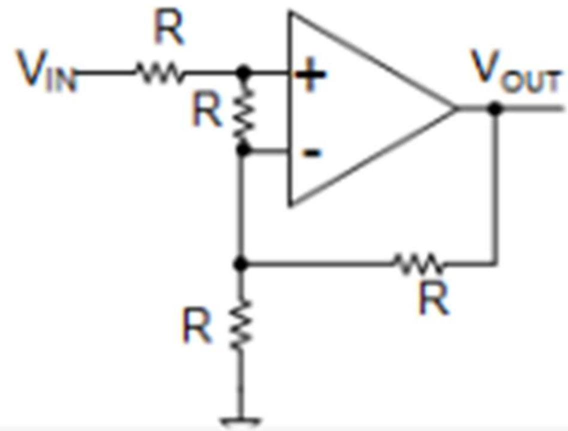
TI BYTE Simulation Exercise

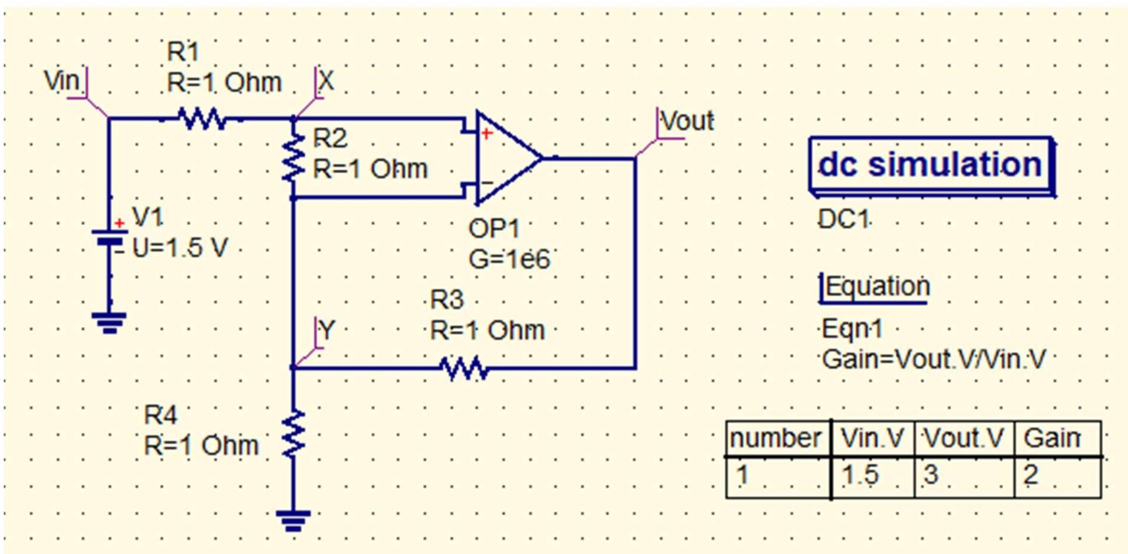
Week 6 : Op-Amps

- **Question 1:**

1. Op amp is ideal. Gain from VIN to VOUT is:
(a) 2
(b) 4
(c) 1
(d) 1.5
(e) 3
(f) 2.5
(g) 0
(h) ∞



➢ **QUCS Circuit:**



number	Vin.V	Vout.V	Gain
1	1.5	3	2

- **V_{in} is the input voltage given with an amplitude of 1.5 V.**
- **V_{out} is used to label the output node and find the voltage at that node.**
- **The Op-Amp is considered to be an ideal one, but since an ideal Op-amp is difficult to implement in QUCS, the gain is considered to be very high (~10^6), so that it behaves almost like an ideal one.**

➢ QUCS Result:

Therefore, from the simulation, we get our answer as:

Thus, Gain = 2

Answer: (a)

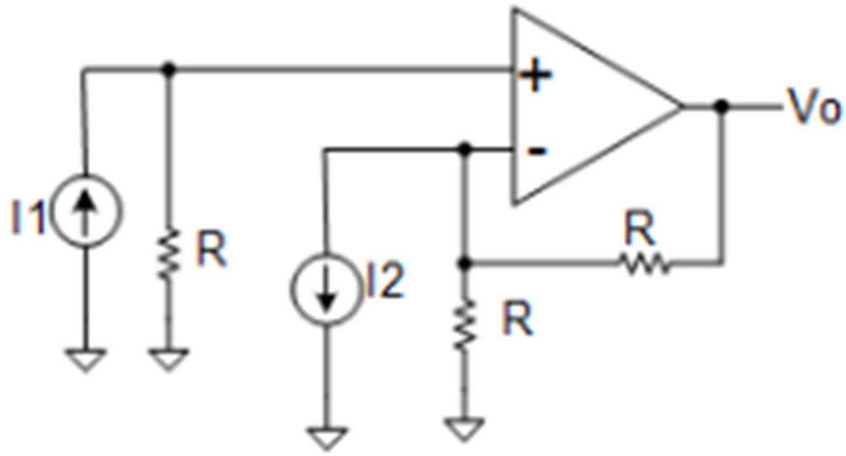
➢ Conclusion:

- **Since the Op-Amp is an ideal one and has infinite input impedance, no input current flows into the Op-Amp.**
- **Now, due to the presence of a negative feedback from the output of the Op-Amp to the inverting terminal of the Op-Amp, the voltage at the inverting and non-inverting terminal should be equal due to virtual short, i.e., $V_x = V_y$.**
- **Thus, there wouldn't be any current flowing through the resistor R2, and thus it can be ignored. So, the circuit simplifies into just a non-inverting amplifier.**
- **Now, since no current flows into the Op-Amp, no current flows through R1. Thus, $V_y = V_x = V_{in} = 1.5$ V.**
- **So, current though R4,** $I = \frac{V_y}{R_4} = \frac{1..5}{1} = 1.5\ A$
- **Therefore, voltage at** $V_{out} = V_y + I \times \mathrm{R3} = 1.5 + 1.5 \times 1 = 3V$
- $Gain = \frac{V_{out}}{V_{in}} = \frac{3}{1.5} = 2$
- **Thus, our answer is verified with the simulated result.**

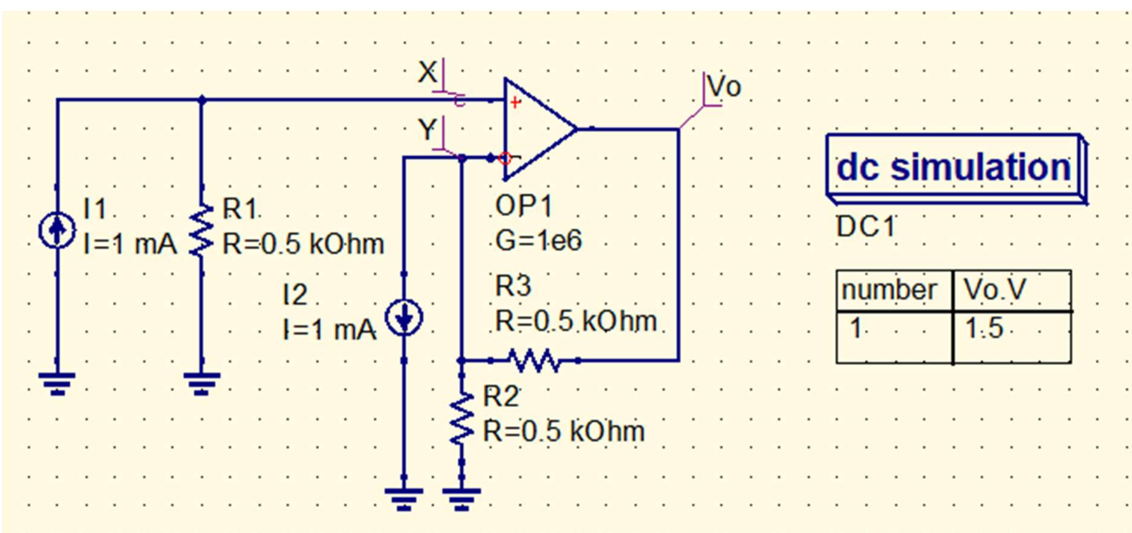
- **Question 2:**

11. I1 and I2 are equal current sources of value 1 mA. Op amp can be considered ideal. What is the voltage at Vo if R= 0.5 kΩ

(a) 0.5V
(b) -0.5V
(c) 5V
(d) 2V
(e) 1V
(f) 0V
(g) 2.5V
(h) 1.5V



➢ QUCS Circuit:



- **The circuit has two current sources I1 and I2, both of value 1 mA.**
- **V_{out} is used to label the output node and find the voltage at that node.**
- **The Op-Amp is considered to be an ideal one, but since an ideal Op-amp is difficult to implement in QUCS, the gain is considered to be very high (~10^6), so that it behaves almost like an ideal one.**

➢ QUCS Result:

Therefore, from the simulation, we get our answer as:

Thus, V_o = 1.5 V

Answer: (h)

➢ Conclusion:

- **Since the Op-Amp is an ideal one having infinite input impedance, no current can flow through it.**
- **Therefore, the current I1 flows totally through R1, causing the voltage at node X to be, V_x = I1R1 = 0.5 V**
- **D due to the presence of a negative feedback from the output of the Op-Amp to the inverting terminal of the Op-Amp, the voltage at the inverting and non-inverting terminal should be equal due to virtual short, i.e., V_x = V_y = 0.5V**
- **Now, current through resistor R2,** $I_3 = \frac{V_y}{R_2} = \frac{0.5}{0.5k} = 1\ mA$
- **So, current flowing through R3,** $I = I_2 + I_3 = 2\ mA$
- **Then,** $V_{out} = V_y + I \times R_3 = 0.5\ V + 2\ mA \times 0.5k\Omega = 1.5\ V$
- **From the simulation, we got the same result, thus our answer is correct and verified.**