Physics Lab
ETH zürich

D PHYS

Electronics A (Analog)

Abstract:
Operational amplifiers are a key component for the processing of analog signals that are found in experimental physics. With these devices, algebraic operations between signals and even differential equations involving the signals can be solved.

During these experiments, the familiarization of the basic usages of operational amplifiers will be achieved, and at the end, a circuit to solve a differential equation will be implemented.

Setup:

Fig 1. Equipment available for this experiment

Basics:

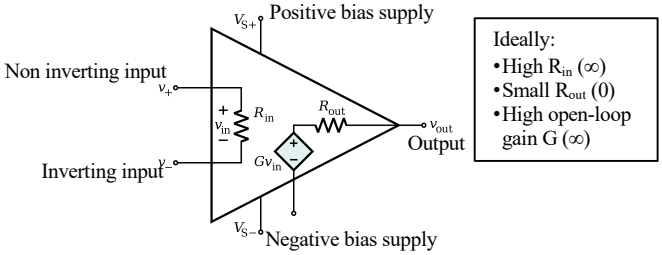
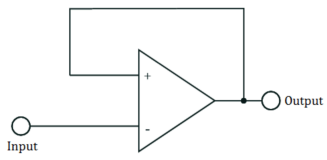
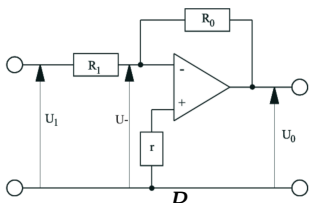


Fig 2. Operational amplifier



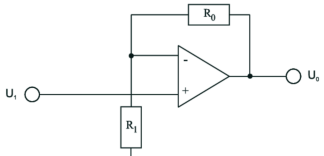
$$U_o = U_{in}$$

Fig 3. Voltage follower (buffer)



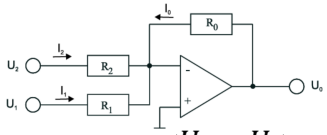
$$U_o = -\frac{R_0}{R_1}U_1$$

Fig 4. Inverting amplifier



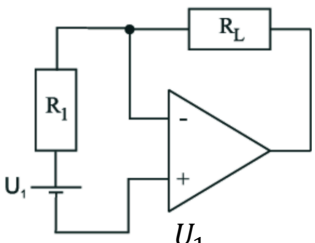
$$U_o = \left(1 + \frac{R_0}{R_1}\right)U_1$$

Fig 5. Non-inverting amplifier



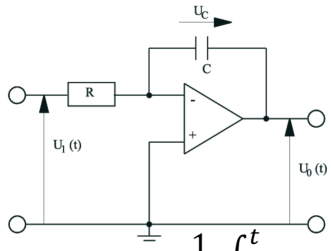
$$U_o = -R_0\left(\frac{U_2}{R_2} + \frac{U_1}{R_1}\right)$$

Fig 6. Summing amplifier



$$I_L = \frac{U_1}{R_1}$$

Fig 7. Constant current

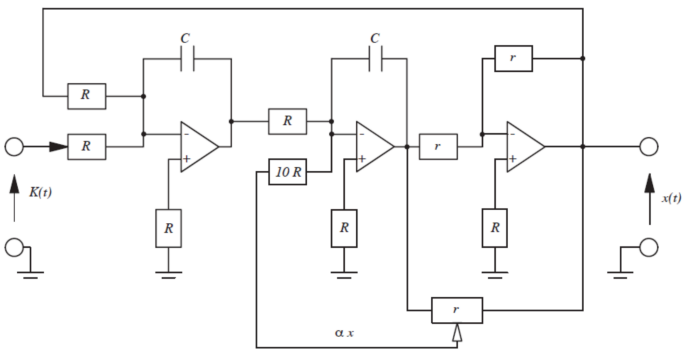


$$U_o(t) = U_o(0) - \frac{1}{RC}\int_0^t U_1(\tau)d\tau$$

Fig 8. Integrator

Experiments:

- Frequency effects: Study the effects of signals at different frequencies: i.e. phase shift or amplitude dependence of periodic signals for different configurations .
- Integrator: Use the integrator circuit to perform the integration of basic signals (e.g. square wave).
- Schmitt Trigger: Using the Schmitt Trigger circuit, study the square waves generated by periodic signals such as sinusoidal waves.
- Differential Equations solution: Understand and implement the circuit shown in Fig. 8 to solve the suggested differential equation. Study the effects of α on the resonance frequency and the signal amplitude for sinusoidal signal input (Fig 10)



$$\ddot{x}(t) + 2\rho\dot{x}(t) + \omega_0^2 x(t) = -\omega_0^2 K(t)$$

Fig 9. Second order differential equation circuit: C=1μF, R=100kΩ, r=10kΩ

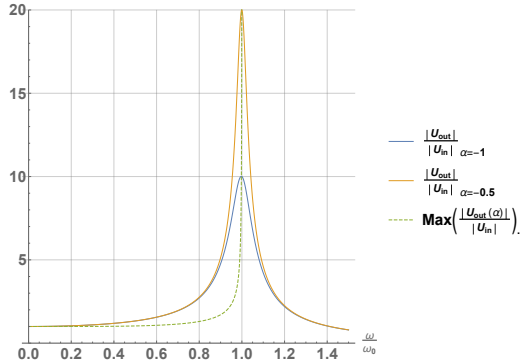


Fig 10. Expected behavior of the amplitude for negative values of α

Poster made by: Diego Alejandro Sanz Becerra

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