Problem 1

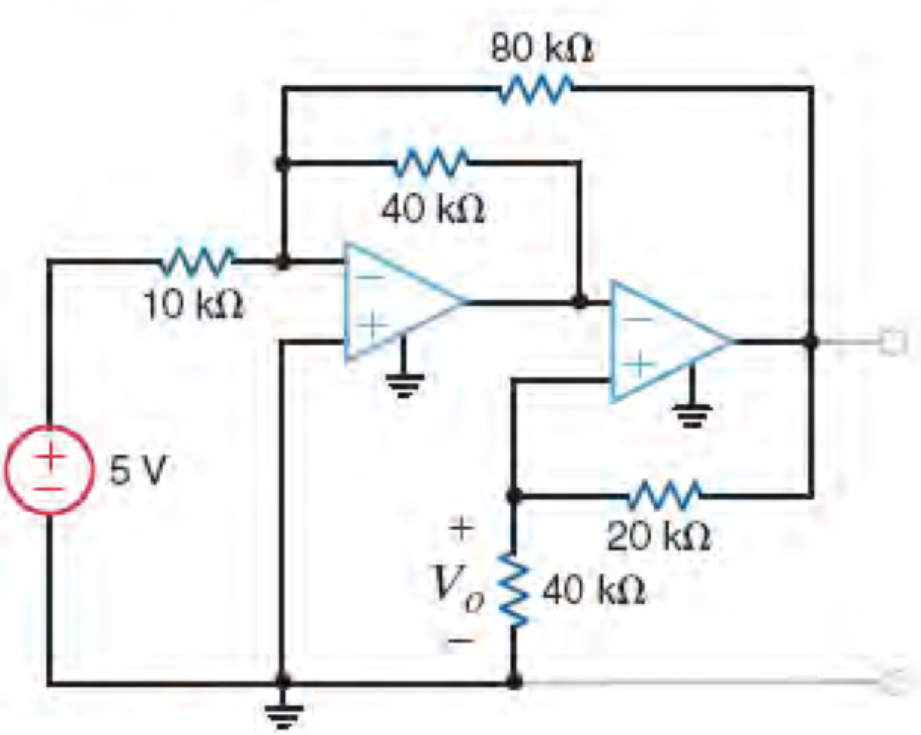
(a) (2 pts) Write a MATLAB routine `[G,b]=NodalAnalysis(filename)` that generates the modified nodal analysis (MNA) equations

$$\boldsymbol{G}\boldsymbol{x} = \boldsymbol{b} \tag{1}$$

from a text file (netlist) that describes an electrical circuit made of resistors, independent current sources, independent voltage sources, voltage-controlled voltage sources. For the netlist, we use the widely-adopted SPICE syntax. For each resistor, the file will contain a line in the form
`Rlabel node1 node2 value`
where "value" is the resistance value. Current sources are specified with the line
`Ilabel node1 node2 DC value`
and current flows from node1 to node2. Note that DC is just a keyword. A voltage source connected between the nodes `node+` and `node-` is specified by the line
`Vlabel node+ node- DC value`
where `node+` and `node-` identify, respectively, the node where the "positive" and "negative" terminal is connected to. A voltage-controlled voltage source, connected between the nodes`node+` and `node-`, is specified by the line
`Elabel node+ node- nodectrl+ nodectrl- gain`
The controlling voltage is between the nodes `nodectrl+` and `nodectrl-`, and the last argument is the source gain.

(b) (2 pts) Explain how did you include the controlled source into the modified nodal analysis formulation. Which general rule can be given to "stamp" a voltage-controlled voltage source into the MNA coefficient matrices?

(c) (2 pts) Consider the circuit shown in the figure. Write an input file for the netlist parser developed in the previous point, and use it to generate the matrices $\boldsymbol{G}$ and $\boldsymbol{b}$ for the circuit. The operational amplifiers have an input resistance of $1\,M\Omega$ and a gain of 10^6. Model them with a resistor and a voltage-controlled voltage source. Use the MATLAB command \ to solve the linear system (1) and determine the voltage V_o shown in the figure.


80 kΩ
40 kΩ
10 kΩ
5 V
20 kΩ
+
V_o
40 kΩ
−