Chapter 7. 頻率響應
(Frequency Response)

7.2 系統轉換函數

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1. S 值域分析

複數頻率 S(Complex Frequency)

$C \rightarrow \quad Z_C = \dfrac{1}{SC}$

$L \rightarrow \quad Z_L = SL$

$R \rightarrow \quad Z_R = R$

$$T(s) = k\frac{(S-Z_1)(S-Z_2)(S-Z_3)\ldots\ldots(S-Z_n)}{(S-P_1)(S-P_2)(S-P_3)\ldots\ldots(S-P_m)}$$

k 為常數

Z_n為零點(Zeros) $\rightarrow 0$

P_m為極點(Poles) $\rightarrow \infty$

電路中電容(1)耦合電容(C_C)

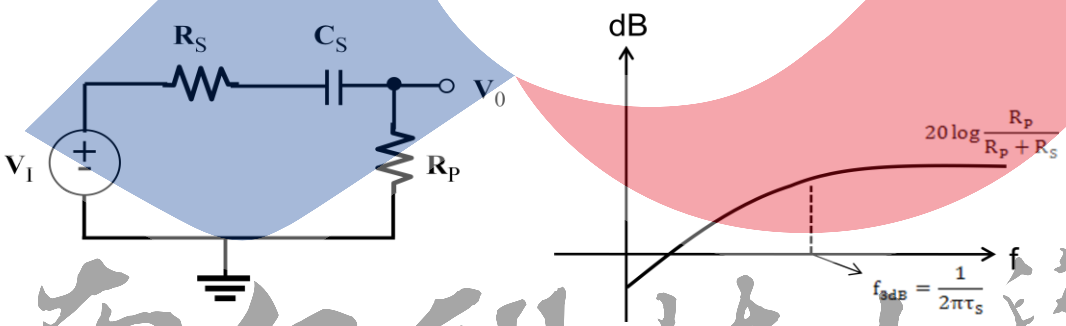
(2)旁路電容(C_S)

(3)電晶體內電容(C_T)

(4)雜散電容(C_{Stray})

(5)負載電容(C_L)

2. 波德圖(Bode Plots)



- 串聯耦合電路大小波德圖

$$A_V = T(S) = K\frac{s\tau}{1+s\tau} = \frac{R_P}{R_P+R_S}\frac{s\tau}{1+s\tau}$$

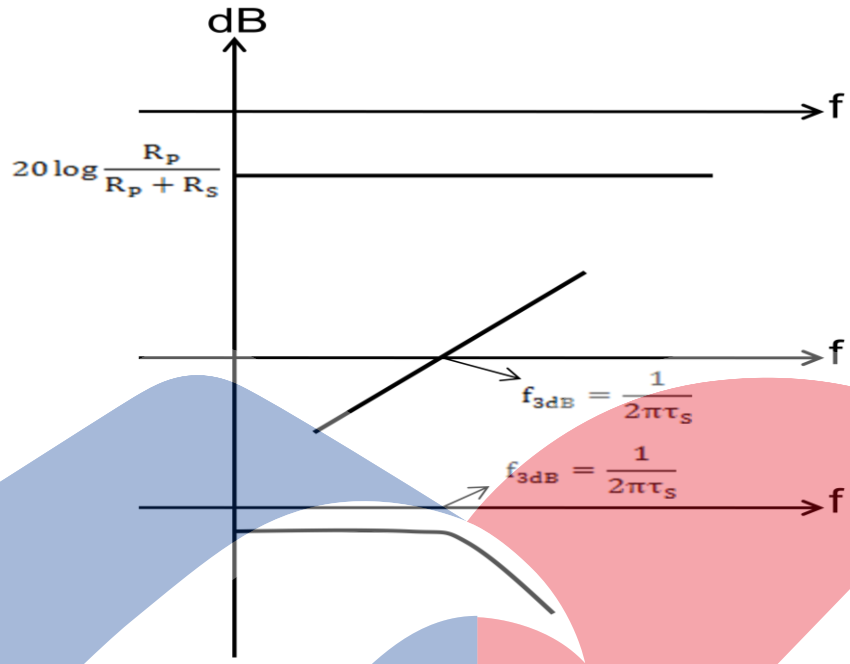
$$S = j\omega \text{ 代入 } T(j\omega) = \frac{R_P}{R_P+R_S}\frac{j\omega\tau}{1+j\omega\tau}$$

$$\omega = 2\pi f \text{ 代入 } T(j2\pi f) = \frac{R_P}{R_P+R_S}\frac{j2\pi f\tau}{1+j2\pi f\tau}$$

$$|T(j2\pi f)| = \left|\frac{R_P}{R_P+R_S}\right|\left|\frac{j2\pi f\tau}{1+j2\pi f\tau}\right| = \frac{R_P}{R_P+R_S}\frac{2\pi f\tau}{\sqrt{1+(2\pi f\tau)^2}}$$

$$|T(j2\pi f)|_{dB} = 20\log|T(j\omega)|$$

$$= 20\log\frac{R_P}{R_P+R_S} + 20\log 2\pi f\tau - 20\log\sqrt{1+(2\pi f\tau)^2}$$



✧ 圖中f_{3dB}稱為分叉點頻率(Break3 point f)

轉角頻率(Corner f)

-3dB 頻率(-3dB f)

- 串聯耦合電路相位波德圖

$A + Bj = ke^{j\theta}$

$k = |A + Bj| = \sqrt{A^2 + B^2}$

$\theta = \tan^{-1}\frac{B}{A}$

$T(j2\pi f) = \frac{R_P}{R_P + R_S}\frac{j2\pi f\tau}{1 + j2\pi f\tau}$

$T(j2\pi f)_\theta = |\frac{R_P}{R_P + R_S}|e^{j\theta 1}\frac{|j2\pi f\tau|e^{j\theta 2}}{|1 + j2\pi f\tau|e^{j\theta 3}}$

$\theta 1 = \tan^{-1}\frac{0}{\frac{R_P}{R_P + R_S}} = 0°$

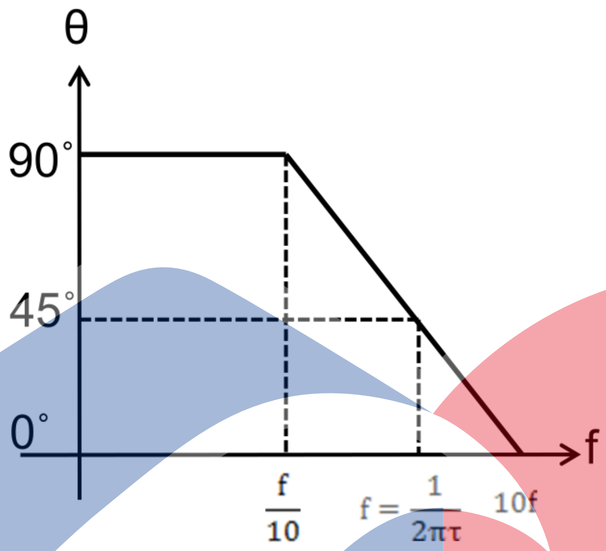
$\theta 2 = \tan^{-1}\frac{2\pi f\tau}{0} = 90°$

$\theta 3 = \tan^{-1}\frac{2\pi f\tau}{1}$

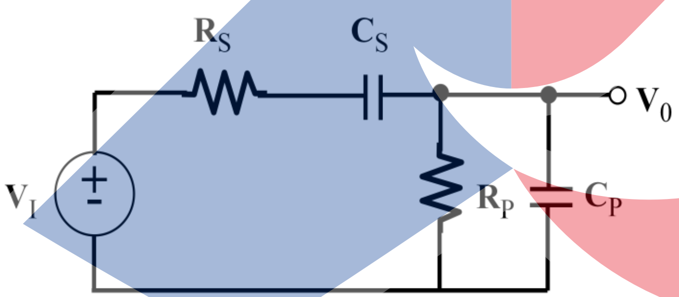
When $f = \frac{1}{2\pi\tau}$

$\theta 3 = \tan^{-1} 1 = 45°$

$$|T(j2\pi f)|_{\theta} = k1e^{j\theta 1}\frac{k2e^{j\theta 2}}{k3} = ke^{j(\theta 1+\theta 2-\theta 3)} = ke^{j(0+90-\tan^{-1}\frac{2\pi f\tau}{1})}$$



3. 短路及開路時間常數



定性觀察$C_S \gg C_P$

則$Z_{CS} = \frac{1}{2\pi f C_S}$

$Z_{CP} = \frac{1}{2\pi f C_P}$

When f 在低頻 $Z_{CP} \gg Z_{CS}$

Z_{CP}視為 OPEN，只考慮C_S的影響

→ 開路時間常數(Open − Circuit time constant)

When f 在高頻 $Z_{CP} \gg Z_{CS}$

Z_{CS}視為 SHORT，只考慮C_P的影響

→ 短路時間常數(Short − Circuit time constant)