



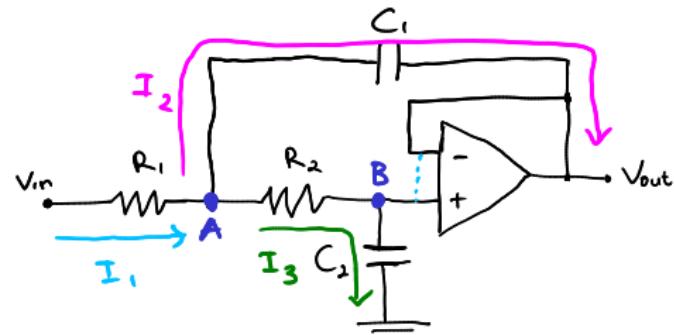
# Electronic Circuit II

Active Filter Second Order

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# Low Pass Second Order Filter Circuit



$$V_B = V_{out} \quad \dots \textcircled{1}$$

$$I_1 = I_2 + I_3 \quad \dots \textcircled{2}$$

$$I_1 = \frac{V_{in} - V_A}{R_1} \quad \dots \textcircled{3}$$

$$I_2 = \frac{V_A - V_{out}}{-jX_{C_1}} \quad \dots \textcircled{4}$$

$$I_3 = \frac{V_A - V_{out}}{R_2} \quad \dots \textcircled{5}$$

$$I_3 = \frac{V_A - V_{out}}{R_2} = \frac{V_{out}}{-jX_{C_2}}$$

$$V_A = \frac{V_{out} \cdot R_2}{-jX_{C_2}} + V_{out}$$

$$V_A = \frac{j \cdot V_{out} \cdot R_2}{X_{C_2}} + V_{out} \quad \dots \textcircled{6}$$

# Low Pass Second Order Filter Circuit

Substitusi persamaan ③, ④, dan ⑤ ke pers. ②

$$\frac{V_{in} - V_A}{R_1} = \frac{V_A - V_{out}}{-jX_{C_1}} + \frac{V_A - V_{out}}{R_2} \dots \textcircled{7}$$

Substitusikan pers. ⑥ ke pers. ⑦

$$\frac{V_{in} - \left( \frac{j \cdot V_{out} \cdot R_2}{X_{C_2}} + V_{out} \right)}{R_1} = \frac{\left( \frac{j \cdot V_{out} \cdot R_2}{X_{C_2}} + V_{out} \right) - V_{out}}{-jX_{C_1}} + \frac{\left( \frac{j \cdot V_{out} \cdot R_2}{X_{C_2}} + V_{out} \right) - V_{out}}{R_2}$$

$$\frac{V_{in} - \left( \frac{j \cdot V_{out} \cdot R_2}{X_{C_2}} + V_{out} \right)}{R_1} = - \frac{V_{out} R_2}{X_{C_1} X_{C_2}} + j \frac{V_{out} R_2}{R_2 X_{C_2}}$$

$$V_{in} - \left( \frac{j V_{out} \cdot R_2}{X_{C_2}} + V_{out} \right) = - \frac{V_{out} \cdot R_1 \cdot R_2}{X_{C_1} \cdot X_{C_2}} + j \frac{V_{out} \cdot R_1}{X_{C_2}}$$

# Low Pass Second Order Filter Circuit

$$V_{in} = - \frac{V_{out} \cdot R_1 \cdot R_2}{X_{C_1} \cdot X_{C_2}} + j \frac{V_{out} \cdot R_1}{X_{C_2}} + \left( j \frac{V_{out} \cdot R_2}{X_{C_2}} + V_{out} \right)$$

$$V_{in} = - \frac{V_{out} \cdot R_1 \cdot R_2}{X_{C_1} \cdot X_{C_2}} + j \frac{V_{out} \cdot R_1}{X_{C_2}} + j \frac{V_{out} \cdot R_2}{X_{C_2}} + V_{out}$$

$$V_{in} = - \frac{V_{out} \cdot R_1 \cdot R_2}{X_{C_1} \cdot X_{C_2}} + j \left( \frac{V_{out} \cdot R_1}{X_{C_2}} + \frac{V_{out} \cdot R_2}{X_{C_2}} \right) + V_{out}$$

$$V_{in} = \left\{ - \frac{R_1 R_2}{X_{C_1} X_{C_2}} + j \left( \frac{R_1 + R_2}{X_{C_2}} \right) + 1 \right\} V_{out}$$

$$\frac{V_{in}}{V_{out}} = - \frac{R_1 R_2}{X_{C_1} X_{C_2}} + j \left( \frac{R_1 + R_2}{X_{C_2}} \right) + 1$$

# Low Pass Second Order Filter Circuit

$$\frac{V_{in}}{V_{out}} = - \frac{R_1 R_2}{X_{C1} X_{C2}} + j \left( \frac{R_1 + R_2}{X_{C2}} \right) + 1$$

$$\frac{V_{in}}{V_{out}} = 1 - \frac{R_1 R_2}{X_{C1} X_{C2}} + j \left( \frac{R_1 + R_2}{X_{C2}} \right)$$

$$\frac{V_{in}}{V_{out}} = \boxed{1 - \frac{R_1 R_2}{X_{C1} X_{C2}}} + j \boxed{\left( \frac{R_1 + R_2}{X_{C2}} \right)}$$

↓                      ↓

Real                    Imaginer

# Low Pass Second Order Filter Circuit

$$\frac{V_{in}}{V_{out}} = \left[ 1 - \frac{R_1 R_2}{X_{C1} X_{C2}} \right] + j \left( \frac{R_1 + R_2}{X_{C2}} \right)$$

↓      Real      ↓      Imajiner

Pada orde 2, Komponen Real bernilai Nol .  
 Setingga

$$1 - \frac{R_1 R_2}{X_{C1} X_{C2}} = 0 \rightarrow \frac{R_1 R_2}{X_{C1} X_{C2}} = 1$$

# Low Pass Second Order Filter Circuit

$$\frac{R_1 R_2}{X_{C1} X_{C2}} = 1 \rightarrow R_1 R_2 = X_{C1} X_{C2}$$

$$R_1 R_2 = \frac{1}{2\pi f C_1} \cdot \frac{1}{2\pi f C_2}$$

$$R_1 R_2 = \frac{1}{(2\pi)^2 f^2 C_1 C_2}$$

pers. frequency  
 ↓ Cut off!

$$f = \frac{1}{2\pi \sqrt{R_1 R_2 C_1 C_2}}$$

$$(2\pi)^2 R_1 R_2 C_1 C_2 = \frac{1}{f^2}$$

$$f^2 = \frac{1}{(2\pi)^2 R_1 R_2 C_1 C_2}$$

$$f = \sqrt{\frac{1}{(2\pi)^2 R_1 R_2 C_1 C_2}}$$