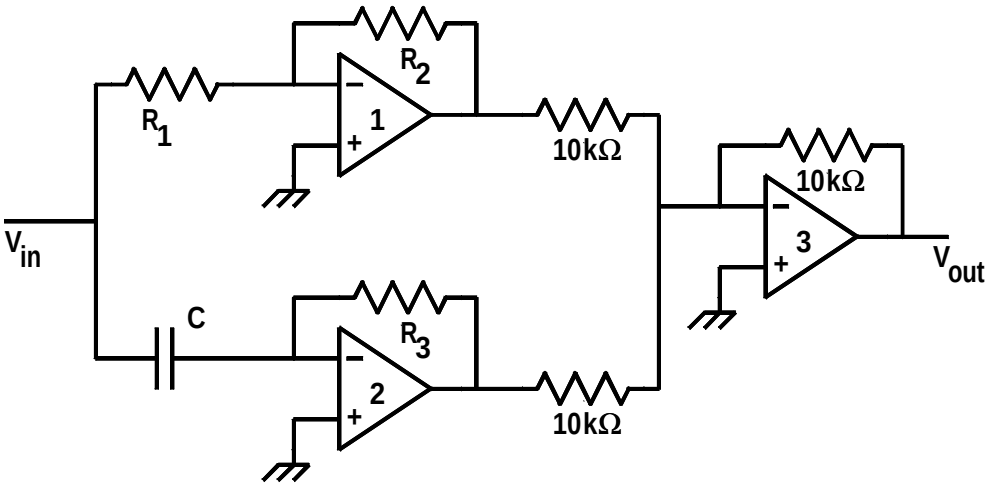
- In analog computers, quantities or variables are represented by voltages.

- Computations are carried out by passing the voltage signals through adders, inverters, differentiators and integrators and other functional amplifiers.

- The results of individual computations are combined by using adders.



Circuit blocks used in analog computers are: DC amplifiers, adders, differentiators, integrators and logarithmic amplifiers.

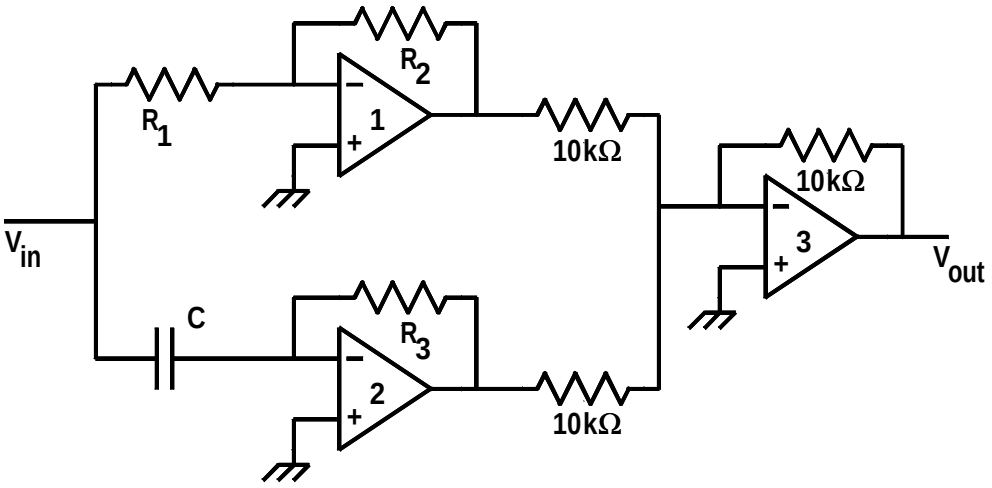
Other circuit blocks used include: multipliers, dividers and square root extractors all of which are readily available as standard ICs

In analog computers, voltages are used to represent physical real world quantities
Circuit blocks carry out computations on these voltages.
In digital computers, numbers are used to represent physical real world quantities and the numbers are then manipulated digitally in accordance with a program.
In analog computing, the circuit can be considered to be the program
Any revision of the program requires a circuit redesign.

Analog computers are often used because of the low cost of op-amps, the robustness of analog control systems and because many real world sensors have voltage outputs which are directly compatible with the inputs of analog computing systems.

Design a circuit which implements the following function of the input voltage, V_{in}.

$$V_{out} = 3.3V_{in} + 2.2\frac{dV_{in}}{dt}$$



PD or Proportional plus Derivative action controller.

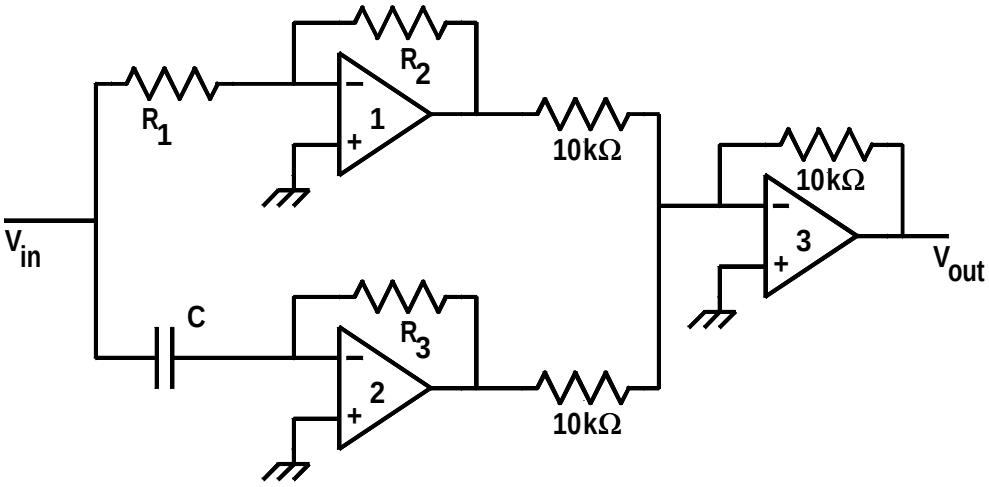
$$V_{out} = 3.3V_{in} + 2.2\frac{dV_{in}}{dt}$$

Controller with gain 3.3 and derivative or rate action of $2.2\frac{dV_{in}}{dt}$

Proportional action corrects the error.

Derivative action makes correction based on trend

Aim at predicted position of ball.



$$V_{out} = 3.3V_{in} + 2.2\frac{dV_{in}}{dt}$$

Op-amp 1 gives the gain of $3.3V_{in}$ and so $\frac{R_2}{R_1} = 3.3$.

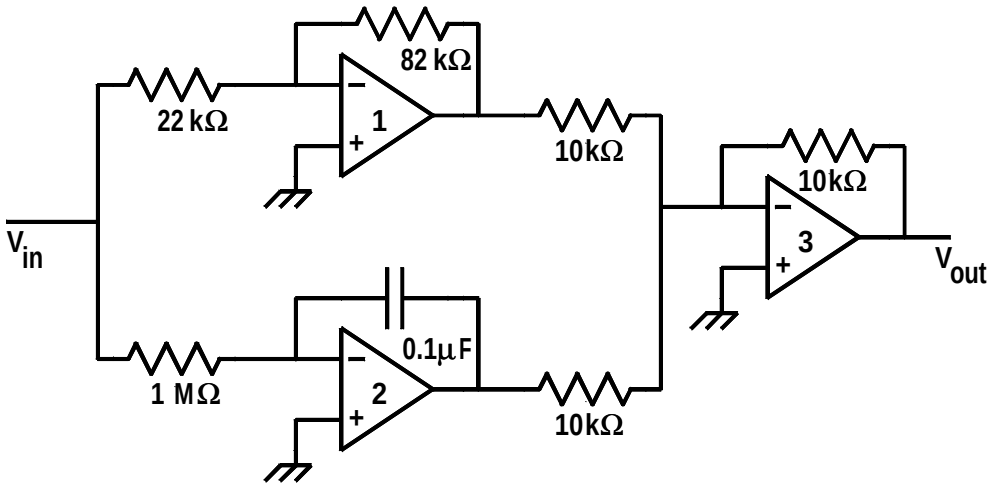
Op-amp 2 gives the derivative action, $2.2\frac{dV_{in}}{dt}$, so we have $R_3C = 2.2$.

Two signals are then added using op-amp 3. There are two stages of inversion, so the sign of the output signal is correct.

Design a circuit which has an output which is given by

$$V_{out} = 23V_1 - 12V_2 + 8V_3$$

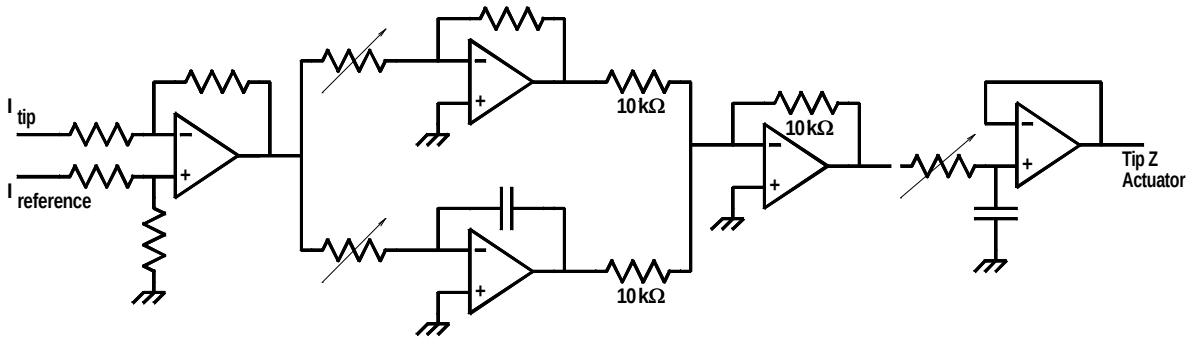
where V_1, V_2 and V_3 are inputs to the circuit.



Derive the mathematical expression which gives the output of the circuit in terms of the single input V_{in}.

A circuit has three inputs, V_1, V_2 and V_3. Design a circuit which will give an output which is described by

$$V_{out} = 1.9V_1 - 2.8V_2 + 8.2V_3 + 0.6\frac{dV_1}{dt} - 3.6\int V_2 dt$$



STM scanning tip height servo control

Used to move the scanning tip up and down as it scans the surface in Burleigh Instruments Scanning Tunneling Microscope

The input signal is the tip tunneling current. The output signal drives the tip in the z direction.