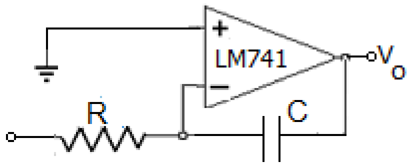
Electronics

Opamp integrator and derivator

Problem 1.- For an error correction controller, we want to design a circuit that integrates a voltage signal such that it yields a 1V output when an input of 250mV is present for 250ms.

Solution: We can use the integrator shown below



To meet the specification:

$$\frac{1}{RC}\int_0^{250ms} 250mV dt = 1V \rightarrow RC = \frac{250mV \times 250ms}{1V} = 62.5ms$$

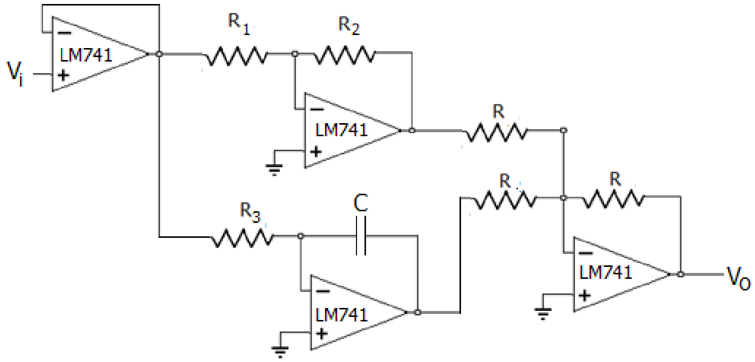
This time constant can be obtained using the standard values of 10kohm and 6.2µF or other combinations. This circuit can be connected to an inverter amplifier to restore the positive polarity.

Problem 2.- Design a circuit that generates a PI control signal for an input signal 0-0.1V with the following specifications:

- The proportional component (P) is 10 times the error.
- The integral component gives an output of 1V for 0.1V error integrated over 60 seconds.

The output should be the sum of these two components. The circuit should not load the error signal.

Solution: An adding circuit of the two signals would solve this problem, like the following:



The follower at the input assures that the circuit will not load the error signal as it presents very large impedance.

The top opamp gives the gain of 10 (inverted) choosing the resistors

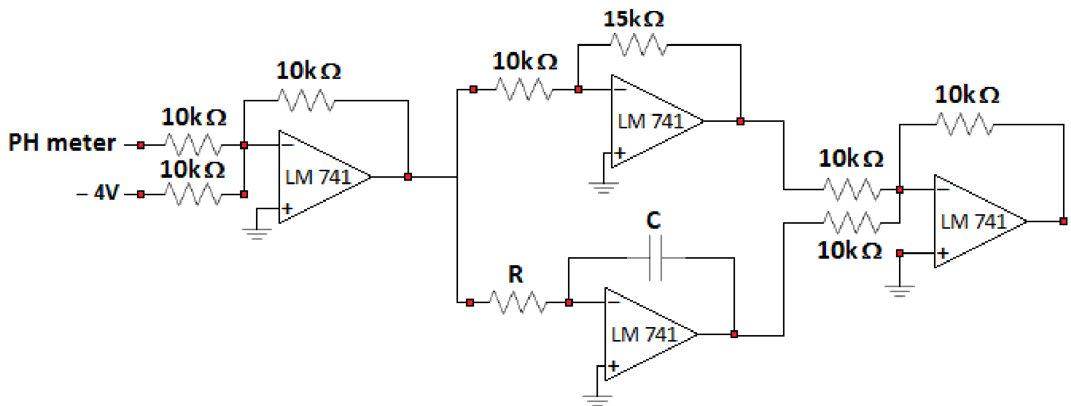
R_1=10kΩ, R_2=100kΩ

The bottom opamp will integrate the signal (and invert it) with RC=6s by selecting R_3=180kΩ and C=33µF.

Finally, the adding circuit can be designed with R=10kΩ to sum the signals and restore the polarity.

Problem 3.- In a refinery, PH is measured with an instrument whose output is a 1-5V voltage and the set-point is 4V. Design a circuit that gives a signal proportional to the error with coefficient 1.5 and an integral of the error with coefficient 0.0012Hz.

Solution: A possible solution is shown below. First, we subtract the reference voltage (which will give us the error), then one opamp is used to get the proportional signal and the other the integral and finally we add these two. The order of the devices is such that the final polarity is the correct one.



This is not the only way of solving this problem.