Electronic Circuits Design

Lecture – 4

- *Summing Amplifier*
- *Differential Amplifier*
- *Instrumentation Amplifier*

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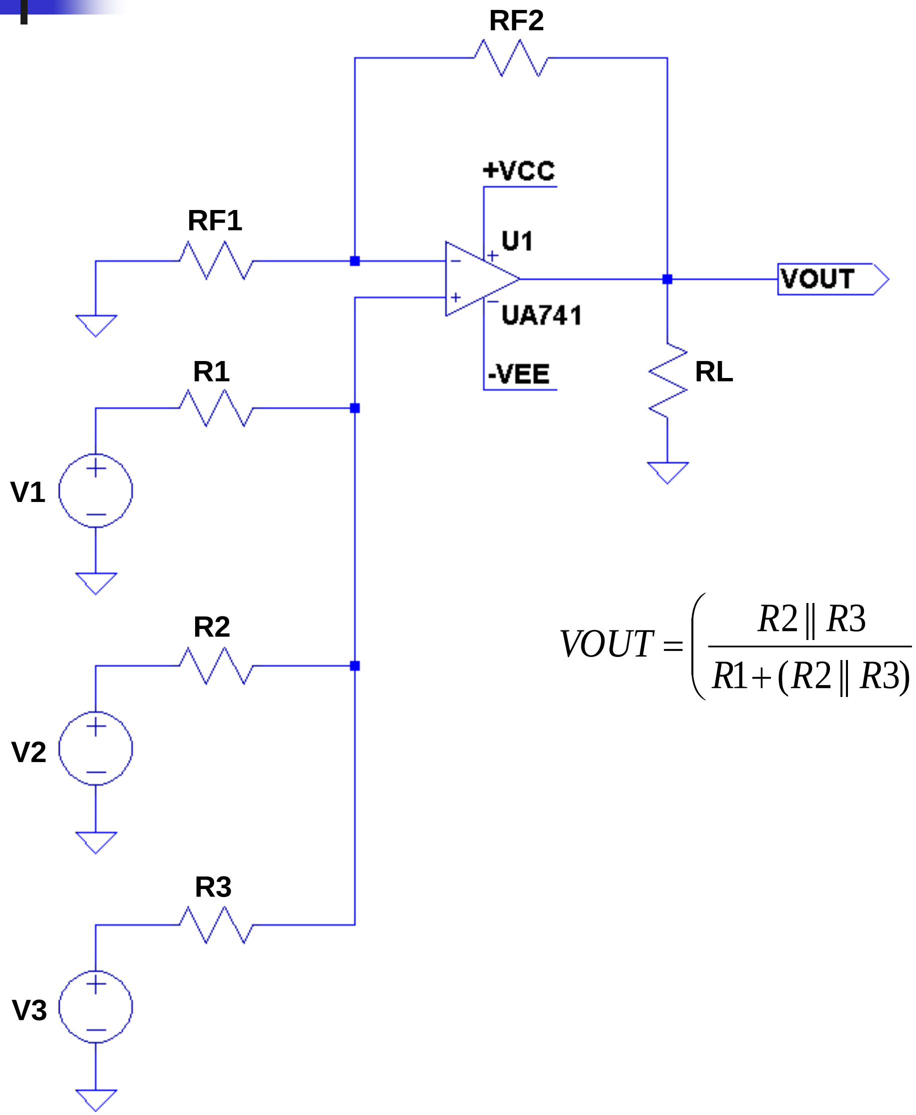
Summing Amplifier



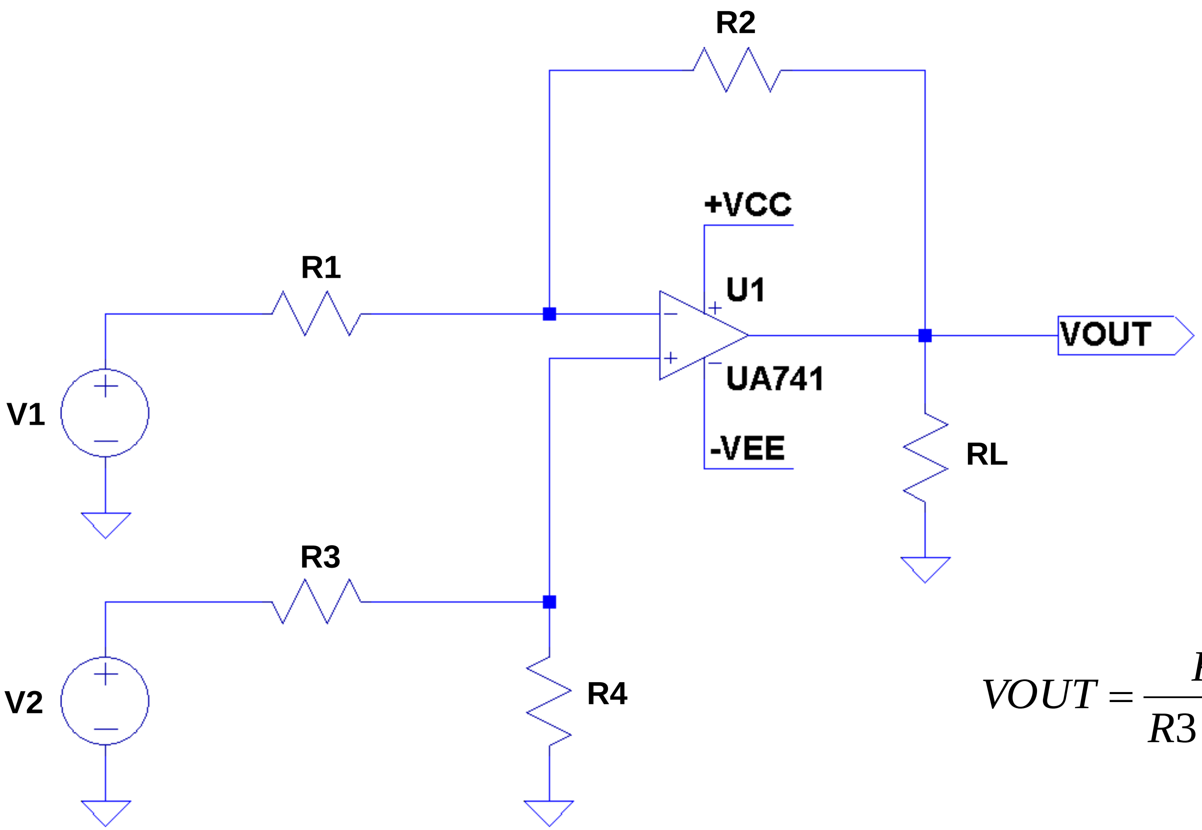
$$VOUT = \left(\frac{R2 \parallel R3}{R1 + (R2 \parallel R3)} V1 + \frac{R1 \parallel R3}{R2 + (R1 \parallel R3)} V2 + \frac{R1 \parallel R2}{R3 + (R1 \parallel R2)} V3 \right) \left(1 + \frac{RF2}{RF1} \right)$$

Lab-1: Summing Amplifier

- **Simulation Condition**
  - Op Amp: μA741
  - RL = 5 kΩ
  - +VCC = 15 V, -VEE = -15 V
  - $V1 = 1\sin(2\pi \times 10^3 t)$ V, $V2 = 2\sin(2\pi \times 10^3 t)$ V, $V3 = 3\sin(2\pi \times 10^3 t)$ V
  - Transient analysis from 0 to 10ms

1) Determine the values of R1, R2, R3, RF1 and RF2 to provide VOUT = V1 + V2 + V3.
2) Create the LTSpice schematic of the summing amplifier circuit.
3) Obtain a plot of V1, V2, V3 and VOUT versus time.
4) Change the input voltages to $V1 = 1\sin(2\pi \times 400t)$ V, $V2 = 1\sin(2\pi \times 2000t)$ V and $V3 = 1\sin(2\pi \times 10^4 t)$ V, then obtain a plot of V1, V2, V3 and VOUT versus time.
5) Change the input voltages to V1 = PULSE(0V 2V 2ms 1ns 1ns 1.95ms 4ms), V2 = PWL(0s -10V 10ms 10V) and $V3 = 2\sin(2\pi \times 10^4 t)$ V, then obtain a plot of V1, V2, V3 and VOUT versus time.

Differential Amplifier



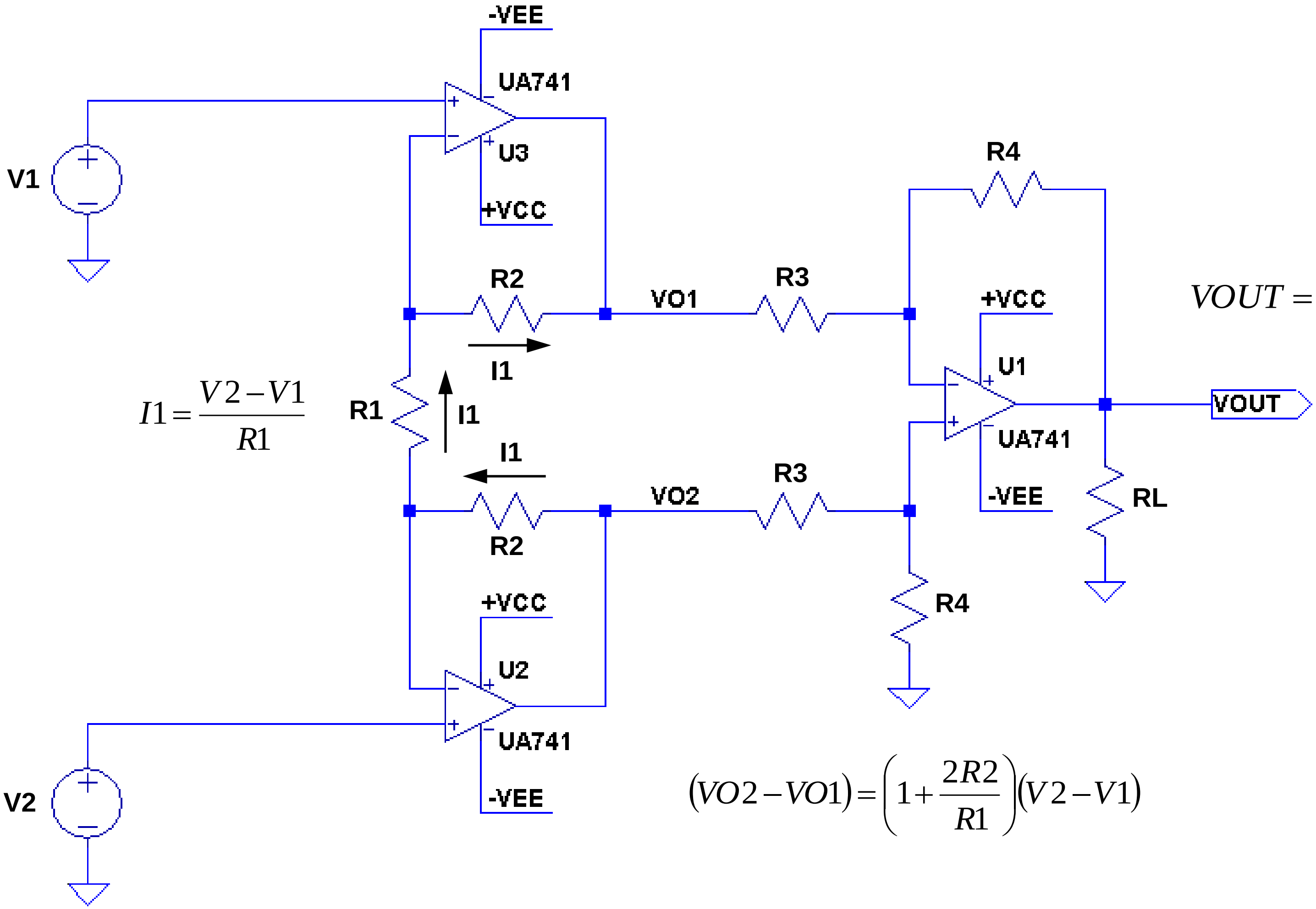
$$VOUT = \frac{R4}{R3+R4}\left(1+\frac{R2}{R1}\right)V2 - \frac{R2}{R1}V1$$

Lab-2: Differential Amplifier

- **Simulation Condition**
  - Op Amp: μA741
  - RL = 5 kΩ
  - +VCC = 15 V, -VEE = -15 V
  - $V1 = 0.5\sin(2\pi\times 10^4 t)$ V, $V2 = 2.5\sin(2\pi\times 10^4 t)$ V
  - Transient analysis from 0 to 1ms

1) **Determine the values of R1, R2, R3 and R4 to provide VOUT = 3(V2 – V1).**
2) **Create the LTSpice schematic of the differential amplifier circuit.**
3) **Obtain a plot of V1, V2 and VOUT versus time.**
4) **What is the lowest value of RL for maintaining the proper circuit operation.**

Instrumentation Amplifier



$$I1 = \frac{V2 - V1}{R1}$$

$$VOUT = \frac{R4}{R3}\left(1 + \frac{2R2}{R1}\right)(V2 - V1)$$

$$(VO2 - VO1) = \left(1 + \frac{2R2}{R1}\right)(V2 - V1)$$

Lab-3: Instrumentation Amplifier

- **Simulation Condition**
  - **Op Amp: μA741**
  - **RL = 5 kΩ**
  - **+VCC = 15 V, -VEE = -15 V**
  - **$V1 = 1\sin(2\pi \times 10^3 t)$ V, $V2 = 2\sin(2\pi \times 10^3 t)$ V**
  - **Transient analysis from 0 to 10ms**

1) **Determine the values of R1, R2, R3 and R4 to provide VOUT = 5(V2 - V1).**
2) **Create the LTSpice schematic of the instrumentation amplifier circuit.**
3) **Obtain a plot of V1, V2, VO1, VO2 and VOUT versus time.**
4) **Change the input voltage V2 to $V2 = V_P\sin(2\pi \times 10^3 t)$ V, then find the highest value of V_P for maintaining the proper circuit operation.**