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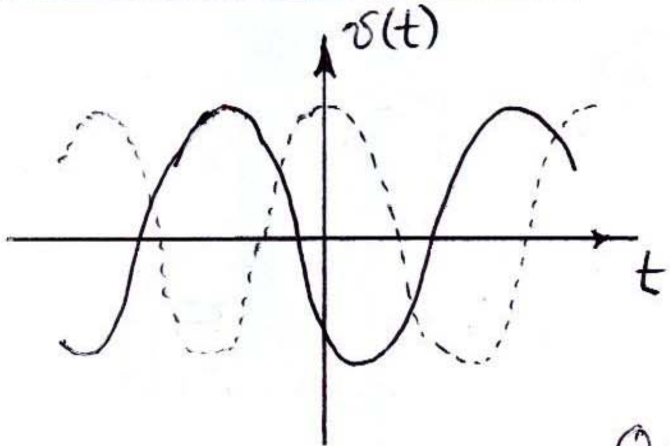
Lecture 7

Linear AC circuits



$v(t) = V_0 \cos(\omega t + \varphi)$

Q: why study AC (sine) response?

1)

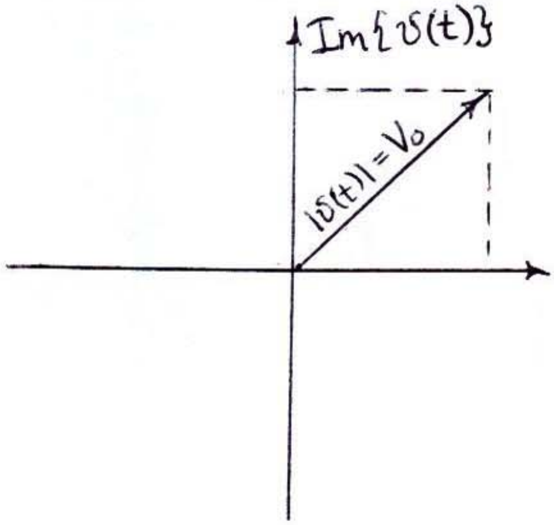
Q: if you have ________ network, what shape on input remains the same on the output?

2)

3) superposition:

Complex notation

—



Euler formula

$e^{j\alpha} = \cos\alpha + i\sin\alpha$

$j^2 \equiv -1$

$v(t) =$

Usually simply write $v(t) =$

Time vs. freq. domain analysis

Time domain: $v(t), i(t)$

KVL & KCL $\Rightarrow$

–

–

Freq. domain: $V(\omega), I(\omega)$

$\frac{d}{dt}(e^{j\omega t}) \rightarrow$

$\int e^{j\omega t} dt \rightarrow$

KVC&KCL $\Rightarrow$

Time domain $\longleftrightarrow$ Freq. domain

- two ways to look
- Fourier analysis :

Complex impedance

$V(\omega) =$

admittance = generalized conductance

Let $i(t) = I_0 e^{j\omega t}$, $v(t) = V_0 e^{j(\omega t + \varphi)}$

$Z(\omega) =$

Impedance can change both ____________________

$$Z = R + jX = Z_0 e^{j\varphi} \;, \Rightarrow$$

Capacitance

$$\frac{dv}{dt} = \frac{i}{C} \;.$$

$$Z_C = \frac{v(t)}{i(t)} =$$

voltage ______ current by 90°

Inductance

$$v = L\frac{di}{dt}$$

$$Z_L = \frac{v(t)}{i(t)} =$$

voltage ________ current by 90°

$\longrightarrow i$

	$\omega \to 0$	$\omega \to \infty$
Z_R		
Z_L		
Z_C		

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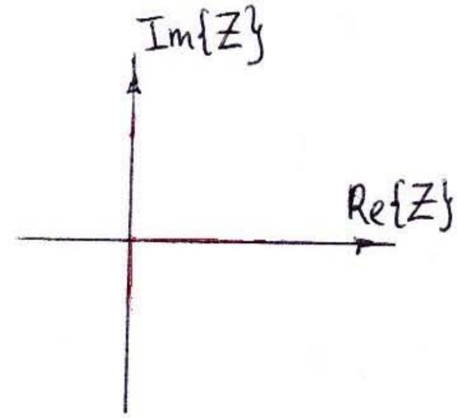
Lecture 8

Combining R, L, C

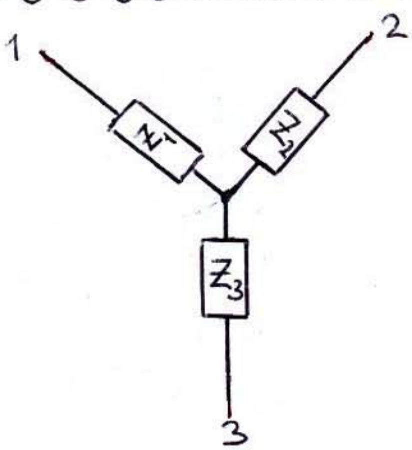
series:

parallel:

E.g.



Y – Δ transformation



same as before, but now complex

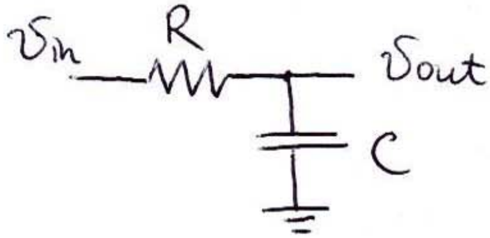
$\Delta \rightarrow Y$:

$Y \rightarrow \Delta$:

AC circuit analysis

* superposition
* Thevenin & Norton
* KCL & KVL

Lo-pass filter



$\Rightarrow$

Transfer fcn (a.k.a. complex gain)

$G(\omega) \equiv$

L.P. : $G(\omega) =$

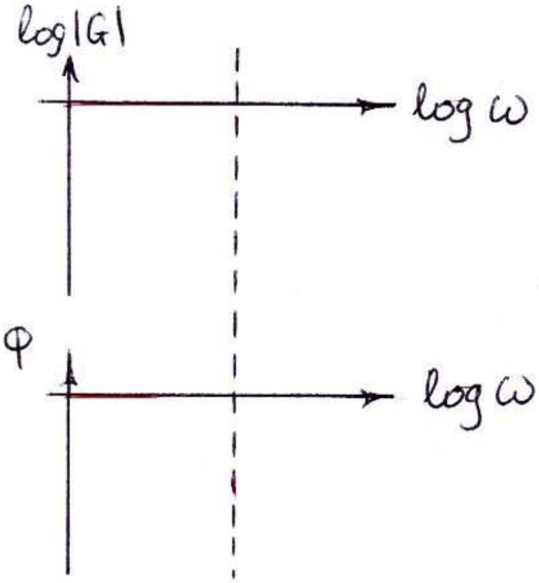
magn. $|G(\omega)| =$

phase $\varphi[G] =$

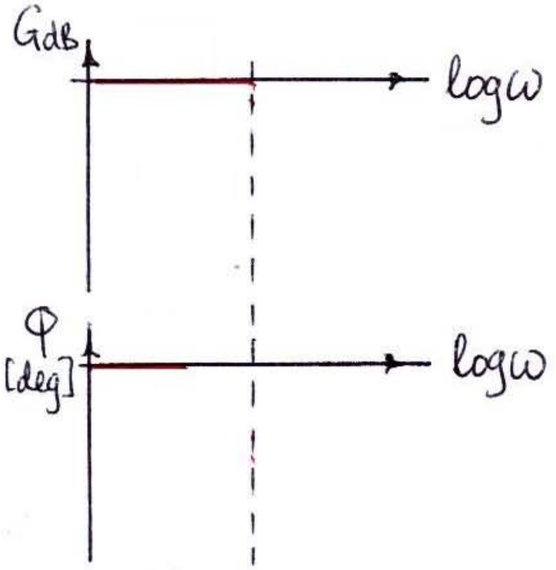
Bode plots

$$G(\omega) = |G(\omega)|\, e^{j\varphi[G(\omega)]}$$

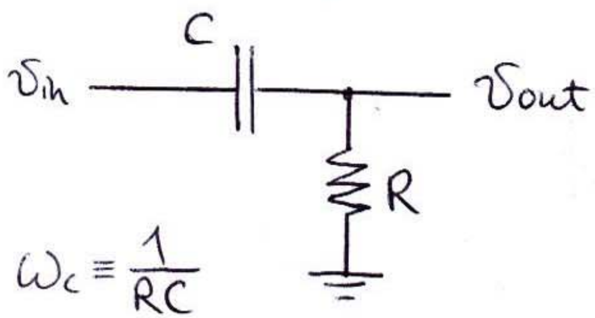
Bode plots =



Usually draw uncorrected Bode plots.

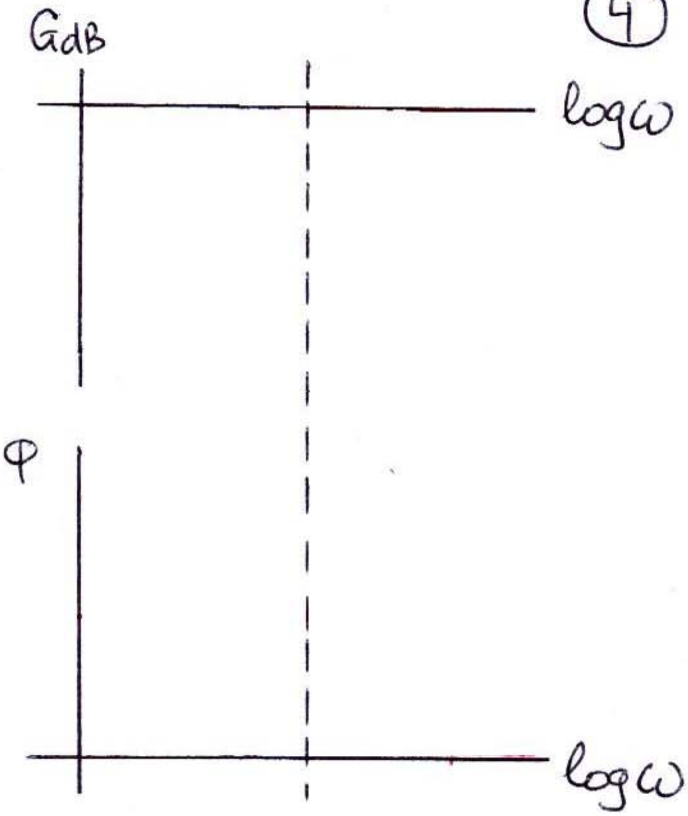


Hi-pass filter



$\omega_c \equiv \frac{1}{RC}$

$G(\omega) =$



Note: Bode plots ⇒ always two

$G(\omega) = |G(\omega)|\, e^{j\varphi[G(\omega)]}$

– magnitude & phase ________________

– e.g. change in magn. ________________

Standard (zero-pole) form of G

$G(\omega) =$

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Lecture 9

S-plane

$s \equiv \sigma + j\omega$

$v(t) = V_o e^{st}$; $\text{Re}\{s\} < 0$

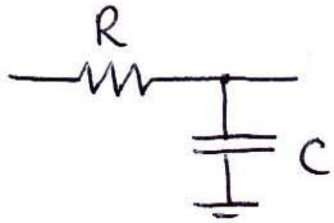
$\text{Re}\{s\} > 0$

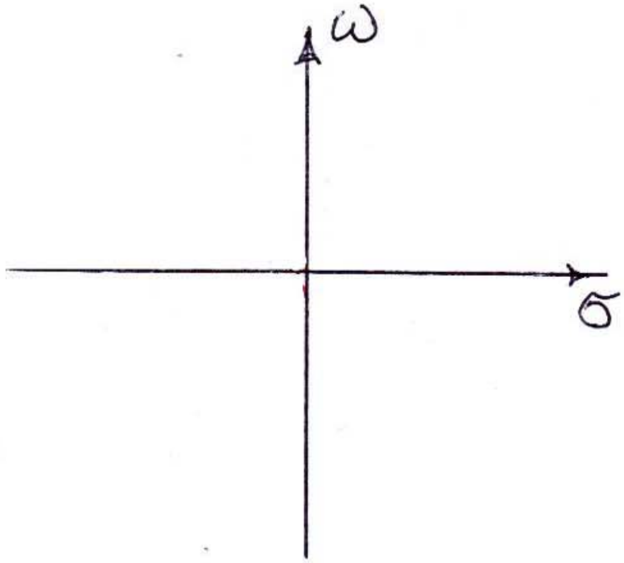
if $s = j\omega \Rightarrow$

Impedence in s-domain: $Z_C = \frac{1}{sC}$, $Z_L = sL$

$G(s) = \frac{V_{out}(s)}{V_{in}(s)}$ - gain (transfer fcn) in s-plane

Ex.





$G(\omega)$:

$G(s)$:

Zero-pole form of transfer fcn

②

Most natural when using s-plane

$$G(s) = \frac{N(s)}{D(s)} =$$

$\Rightarrow$ G(s) @

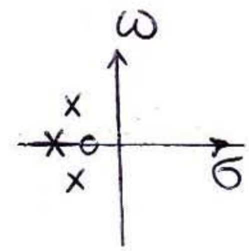
–

Some properties

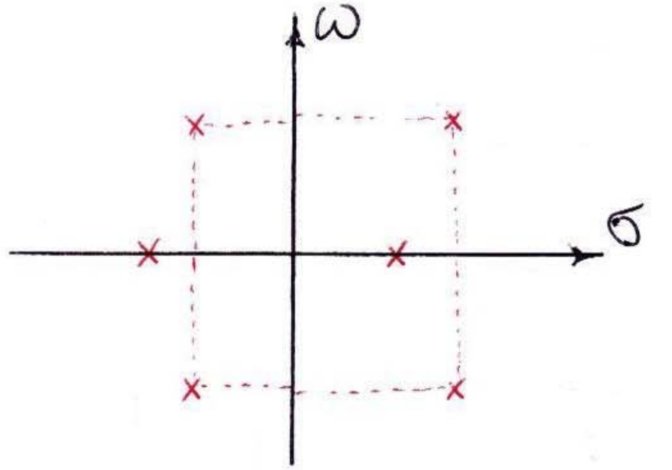
1)

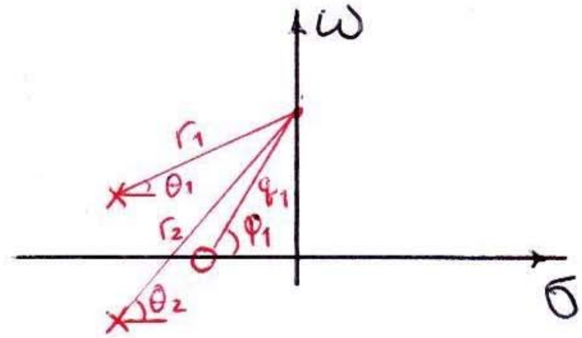
2)

3)



4)



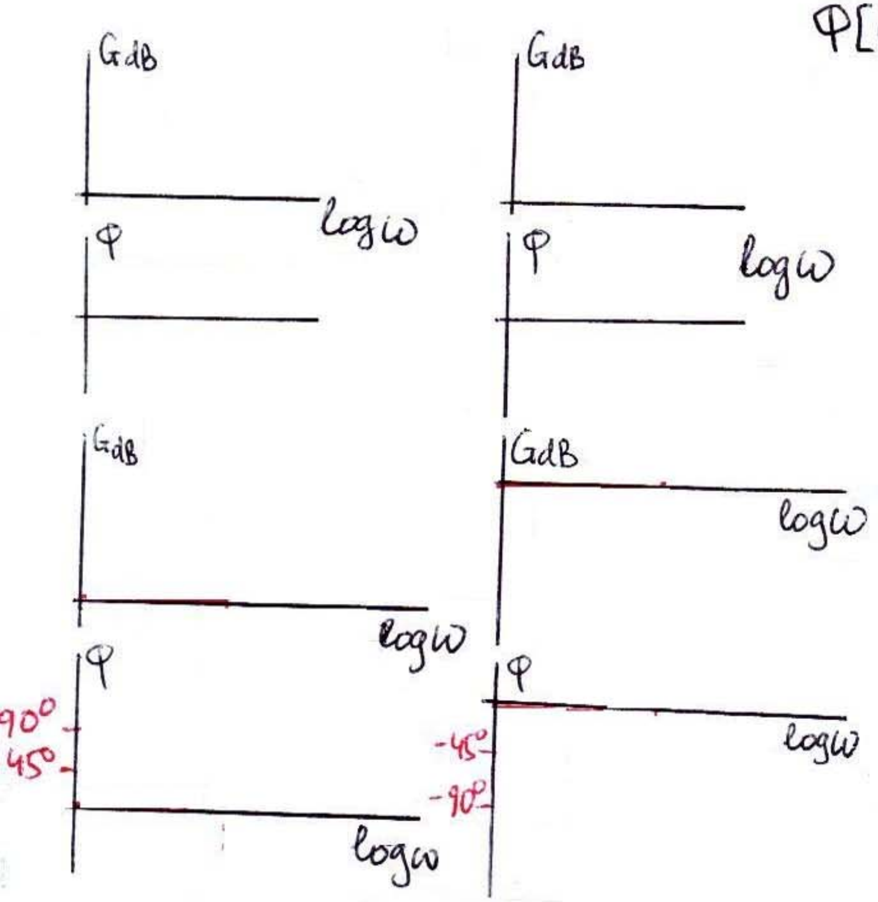


Bode Plots:

$$|G(\omega)| =$$

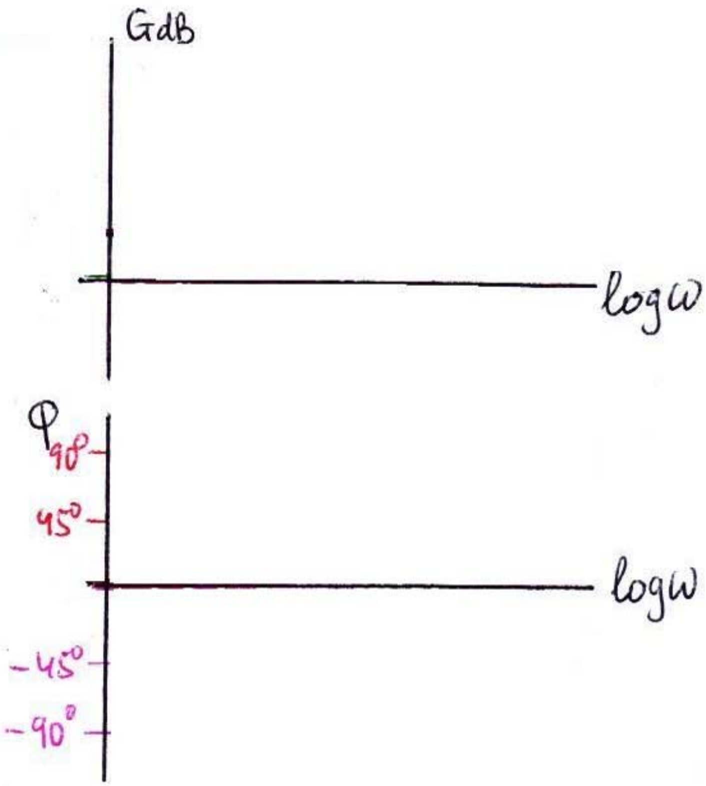
$$\varphi[G(\omega)] =$$

⇒ on Bode plots:

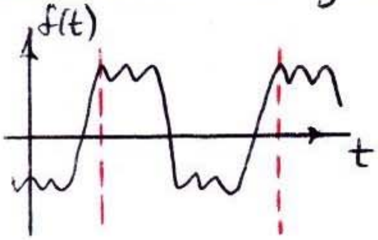


Ex. $G = K \dfrac{1 + j\omega/\omega_z}{1 + j\omega/\omega_p}$ ⇒

let $\omega_z \ll \omega_p$



Fourier Analysis



Basic idea:

$$f(t) = \sum_{n=-\infty}^{\infty} c_n e^{jn\omega t}$$

Definition: g(t) and h(t) orthogonal if

$\{e^{jn\omega t}\}$ forms orthogonal set:

$$f(t) = \sum_{n=-\infty}^{\infty} c_n \qquad e^{jn\omega t}$$

Strategy

1) source decomp. (superp.)

2) find response @ each harmonic $n\omega$

3) find v_{out}