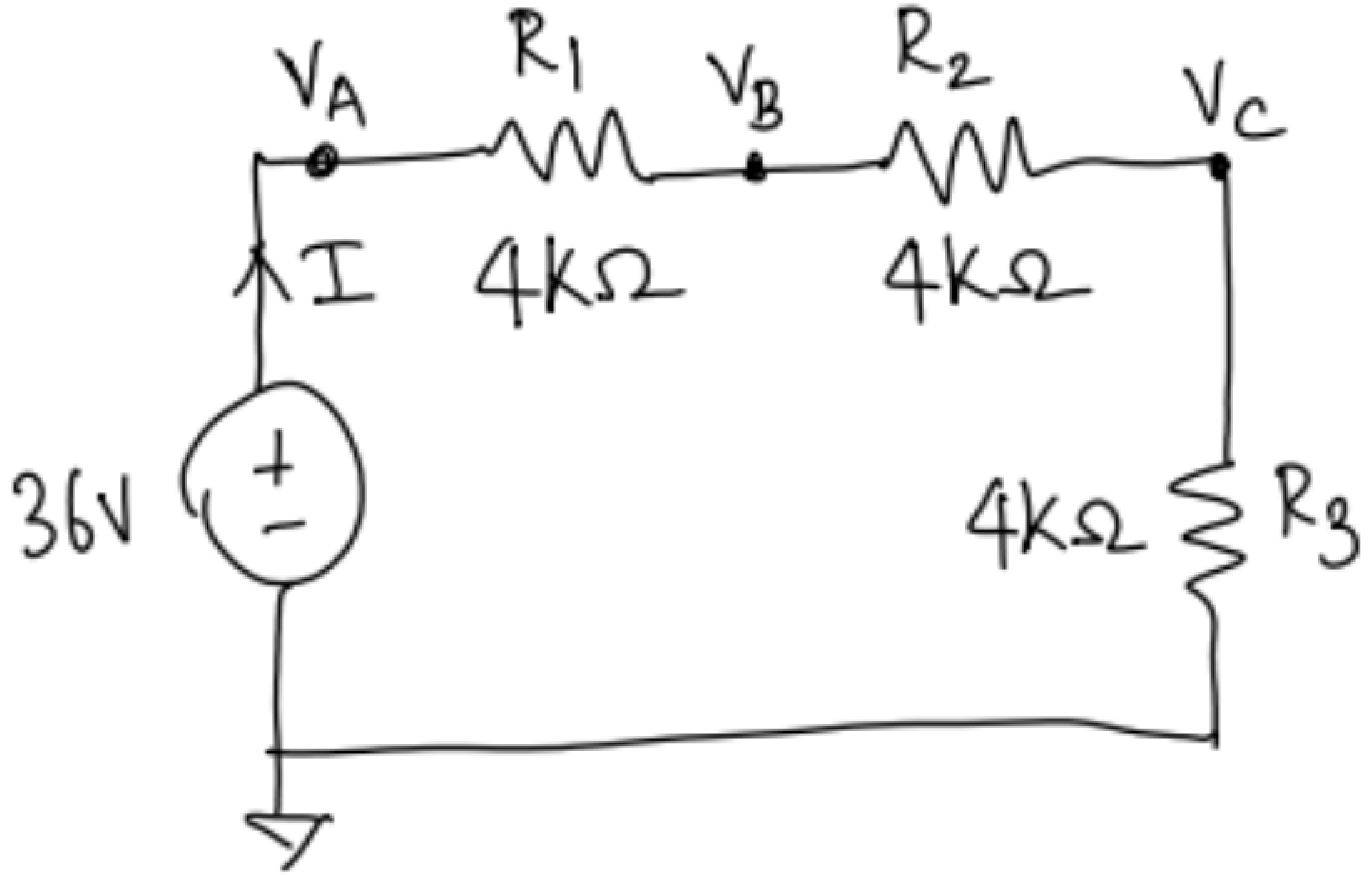
LT Spice question 1 : (DC operating Point)



① perform DC operating point Simulation using LTspice.

② Calculate I, V_a, V_b, V_c Values and verify the results from LTspice Simulation.

Solution:-

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--- Operating Point ---

V(va):        36          voltage
V(vb):        24          voltage
V(vc):        12          voltage
I(R3):        -0.003      device_current
I(R2):        -0.003      device_current
I(R1):        -0.003      device_current
I(V1):        -0.003      device_current
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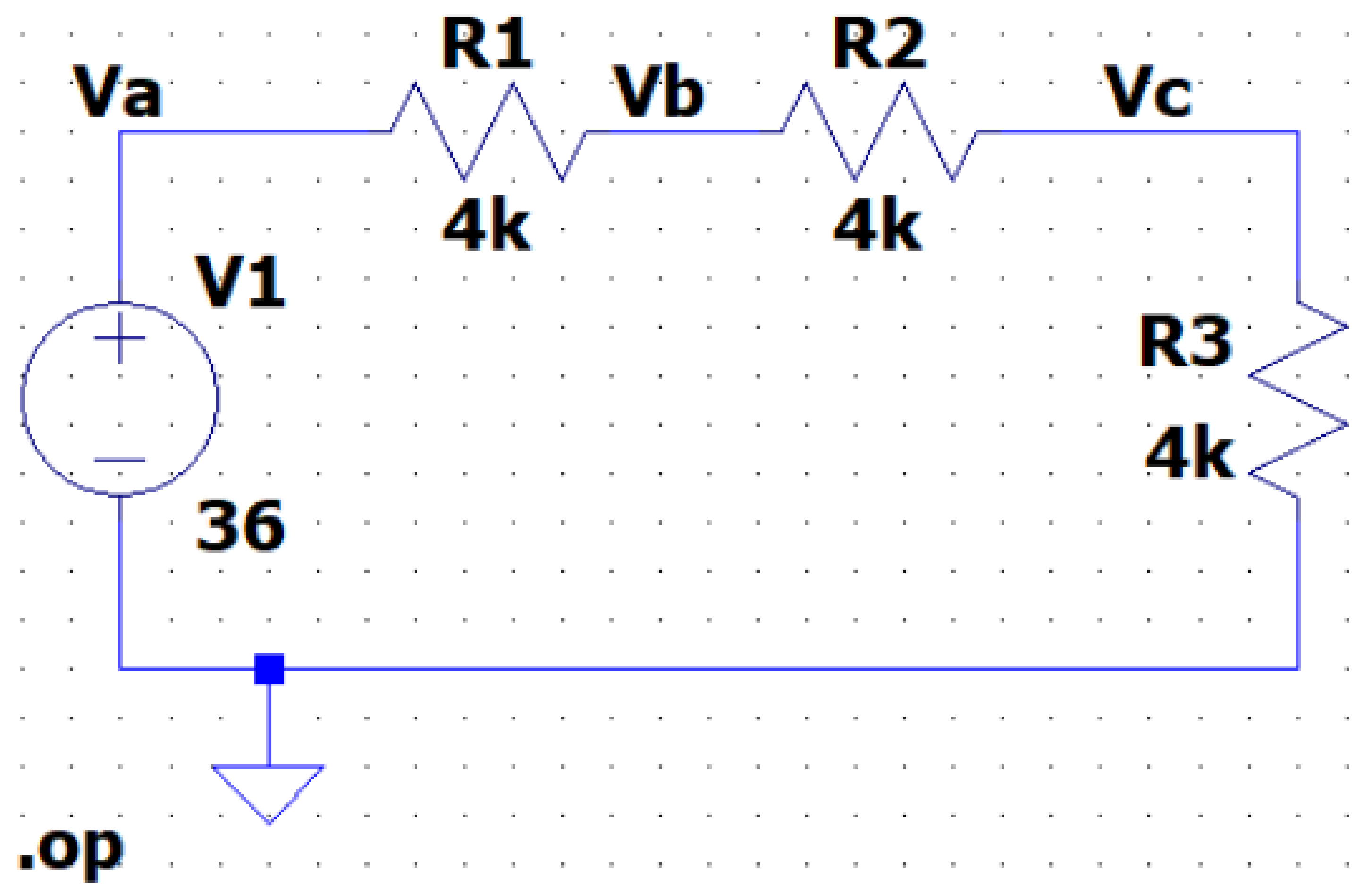
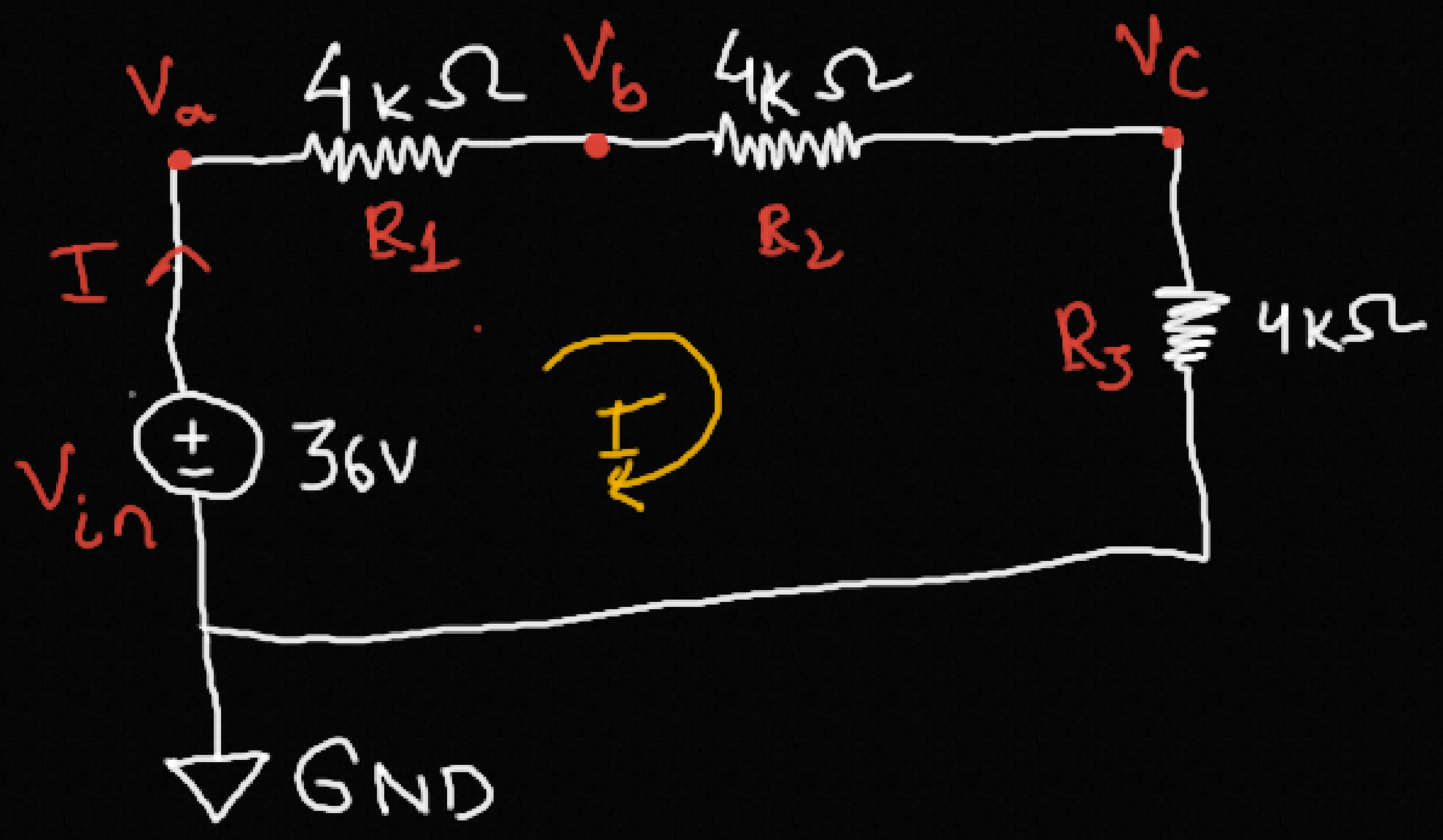




By applying KVL in this closed loop,

$$V_{in} - IR_1 - IR_2 - IR_3 = 0$$

$$\Rightarrow I = \frac{V_{in}}{R_1 + R_2 + R_3} = \frac{36V}{4k\Omega + 4k\Omega + 4k\Omega} = \frac{36V}{12k\Omega}$$

$$\Rightarrow I = 3mA$$

According to voltage divider rule,

$$V_c = \frac{R_3}{R_1 + R_2 + R_3} V_{in} = \frac{4k\Omega}{4k\Omega + 4k\Omega + 4k\Omega} \times 36V$$

$$\Rightarrow V_c = \frac{4k\Omega}{12k\Omega} \times 36V = \frac{1}{3} \times 36 = 12V$$

$$V_B = \frac{R_2 + R_3}{R_1 + R_2 + R_3} V_{in} = \frac{4k\Omega + 4k\Omega}{4k\Omega + 4k\Omega + 4k\Omega} \times 36V$$

$$\Rightarrow V_B = \frac{8k}{12k} \times 36 = \frac{2}{\cancel{3}} \times \overset{12}{\cancel{36}} = 24V$$

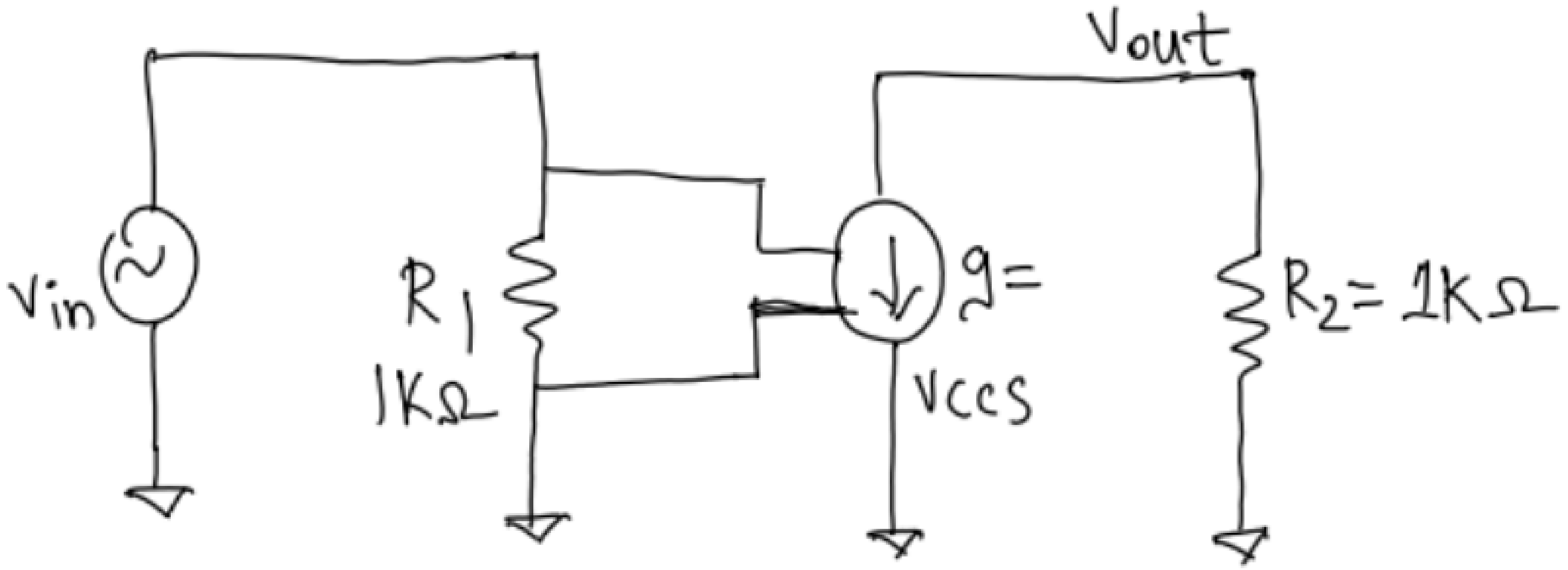
Similarly,

$$V_a = \frac{\cancel{R_1 + R_2 + R_3}}{\cancel{R_1 + R_2 + R_3}} \cdot V_{in}$$

$$V_a = V_{in} = 36V$$

∴ Current $I = 3mA$ and voltage, $V_a = 36V$, $V_b = 24V$ and $V_c = 12V$.

LTspice question 2 : Transient analysis

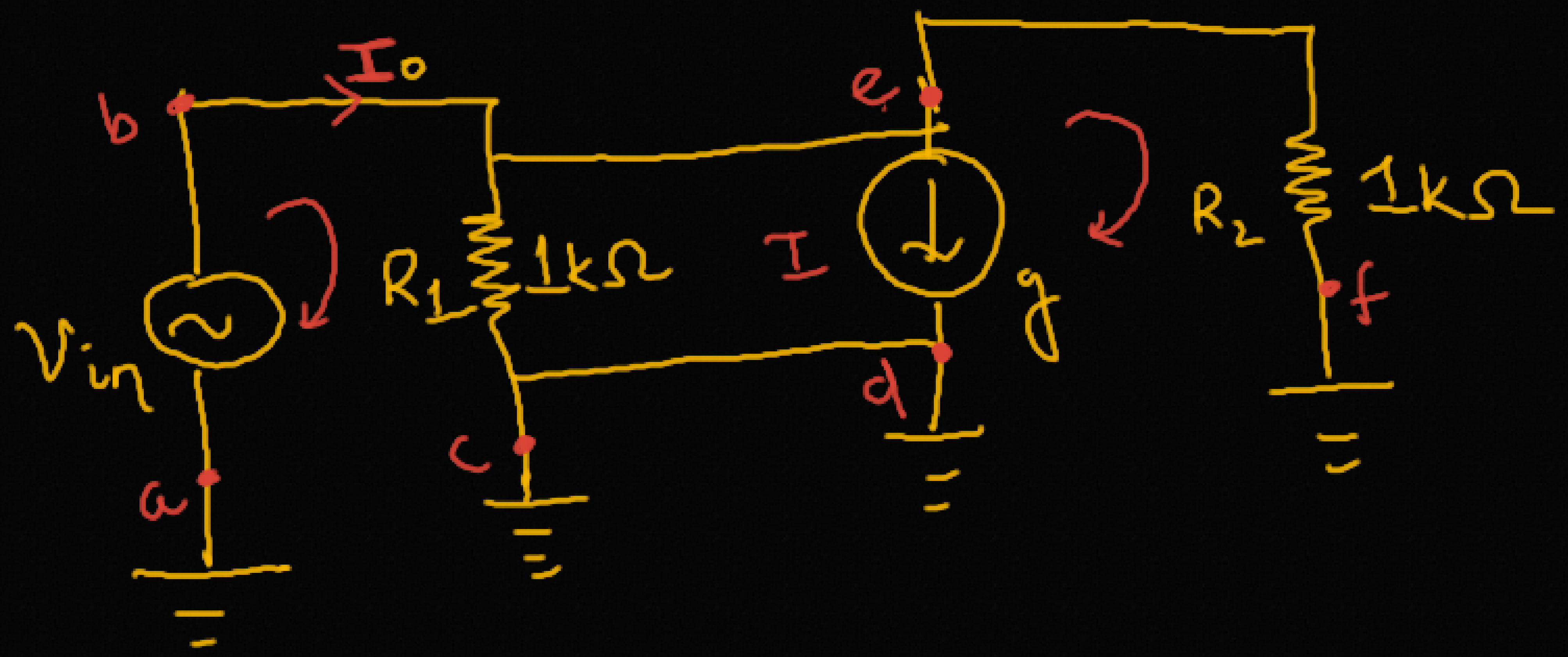


→ Write expression for $\frac{V_{out}}{V_{in}}$.

→ Find value of g for $\frac{V_{out}}{V_{in}} = 2$

Verify the handcalculation results with simulation results

→ Vin ⇒ Sine wave with amplitude 1V, frequency 1Hz.
Perform Transient Simulation in LTSPICE with stop time = 3S



(a) In the given figure, I is acting as voltage dependent current source. It is dependent on the voltage across 1kΩ resistor.

If we apply KVL in loop abc,

$$V_{in} - I_o R_1 = 0 \Rightarrow \boxed{I_o = \frac{V_{in}}{R_1}}$$

as $R_1 = 1k\Omega$, $I_o = V_{in}$ (mA)

as we know in a voltage dependent current source,

$$I = g \cdot V \quad \text{where, } g = \text{conductance}$$

So, in the given problem, the voltage developed across R_1 resistor will be, $V = I_o R_1$

In the loop def,

the voltage dependent current source,

$$I = g \cdot V = g \cdot I_o R_1 = g \cdot V_{in}$$

So, in def the current I will flow through R_2 resistor. So,

$$\boxed{\frac{V_{out}}{R_2} = I}$$

Hence, $\frac{V_{out}}{R_2} = g \cdot V_{in} \Rightarrow \frac{V_{out}}{V_{in}} = g \cdot R_2$

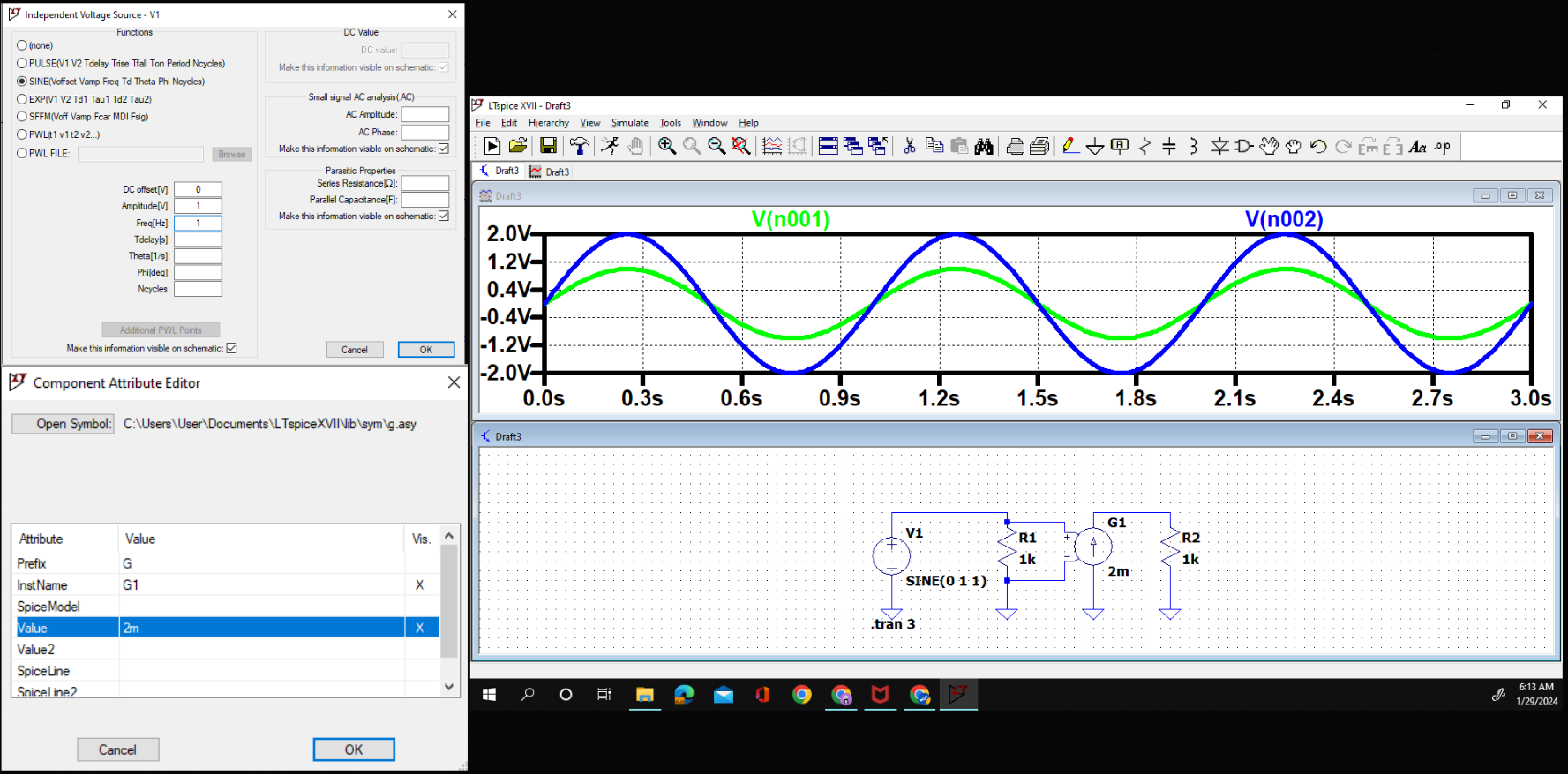
Now, as given in the question, $R_2 = 1k\Omega \Rightarrow \frac{V_{out}}{v_{in}} = g(m\Omega^{-1})$

In the following expression, we must take g_m (in milli $\Omega^{-1} = 10^{-3}\Omega^{-1}$) as we have taken R_1 and R_2 in $k\Omega$.

(b) In orderu to make $\frac{V_{out}}{v_{in}} = 2$.

$$\Rightarrow g = 2m\Omega^{-1} = 2\times10^{-3}\Omega^{-1}.$$

$\therefore$ for $\frac{V_{out}}{v_{in}} = 2$ we need to have the condutance of VCCS as $2\times10^{-3}\Omega^{-1}$.


Independent Voltage Source - V1
Functions
(none)
PULSE(V1 V2 Tdelay Trise Tfall Ton Period Ncycles)
SINE(Voffset Vamp Freq Td Theta Phi Ncycles)
EXP(V1 V2 Td1 Tau1 Td2 Tau2)
SFFM(Voff Vamp Fcar MDI Fsig)
PWL(t1 v1 t2 v2...)
PWL FILE:
Browse
DC offset[V]: 0
Amplitude[V]: 1
Freq[Hz]: 1
Tdelay[s]:
Theta[1/s]:
Phi[deg]:
Ncycles:
Additional PWL Points
Make this information visible on schematic:
DC Value
DC value:
Make this information visible on schematic:
Small signal AC analysis(.AC)
AC Amplitude:
AC Phase:
Make this information visible on schematic:
Parasitic Properties
Series Resistance[Ω]:
Parallel Capacitance[F]:
Make this information visible on schematic:
Cancel
OK
Component Attribute Editor
Open Symbol: C:\Users\User\Documents\LTspiceXVII\lib\sym\g.asy
Attribute | Value | Vis.
Prefix | G
InstName | G1 | X
SpiceModel
Value | 2m | X
Value2
SpiceLine
SpiceLine2
Cancel
OK
LTspice XVII - Draft3
File Edit Hierarchy View Simulate Tools Window Help
Draft3
Draft3
V(n001)
V(n002)
2.0V
1.2V
0.4V
-0.4V
-1.2V
-2.0V
0.0s 0.3s 0.6s 0.9s 1.2s 1.5s 1.8s 2.1s 2.4s 2.7s 3.0s
V1
SINE(0 1 1)
R1
1k
G1
2m
R2
1k
.tran 3
6:13 AM
1/29/2024