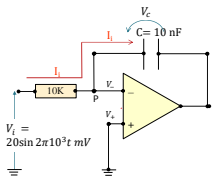
Tutorial 1 Question 7



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

$$RC = 0.0001 \text{ S}$$

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

$$V_o = \frac{-1}{0.0001}.\int 20\sin(2\pi 10^3 t)\,dt$$

$$V_o = -200000.\frac{\cos(2\pi 10^3 t)}{2\pi 10^3}$$

$$V_o = -\frac{100}{\pi}.\cos(2\pi 10^3 t)\ mV$$

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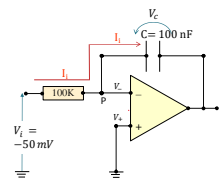
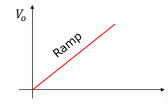
Ramp Generator





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

$$RC = 0.01 \text{ S}$$

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

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

$$V_o = 5.t \text{ Volts}$$

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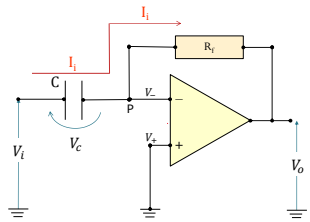
10) Differentiator



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10) Differentiator

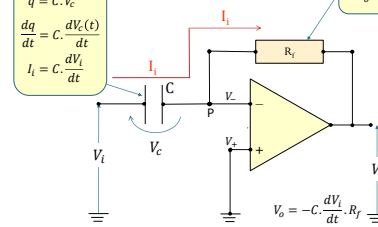
$$q = C.V_c$$

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

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

$$V_P - V_o = I_i R_f$$

$$V_o = -I_i R_f$$



$$V_o = -C.\frac{dV_i}{dt}.R_f$$

$$V_o = -R_f C.\frac{dV_i}{dt}$$

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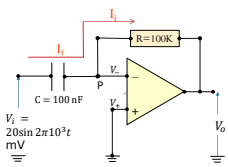
Tutorial 1 Question 8



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

$$RC = 0.01$$

$$V_o = -RC.\frac{dV_i}{dt}$$

$$V_o = -RC.\frac{d(20\sin 2\pi 10^3 t)}{dt}$$

$$V_o = -(0.2)2\pi 10^3.\cos(2\pi 10^3 t)$$

$$V_o = -400\pi.\cos(2\pi 10^3 t)\ mV$$

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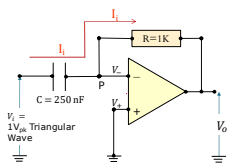
Tutorial 1 Question 9



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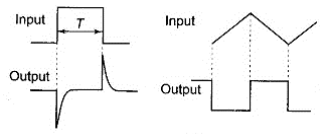
E.g. Use of a Differentiator



$V_o = -R_f C.\frac{dV_i}{dt}$.

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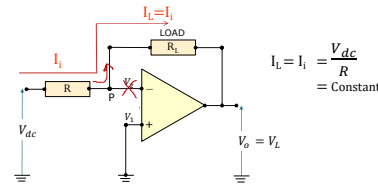
11) Constant Current Source



$I_L = I_i = \frac{V_{dc}}{R}$ = Constant

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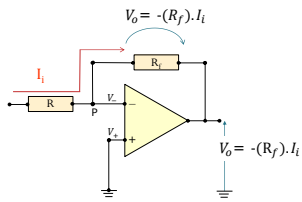
12) Current to Voltage Converter



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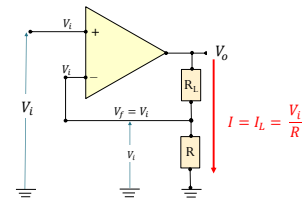
13) Voltage to Current Converter



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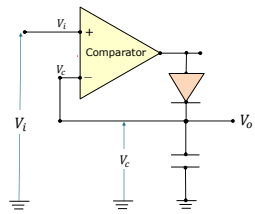
14) Peak Detector



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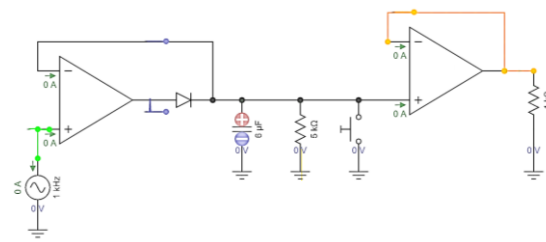

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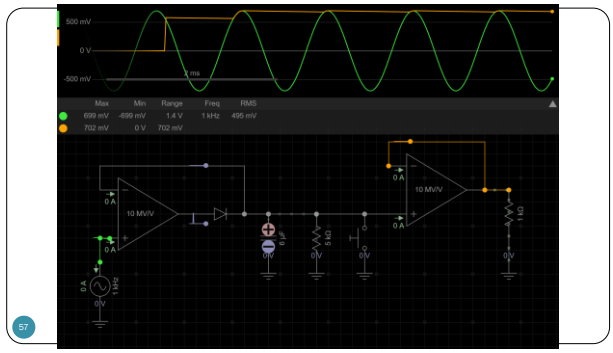

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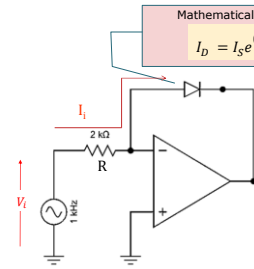
15) Logarithmic Amplifier

Mathematical Model

$$I_D = I_S e^{\left(\frac{V_D}{V_T}\right)}$$



$$I_D = I_i = \left(\frac{V_i}{R}\right)$$

$$V_D = -V_o$$

$$I_D = I_S e^{\left(\frac{V_D}{V_T}\right)}$$

$$\frac{V_i}{IsR} = e^{-\left(\frac{V_o}{V_T}\right)}$$

$$\ln\left|\frac{V_i}{I_S R}\right| = \frac{-V_o}{V_T}$$

$$V_o = -\,V_T \ln\left|\frac{V_i}{I_S R}\right|$$

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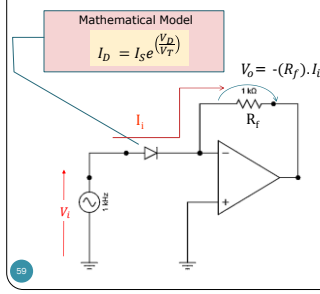
16) Exponential (Anti-logarithmic Amplifier

Mathematical Model

$$I_D = I_S e^{\left(\frac{V_D}{V_T}\right)}$$

$$V_o = -(R_f).I_i$$



$$V_o = -(R_f).I_i$$

$$I_D = I_i = -\left(\frac{V_o}{R_f}\right)$$

$$V_D = V_i$$

$$I_D = I_S e^{\left(\frac{V_D}{V_T}\right)}$$

$$-\left(\frac{V_o}{R_f}\right) = I_S e^{-\left(\frac{V_i}{V_T}\right)}$$

$$V_o = -\,I_S R_f e^{-\left(\frac{V_i}{V_T}\right)}$$

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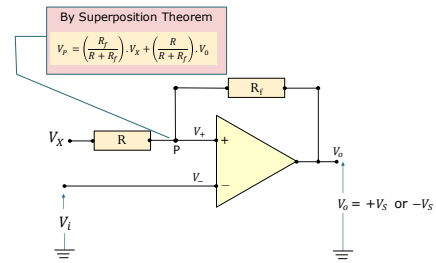
17) Schmitt Trigger

By Superposition Theorem

$$V_P = \left(\frac{R_f}{R+R_f}\right).V_X + \left(\frac{R}{R+R_f}\right).V_0$$



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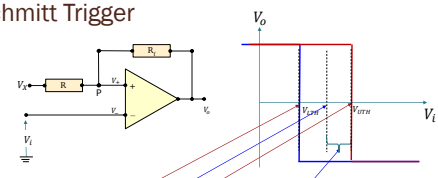
15) Schmitt Trigger



$$V_P = \left(\frac{R_f}{R+R_f}\right).V_X + \left(\frac{R}{R+R_f}\right).V_0$$

$$V_{LTH} = \left(\frac{R_f}{R+R_f}\right).V_X - \left(\frac{R}{R+R_f}\right).V_S$$

$$V_{UTH} = \left(\frac{R_f}{R+R_f}\right).V_X + \left(\frac{R}{R+R_f}\right).V_S$$

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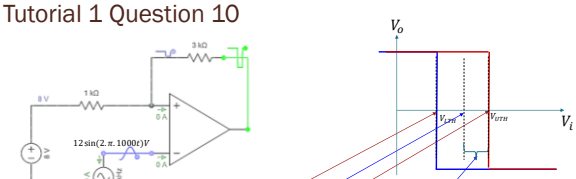
Tutorial 1 Question 10



$$V_P = \left(\frac{R_f}{R+R_f}\right).V_X + \left(\frac{R}{R+R_f}\right).V_0$$

$$V_{LTH} = \left(\frac{R_f}{R+R_f}\right).V_X - \left(\frac{R}{R+R_f}\right).V_S$$

$$V_{UTH} = \left(\frac{R_f}{R+R_f}\right).V_X + \left(\frac{R}{R+R_f}\right).V_S$$

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