TI DSP, MCU, Xilinx Zynq FPGA 기반의 프로그래밍 전문가 과정

<회로이론>
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강사 – Innova Lee(이상훈)
gcccompil3r@gmail.com

학생 – 안상재
sangjae2015@naver.com

- opamp 개론

- 가산기, 반전 증폭기 계산

- **임피던스**

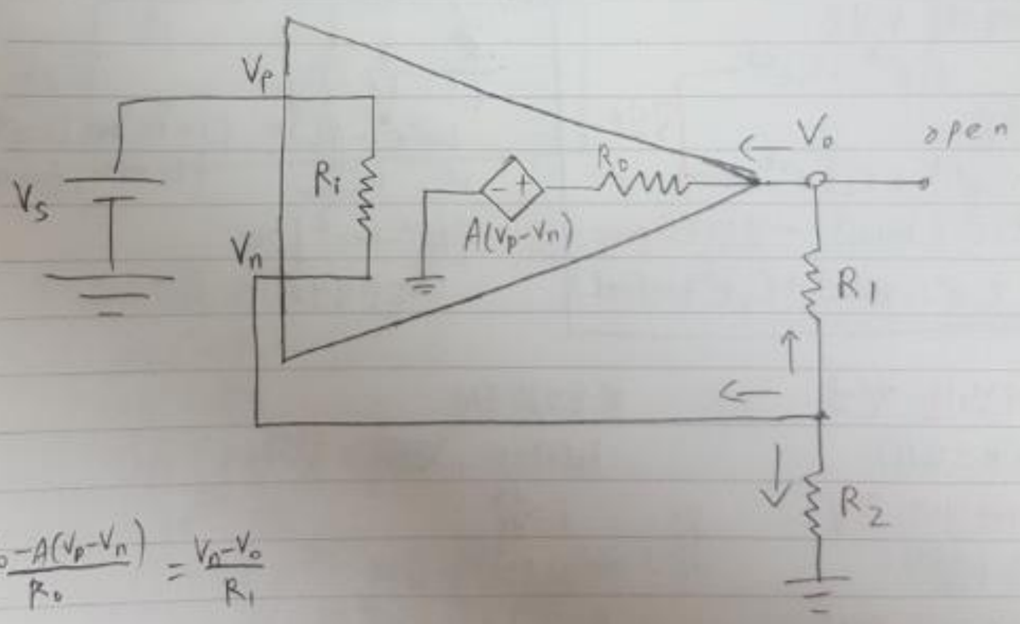
- **실효치 전압**

- **코일 임피던스**

- **콘덴서 임피던스**

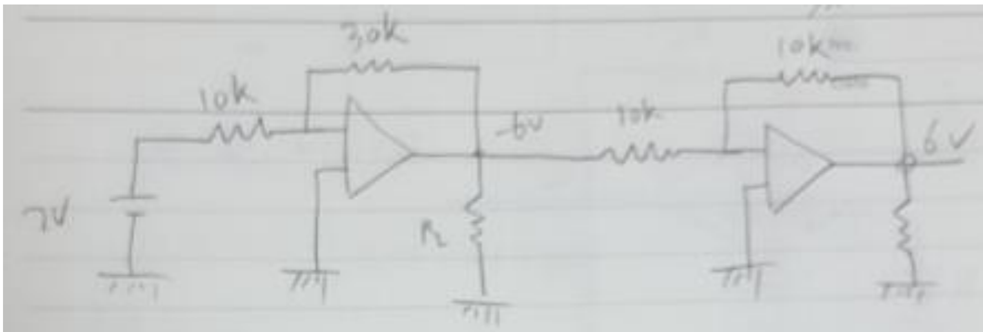
<6.21>

OPAMP - 신호증폭

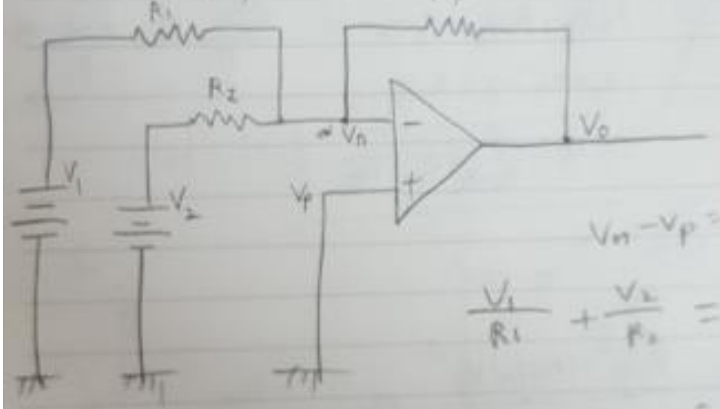


$$\frac{V_o - A(V_p - V_n)}{R_o} = \frac{V_n - V_o}{R_1}$$

$$\frac{V_n - V_o}{R_1} + \frac{V_n - V_p}{R_i} + \frac{V_n}{R_2} = 0$$



Ex) 가산기



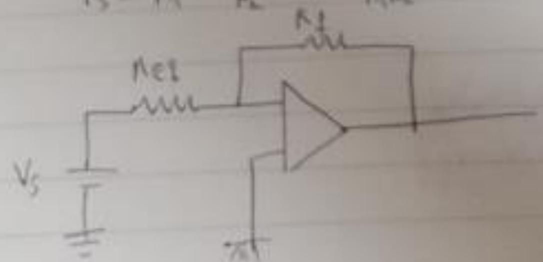
$$V_n - V_p = 0$$

$$\frac{V_1}{R_1} + \frac{V_2}{R_2} = \frac{V_n - V_o}{R_f}$$

$$= \frac{-V_o}{R_f}$$

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

$$i_s = \frac{V_1}{R_1} + \frac{V_2}{R_2} = \frac{R_2V_1 + R_1V_2}{R_1R_2} \qquad \left(R_{eq} = \frac{R_1R_2}{R_1+R_2}\right)$$



$$G = -\frac{R_f}{R_{eq}} = \frac{-(R_1+R_2)}{R_1R_2}R_f$$

$$= -\left(\frac{R_f}{R_2} + \frac{R_f}{R_1}\right)$$

$$V_s = \frac{R_1V_2 + R_2V_1}{R_1+R_2} = \frac{R_1}{R_1+R_2}V_2 + \frac{R_2}{R_1+R_2}V_1$$

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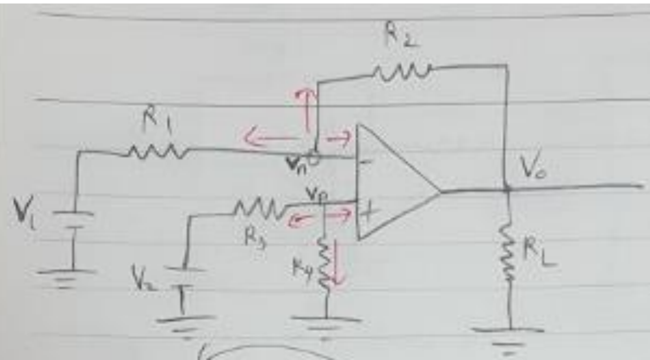
Date



$i_p = i_n = 0$, $V_p = V_n$

$$\frac{V_n - V_1}{R_1} + \frac{V_n - V_o}{R_1} = 0$$

$$\frac{V_p - V_2}{R_3} + \frac{V_p}{R_4} = 0$$

$$R_4V_p - R_4V_2 + R_3V_p = 0$$

$$(R_3+R_4)V_p = R_4V_2$$

$$\boxed{V_p = \frac{R_4}{R_3+R_4}V_2 = V_n}$$

$$\frac{\frac{R_4V_2}{R_3+R_4} - V_1}{R_1} + \frac{\frac{R_2V_2}{R_3+R_4} - V_o}{R_2} = 0$$

$$\Rightarrow \frac{\frac{R_4V_2}{R_3+R_4} - V_1}{R_1} + \frac{\frac{R_4}{R_3+R_4}V_2 - V_o}{R_2} = 0$$

$$\Rightarrow \frac{R_4V_2 - (R_3+R_4)V_1}{R_1(R_3+R_4)} + \frac{R_4V_2 - (R_3+R_4)V_o}{R_2(R_3+R_4)} = 0$$

$$\frac{R_2R_4V_2 - R_2(R_3+R_4)V_1 + R_1R_4V_2 - R_1(R_3+R_4)V_o}{R_1R_2(R_3+R_4)} = 0$$

$$\frac{R_2R_4V_2 - R_2(R_3+R_4)V_1 + R_1R_4V_2}{\boxed{R_1R_2(R_3+R_4)}} = \frac{R_1(R_3+R_4)V_o}{\boxed{R_1R_2(R_3+R_4)}}$$

$$\Rightarrow V_o = \frac{R_2R_4V_2 - R_2(R_3+R_4)V_1 + R_1R_4V_2}{R_1(R_3+R_4)}$$

$$= \underbrace{\boxed{\frac{(R_2R_4 + R_1R_4)}{R_1(R_3+R_4)}}}_{G_2}V_2 - \underbrace{\boxed{\frac{R_2}{R_1}}}_{G_1}V_1$$

i) $\omega > \omega_0$

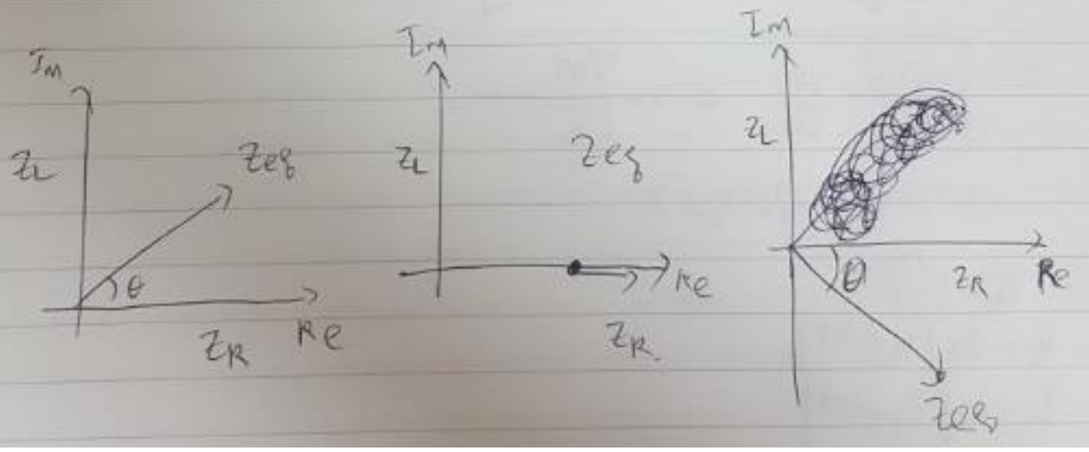
$|Z_L| > |Z_C| \rightarrow \theta > 0$ 유도성회로

ii) $\omega = \omega_0$

$|Z_L| = |Z_C| \rightarrow \theta = 0$ 순수한저항

iii) $\omega < \omega_0$

$|Z_L| < |Z_C| \rightarrow \theta < 0$ 용량성회로



why use Half power?

$$V_{rms} = \sqrt{\frac{1}{T}\int_0^T v^2(t)dt} \qquad \omega = 2\pi f$$

$$V_{rms} = \sqrt{\frac{1}{T}\int_0^T V_m^2 \cos^2(\omega t)dt} \qquad \frac{\omega}{2\pi} = \frac{1}{T}$$

$$= \sqrt{\frac{\omega}{2\pi}\int_0^{\frac{2\pi}{\omega}} V_m^2 \cos^2(\omega t)dt} = \sqrt{\frac{\omega V_m^2}{2\pi}\int_0^{\frac{2\pi}{\omega}} \frac{1}{2}(1+\cos(2\omega t))dt}$$

$$= \sqrt{\frac{\omega V_m^2}{4\pi}\int_0^{\frac{2\pi}{\omega}} (1+\cos(2\omega t))dt} = \sqrt{\frac{\omega V_m^2}{4\pi}\left[t+\frac{1}{2\omega}\sin(2\omega t)\right]_0^{\frac{2\pi}{\omega}}}$$

$$= \sqrt{\frac{\omega V_m^2}{4\pi}\frac{2\pi}{\omega}} = \frac{V_m}{\sqrt{2}}$$

<인덕터의 임피던스>

$$V_L = L\frac{dI_L}{dt}$$

$$V_L = Re[V_L e^{i\omega t}]$$

$$I_L = Re[I_L e^{i\omega t}]$$

$$Re[V_L e^{i\omega t}] = L\frac{d}{dt}[Re(I_L e^{i\omega t})] = Re[i\omega L I_L e^{i\omega t}]$$

$$V_L = i\omega L I_L$$

$$Z_L = \frac{V_L}{I_L} = i\omega L$$

phasor Domain에서 인덕터는 직류에서 단락회로와 같이 작용하며
매우 높은 주파수에서는 개방회로와 같이 동작한다.

<콘덴서의 임피던스>

$$i_c = C\frac{dV_c}{dt}$$

$$V_c = Re[V_c e^{i\omega t}]$$

$$I_c = Re[I_c e^{i\omega t}]$$

$$Re[I_c e^{i\omega t}] = C\frac{d}{dt}Re[V_c e^{i\omega t}] = Re[i\omega C V_c e^{i\omega t}]$$

$$I_c = i\omega C V_c$$

$$\therefore Z_c = \frac{V_c}{I_c} = \frac{1}{i\omega C}$$

phasor Domain에서는
커패시터는 직류에서 개방회로와
같이 작용하며, 매우 높은 주파수에서는
단락회로와 같이 동작한다.