Application Circuits

1) Voltage Comparator
2) Unity Gain Amplifier/Voltage Follower/Buffer Circuit
3) Non-Inverting Amplifier
4) Inverting Amplifier
5) Scaling Adder
6) Scaling Subtractor
7) Instrumentation Amplifier
8) Integrator
9) Differentiator
10) Constant Current Source
11) Current to Voltage Converter
12) Voltage to Current Converter/Transconductance Amplifier
13) Output Bounding Circuit

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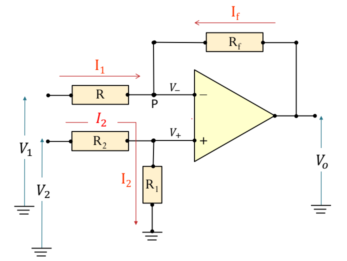
6) Scaling Subtractor



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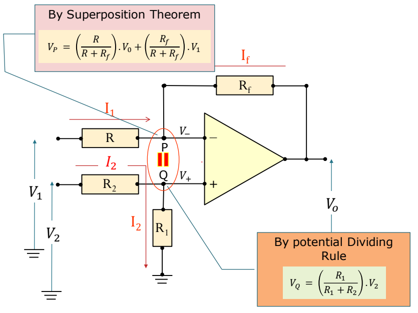

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$V_P = \left(\frac{R}{R+R_f}\right).V_0 + \left(\frac{R_f}{R+R_f}\right).V_1$ $\quad$ $V_Q = \left(\frac{R_1}{R_1+R_2}\right).V_2$

Using the Virtual short circuit principle of the Opamp,

$$V_P = V_Q$$

$$\left(\frac{R}{R+R_f}\right).V_0 + \left(\frac{R_f}{R+R_f}\right).V_1 = \left(\frac{R_1}{R_1+R_2}\right).V_2$$

$$\left(\frac{R}{R+R_f}\right).V_0 = \left(\frac{R_1}{R_1+R_2}\right).V_2 - \left(\frac{R_f}{R+R_f}\right).V_1$$

$$V_0 = \frac{R+R_f}{R}\frac{R_1}{R_1+R_2}.V_2 - \frac{R+R_f}{R}\frac{R_f}{R+R_f}.V_1$$

$$V_0 = \frac{R_1}{R}\left(\frac{R+R_f}{R_1+R_2}\right).V_2 - \left(\frac{R_f}{R}\right).V_1$$

$$\boxed{V_o = K_2 V_2 - K_1 V_1}$$

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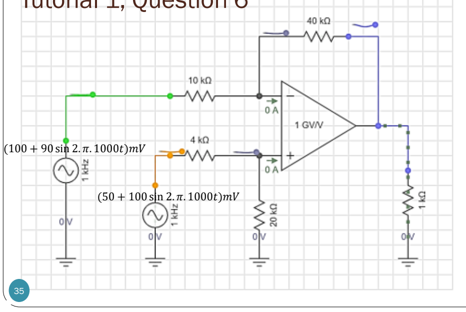
Tutorial 1, Question 6



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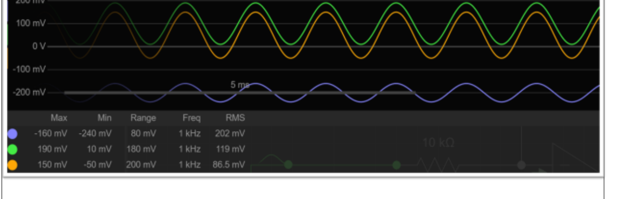

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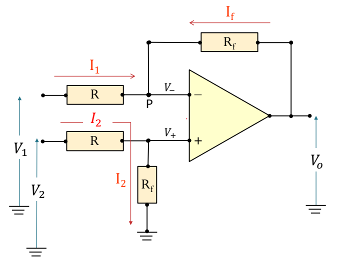
7) Differential Amplifier



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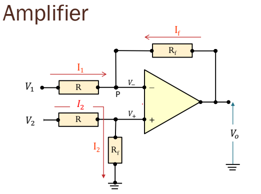
7) Differential Amplifier



$$V_0 = \frac{R_1}{R}\left(\frac{R+R_f}{R_1+R_2}\right).V_2 - \left(\frac{R_f}{R}\right).V_1$$

$$V_0 = \frac{R_f}{R}\left(\frac{R+R_f}{R_f+R}\right).V_2 - \left(\frac{R_f}{R}\right).V_1$$

$$\boxed{V_0 = \left(\frac{R_f}{R}\right)[V_2 - V_1]}$$

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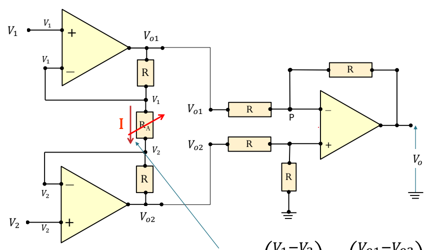
8) Instrumentation Amplifier



$$I = \left(\frac{V_1 - V_2}{R_A}\right) = \left(\frac{V_{o1} - V_{o2}}{2R + R_A}\right)$$

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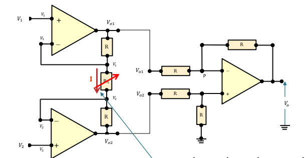

$$I = \left(\frac{V_1 - V_2}{R_A}\right) = \left(\frac{V_{o1} - V_{o2}}{2R + R_A}\right)$$

$$\left(\frac{V_{o1} - V_{o2}}{2R + R_A}\right) = \left(\frac{V_1 - V_2}{R_A}\right)$$

$$(V_{o1} - V_{o2}) = (2R + R_A)\left(\frac{V_1 - V_2}{R_A}\right)$$

$$\boxed{V_o = \left(1 + \frac{2R}{R_A}\right)(V_2 - V_1)}$$

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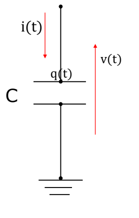
9) Integrator



$$q(t) = C.v(t)$$

$$\frac{d[q(t)]}{dt} = C.\frac{d[v(t)]}{dt}$$

$$i(t) = C.\frac{d[v(t)]}{dt}$$

$$v(t) = \frac{1}{C}.\int i(t).dt$$

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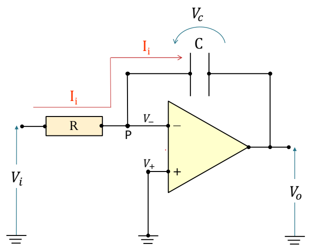
9) Integrator



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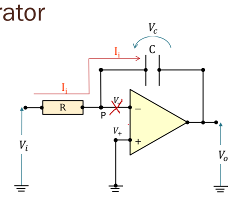
Integrator



$q = C.V_c$

$$\frac{dq}{dt} = C.\frac{dV_c(t)}{dt}$$

$$I_i = C.\frac{dV_c}{dt}$$

$$V_c = \frac{1}{C}.\int I_i.dt$$

$$V_c = \frac{1}{C}.\int \left(\frac{V_i - V_P}{R}\right) dt$$

$$V_c = \frac{1}{C}.\int \left(\frac{V_i}{R}\right).dt$$

$$-V_o = \frac{1}{RC}.\int V_i.dt$$

$$\boxed{V_o = \frac{-1}{RC}.\int V_i.dt}$$

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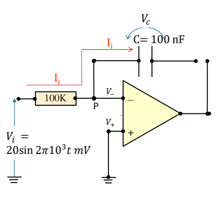
Integrator



$RC = (100.10^3).(100.10^{-9})$

$RC = 0.01$ S

$$V_o = \frac{-1}{RC}.\int V_i.dt$$

$$V_o = \frac{-1}{0.01}.\int 20\sin(2\pi 10^3 t)\,dt$$

$$V_o = -2000\,.\frac{\cos(2\pi 10^3 t)}{2\pi 10^3}$$

$$V_o = -\frac{1}{\pi}\,.\cos(2\pi 10^3 t)\ mV$$

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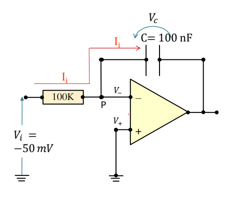
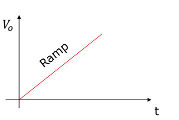
Ramp Generator



$RC = (100.10^3).(100.10^{-9})$

$RC = 0.01$ S



$$V_o = \frac{-1}{RC}.\int V_i.dt$$

$$V_o = \frac{-1}{0.01}.\int (-50).t$$

$V_o = 5.$t Volts

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