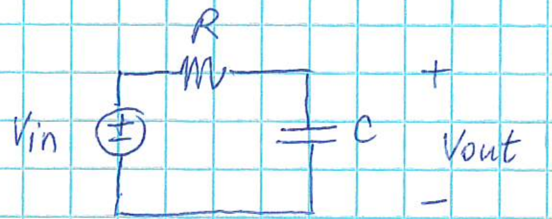
A Few simple circuits: examples

EE303 Handout

Example 1



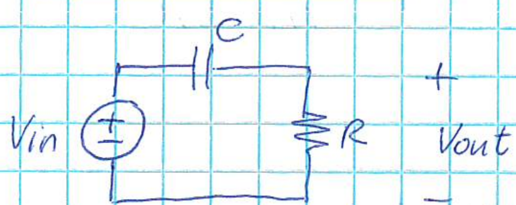
$V_{out} = 0$ for $s \to \infty$

$$\frac{V_{out}}{V_{in}} = \frac{1}{1 + sRC}$$

$$\omega_p = \frac{1}{RC}$$

$\boxed{\text{1 POLE SYSTEM}}$

Example 2



$$\omega_z = 0$$

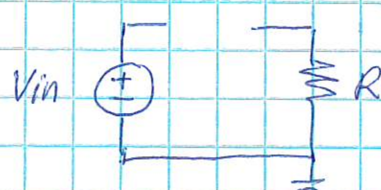
$$\omega_p = \frac{1}{RC}$$

$\boxed{\text{1 POLE 1 ZERO SYSTEM}}$

$$\frac{V_{out}}{V_{in}} = \frac{R}{1/sC + R} = \frac{sRC}{1 + sRC}$$

For $s \to \infty$

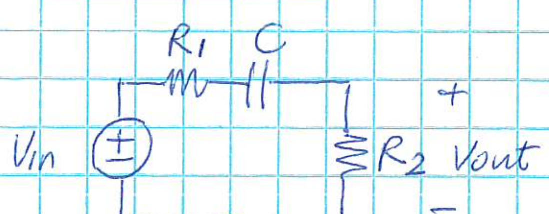
$$\frac{V_{out}}{V_{in}} = 1$$



at $s \to 0$

$V_{out} = 0$

Example 3



$$\omega_z = 0$$

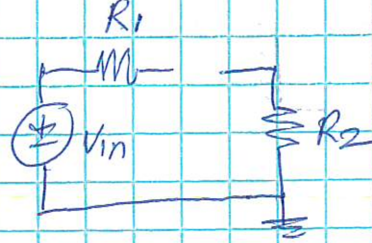
$$\omega_p = \frac{1}{(R_1 + R_2)C}$$

$$\frac{V_{out}}{V_{in}} = \frac{R_2}{\frac{1}{sC} + R_1 + R_2} = \frac{sR_2C}{1 + sC(R_1 + R_2)}$$

$\boxed{\text{1 POLE 1 ZERO SYSTEM}}$

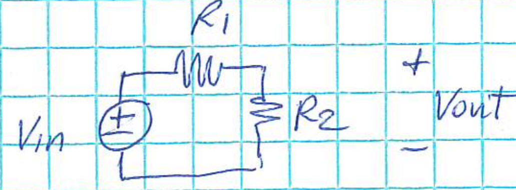
at $s \to 0$

$V_{out} = 0$

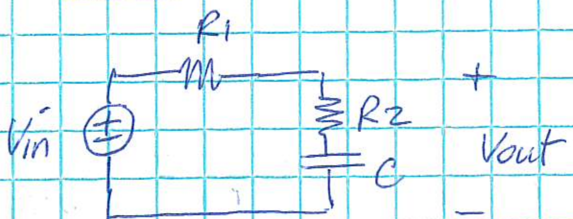


at $s \to \infty$

$V_{out} = \frac{R_2}{R_1+R_2} V_{in}$



Example 4

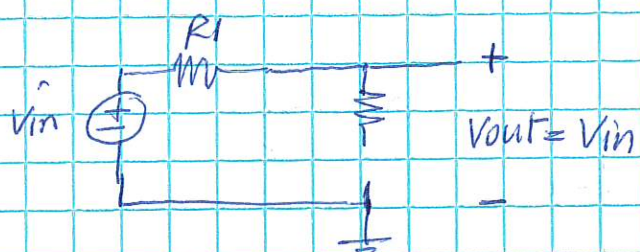


$$\omega_z = \frac{1}{R_2 C}$$

$$\omega_p = \frac{1}{(R_1+R_2)C}$$

$$\frac{V_{out}}{V_{in}} = \frac{R_2 + 1/sC}{R_1 + R_2 + \frac{1}{sC}} = \frac{1 + R_2 C \cdot s}{1 + s(R_1+R_2)\cdot C}$$

at $s \to 0$



1 POLE 1 ZERO	SYSTEM

at $s \to \infty$

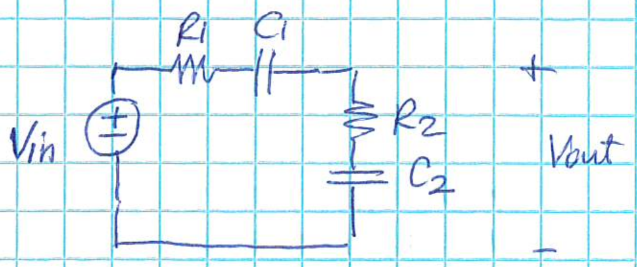
$V_{out} = \frac{R_2}{R_1+R_2} \cdot V_{in}$

at $s = s_z \Rightarrow V_{out} = 0$

$$V_{out} = R_2 \cdot I + I \cdot \frac{1}{s_z C} = I\left(R_2 + \frac{1}{s_z C}\right) = 0 \Rightarrow$$

$$\Rightarrow R_2 + \frac{1}{s_z C} = 0 \Rightarrow s_z = -\frac{1}{R_2 C}$$

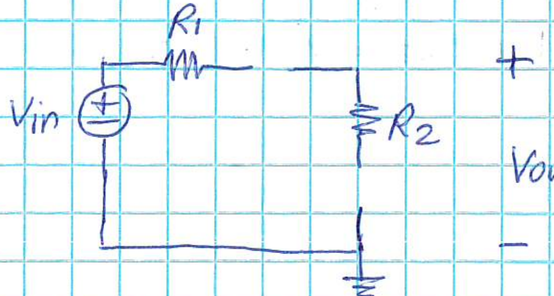
Example 5



$$\omega_z = \frac{1}{R_2 C_2}$$

$$\omega_p = \frac{1}{\frac{C_1 C_2}{C_1 + C_2} \cdot (R_1 + R_2)}$$

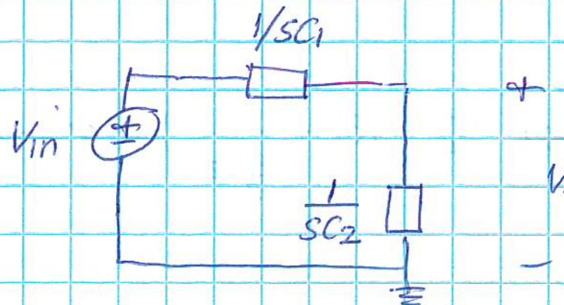
at $s \to 0$



" C_1 does not contribute any zeros at the origin "

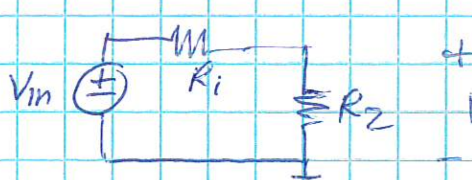
cannot tell !

$$\frac{1}{sC_1} \gg R_1 \quad \text{and} \quad \frac{1}{sC_2} \gg R_2$$



$$V_{out} = \frac{(1/sC_2)V_{in}}{\frac{1}{sC_1} + \frac{1}{sC_2}} = \frac{\left(\frac{1}{sC_2}\right)V_{in}}{\frac{(C_1 + C_2)}{s \cdot C_1 \cdot C_2}} = \frac{C_1}{C_1 + C_2} \cdot V_{in}$$

at $s \to \infty$



$$V_{out} = V_{in} \cdot \frac{R_2}{R_1 + R_2}$$

$$\boxed{\begin{array}{l} 1 \text{ POLE} \\ 1 \text{ ZERO} \end{array} \text{SYSTEM}}$$

$$\omega_p = \frac{1}{\frac{C_1 \cdot C_2}{C_1+C_2}(R_1+R_2)}$$

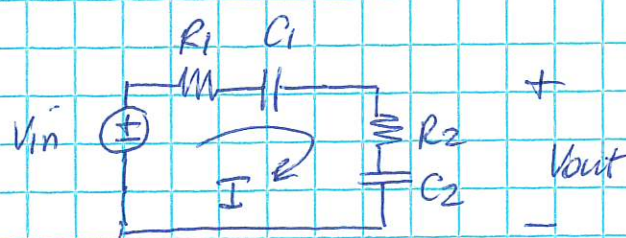
short independent voltage source

C_1 and C_2 are in series :

$$C_T = \frac{C_1 C_2}{C_1+C_2}$$

$$V_{R1} + V_{R2} = V_{C1} + V_{C2}$$

at $s = s_z \rightarrow V_{out} = 0$



$$V_{out} = I \cdot R_2 + I \frac{1}{s_z C_2} = 0 \rightarrow I\left(R_2 + \frac{1}{s_z C_2}\right) = 0 \Rightarrow$$

$$s_z = -\frac{1}{R_2 C_2}$$