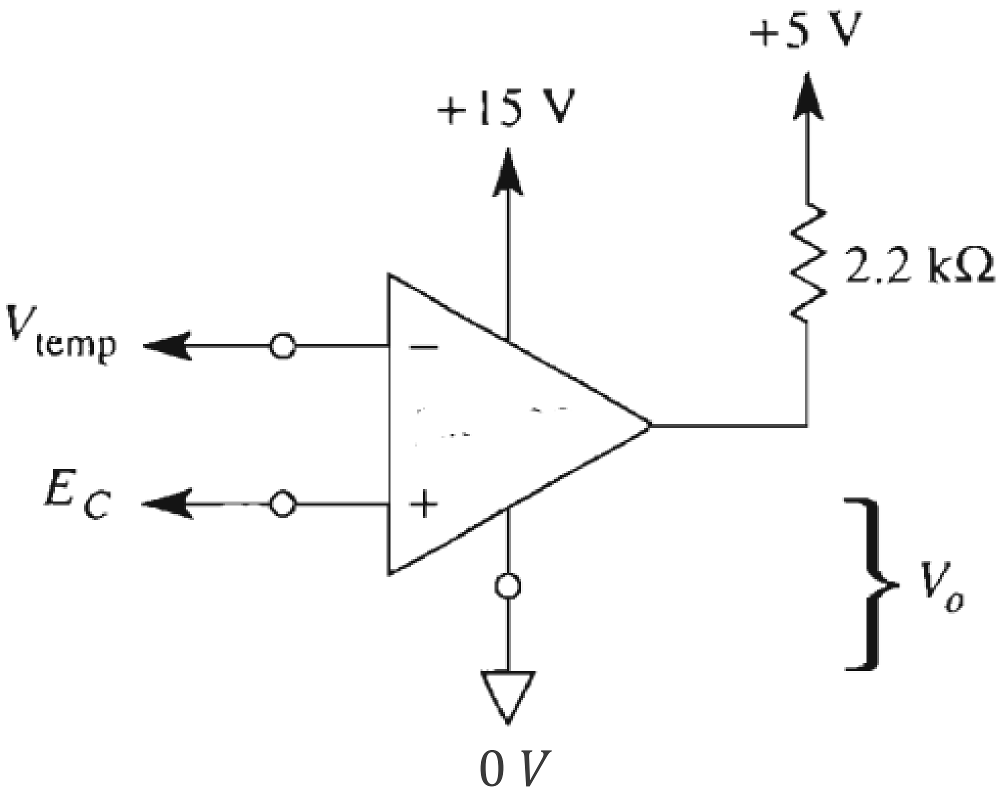
- The frequency of E_C is constant at $50\ Hz$. If $V_{temp} = 4\ V$, (a) plot $V_o\ vs.\ E_C$, (b) plot $V_o\ vs.\ t$, and (c) calculate the high time of V_o.

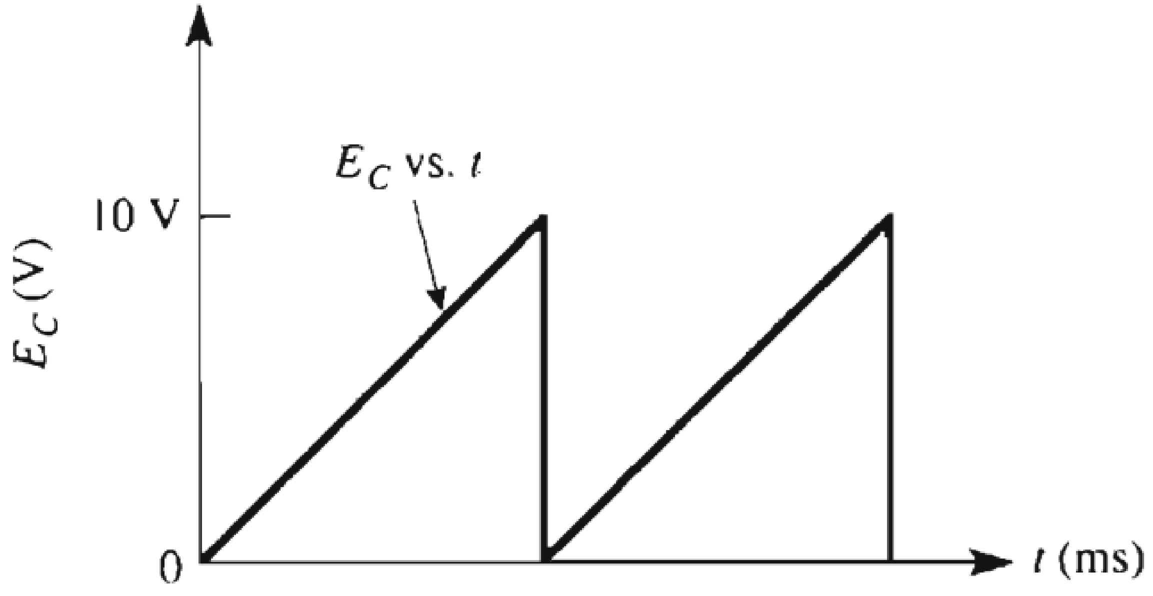




Problem 7

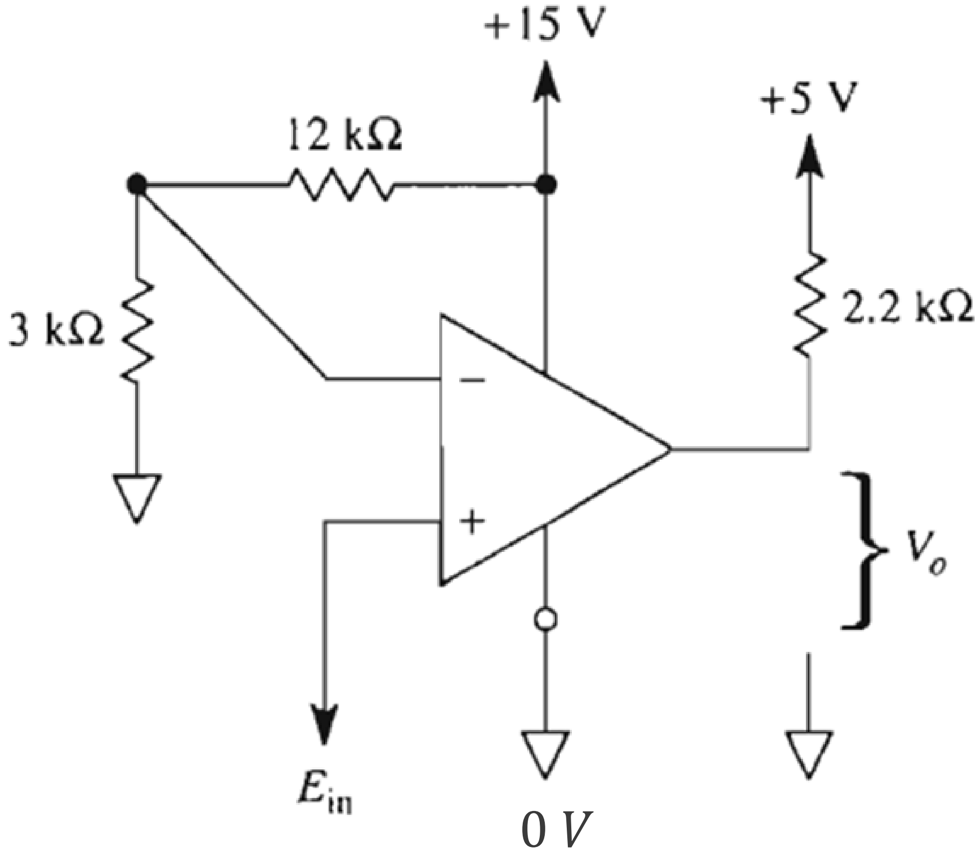
- The frequency of E_C is constant at $50\ Hz$. If $V_{temp} = 3\ V$, (a) plot $V_o\ vs.\ E_C$, (b) plot $V_o\ vs.\ t$, and (c) calculate the high time of V_o.





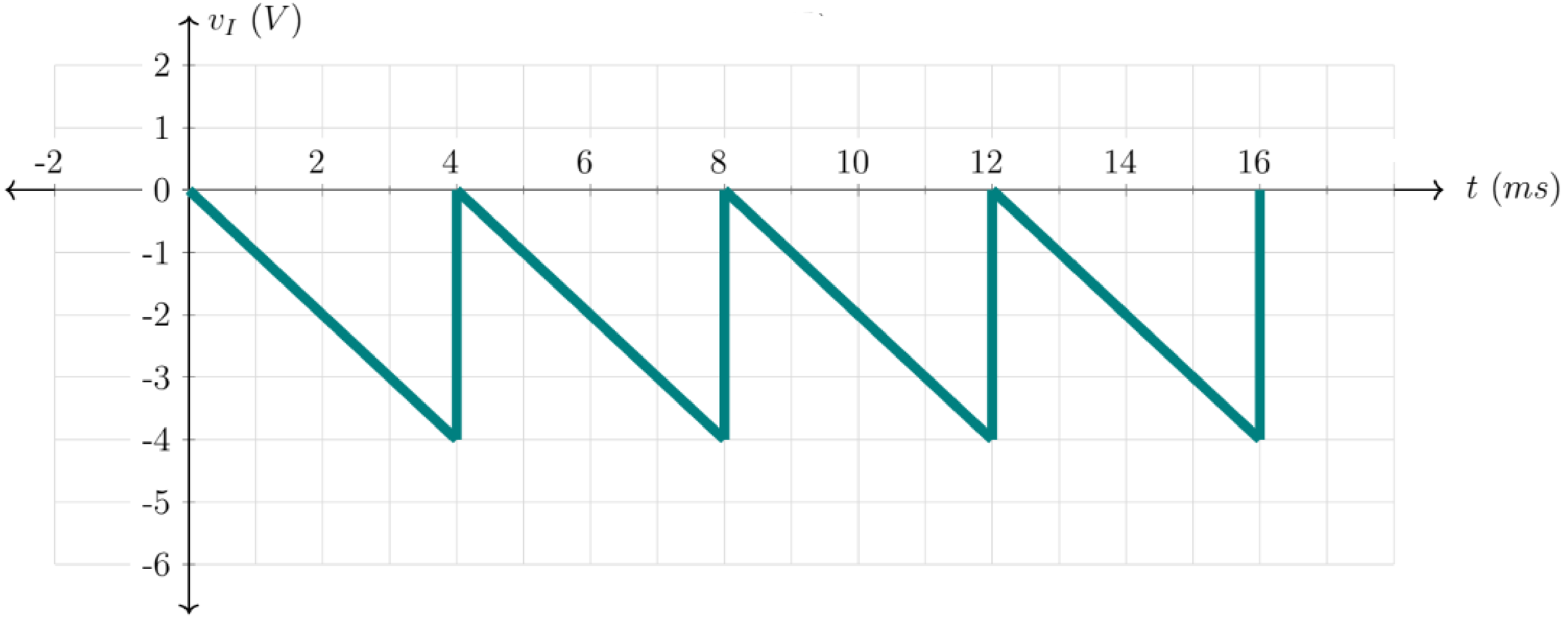
Problem 8

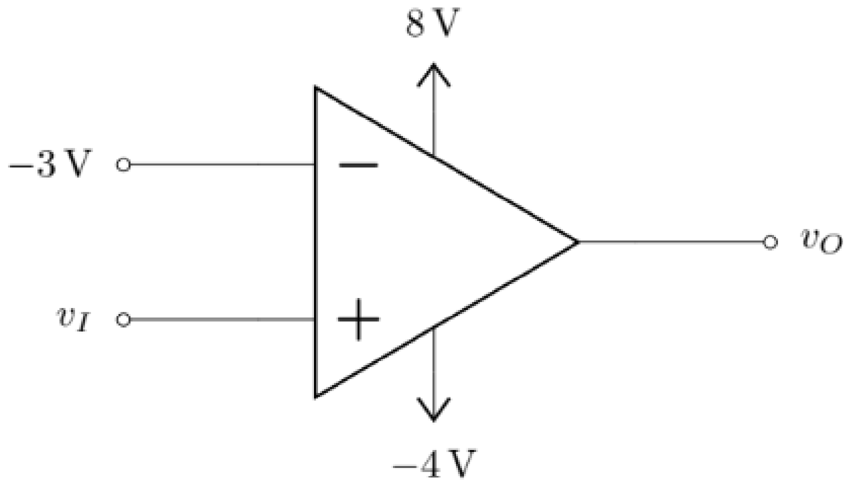
- In the following circuit, E_{in} is a triangular wave of $100\,Hz$ frequency with an amplitude of $5\,V$. Sketch, with appropriate levels of axes crossings, the graphs of $(a)\ V_o\ vs.\ E_{in}$ and $(b)\ V_o\ vs.\ t$.



Problem 9

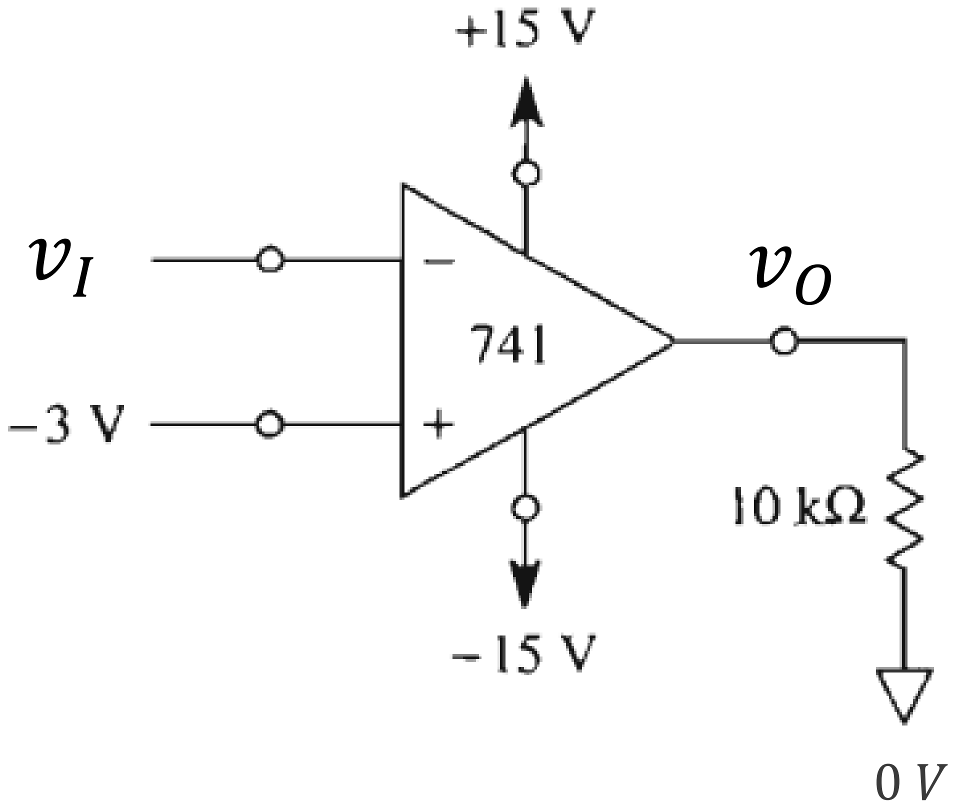
- In the adjacent circuit, v_I is a time varying voltage as plotted below. Sketch, with appropriate levels of axes crossings, the graphs of $(a)\ V_o\ vs.\ t$ and $(b)\ V_o\ vs.\ v_I$.





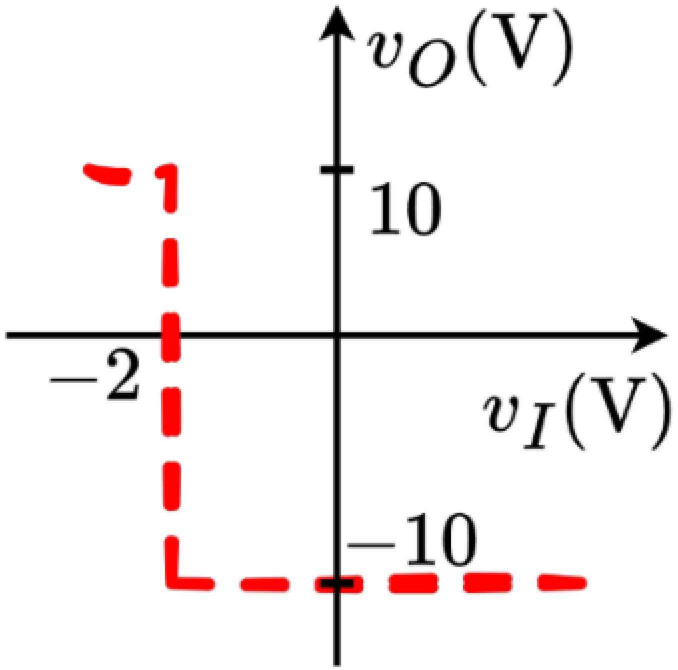
Problem 10

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



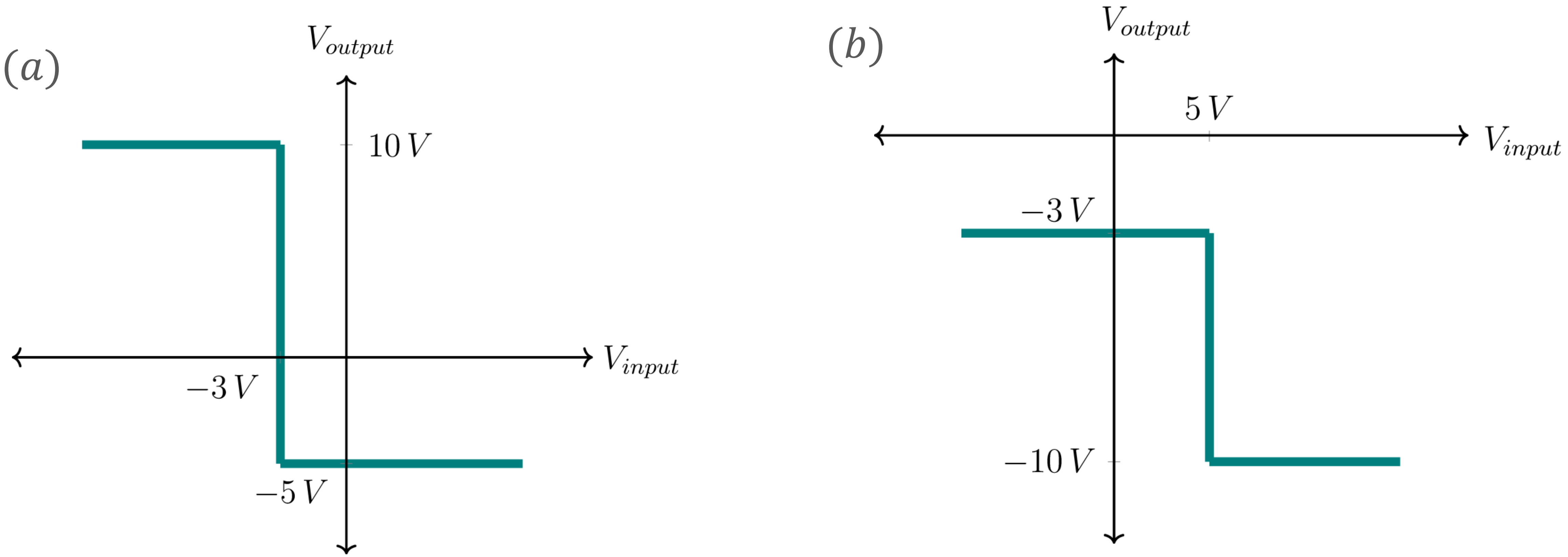
Problem 11

- 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 12

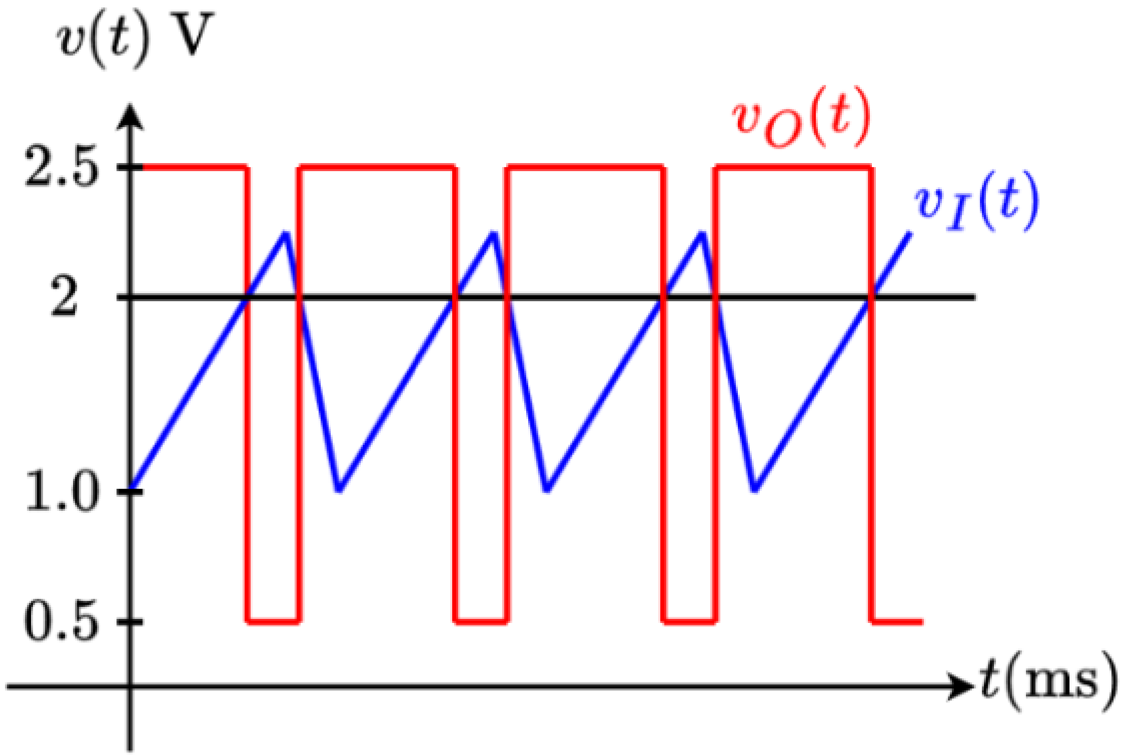
- Design a circuit with a single ideal op-amp for each of the VTC plots shown below. V_{output} and V_{input} are the output voltage and the input voltage respectively.



Problem 13

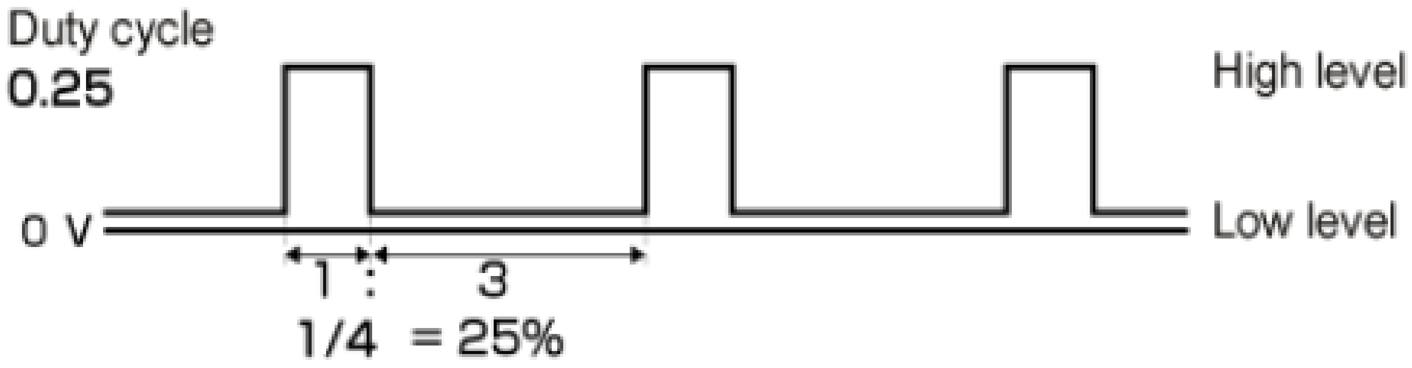
I. Draw the Voltage Transfer Characteristics (v_O $vs.$ v_I) of the following circuit.

II. Also design a circuit that would give rise to the VTC you plotted in I.



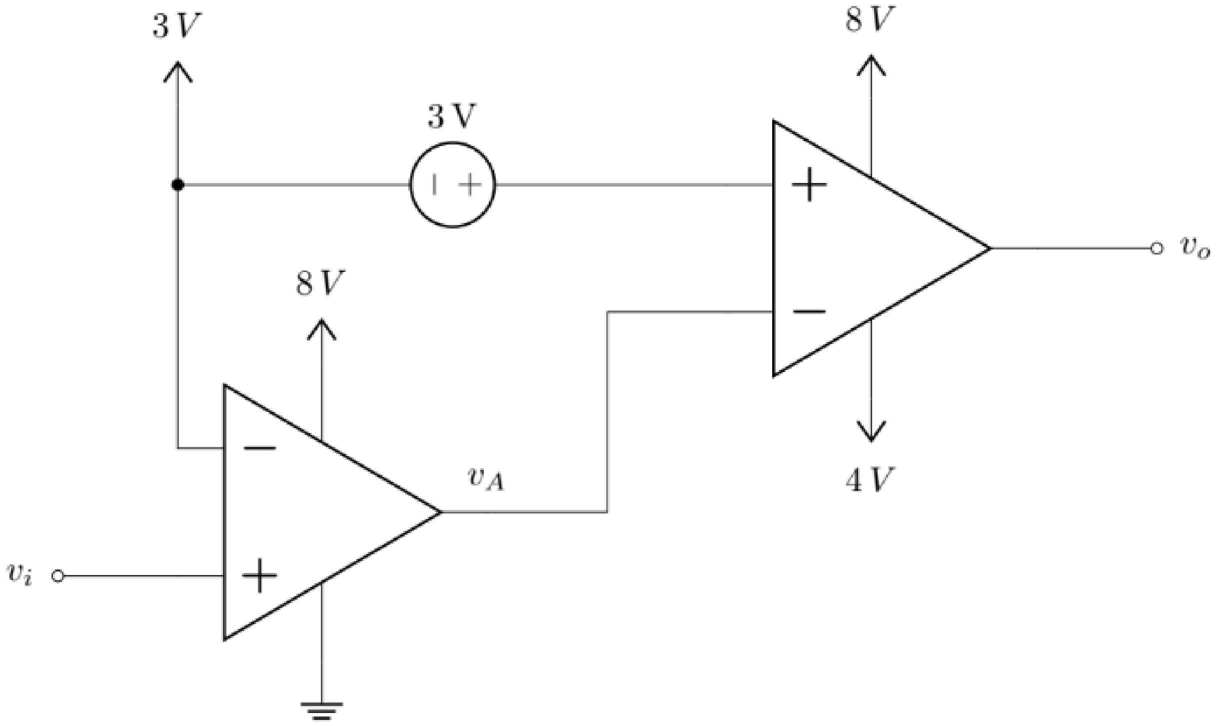
Problem 14

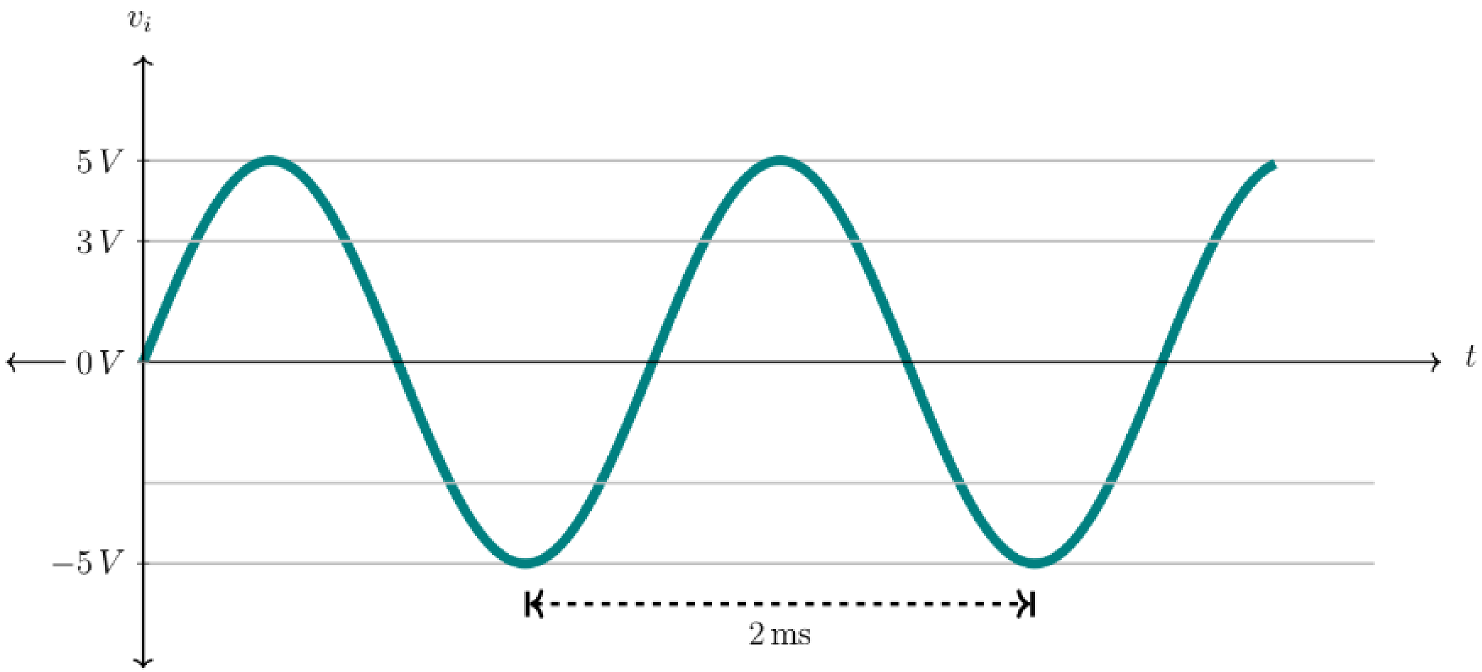
- Design a circuit using op-amp to transform the sinusoidal voltage $v_I = 6\sin(200\pi t)\ (V)$ into a square wave with 25% duty cycle as shown below.



Problem 15

- Sketch v_A $vs. t$ and determine the duty cycle of v_A.
- Sketch 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