Review For Midterm

3.1 – 3.6

Chapter 4 – All

Chapter 5 – RMS Value

page 2.03

$$v(t) = V_m \cos(\omega t + \theta)$$

$$(RMS)^2 = \frac{1}{T}\int_0^T v^2(t)\,dt = \frac{2}{T}\int_0^{T/2} v^2(t)\,dt$$

can do as in book or!

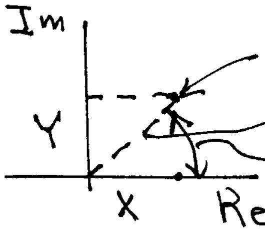
$$v(t) = \frac{V_m}{2} e^{i(\omega t+\theta)} + c.c.$$

$$v^2(t) = \underbrace{2 \times \frac{V_m^2}{4}}_{\text{only contribution}} + \frac{V_m^2}{4}\underbrace{\left(e^{2(i\omega t + i\theta)} + c.c.\right)}_{2\cos(2\omega t + 2\theta)}$$

Thus (periodic in $\frac{T}{2} = \pi/\omega$ and area of positive value = area of negative value so $\int_0^{T/2}(\cdot)\,dt = 0$)

$$RMS = \left(\int_0^{T/2} v^2(t)\,dt\,\frac{2}{T}\right)^{1/2} = \frac{V_m}{\sqrt{2}}$$

5.2 Phasor – Simply complex amplitude multiplying $e^{i\omega t}$. Review rectangular and polar plot of a complex number



$X + iY = Z$

$\sqrt{X^2+Y^2}$ = magnitude

$\theta = \tan^{-1}\frac{Y}{X}$ = phase

To find function represented by phasor Z

$$z(t) = \text{Re}(Z e^{i\omega t})$$

don't forget this!

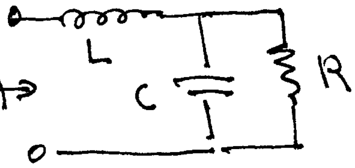
$$= \text{Re}(Z)\cos\omega t - \text{Im}(Z)\sin\omega t$$

$$= \sqrt{X^2+Y^2}\cos(\omega t + \theta)$$

$$Z(\omega) \triangleq r(p)\Big|_{p=j\omega}$$

Example

find $Z(\omega)$ →



Solution

$$r(p) = pL + \tfrac{1}{pC} \parallel R$$

$$= pL + \frac{\tfrac{1}{pC} R}{R + \tfrac{1}{pC}}$$

So $\quad Z(\omega) = j\omega L + R/(1 + j\omega RC)$

Section 5.4 : Once again just find $r(p)$ and substitute $p = j\omega$. The rest is complex arithmetic

5.5 Power. – just as for any $v(t)\,i(t)$ this gives instantaneous power. For sinusoids (periodic) we like to use time averaged power. (Your house meter measures this). The other terms average to zero. Example $v(t) = V\cos\omega t$ and $i(t) = I\cos\omega t$ $\quad v(t)\,i(t) = VI\cos^2\omega t = \frac{VI}{2}(1 + \underbrace{\cos 2\omega t}_{0 \text{ Average}})$

Thus time Average power $= \left(\frac{VI}{2}\right)$. The instantaneous power oscillates between this $\left(\frac{VI}{2}\right)$ and twice this (VI) [Also $\frac{VI}{2} = v_{RMS}\, i_{RMS}$]

Power Factor : If $\quad v(t) = \mathrm{Re}(V e^{j\theta} e^{j\omega t})$

$\qquad\qquad\qquad\quad\; i(t) = \mathrm{Re}(I e^{j\delta} e^{j\omega t})$

$$v(t)\,i(t)\Big|_{\text{time Avg}} = \underbrace{\frac{VI}{4} e^{j(\theta-\delta)} + cc.}_{\substack{\text{these are the}\\ \text{only terms not}\\ \text{involving } e^{2j\omega t}}} = \frac{VI}{2}\underbrace{\cos(\theta-\delta)}_{\substack{\text{power}\\ \text{factor}}}$$

(3)

Note real time Avg Power $= VI e^{j(\theta-\delta)} + c.c.$

$$= \underbrace{\frac{VI}{4}\cos(\theta-\delta)}_{P/2} + \left[j\frac{VI}{4}\sin(\theta-\delta) \right] + \frac{VI}{4}\cos(\theta-\delta)$$

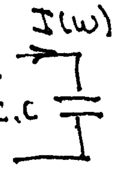
$$\text{cancel} \quad - j\frac{VI}{4}\sin(\theta-\delta)$$

$\frac{VI}{2}\sin(\theta-\delta) =$ Reactive Power $= Q$ by definition

The reactive power cancels from $v(t)\,i(t)$ because $v(t)\,i(t)$ is <u>real</u>   Real Power $= \frac{VI}{2}\cos(\theta-\delta)$

· page 229–230   Apparent Power $= \frac{VI}{2}$

Note for L & C Since $\theta - \delta = \pm \pi/2$ the power is <u>reactive</u>. <u>Do</u> <u>it</u> <u>this</u> <u>way</u> for sins and cosines <u>Define</u>



$v(t) = \frac{Ve^{j\omega t}}{2} + c.c$

$\boxed{\text{Complex Power}}$

$$P_c = 2\left(\frac{V}{2}e^{j\omega t}\right)\left(\frac{I}{2}e^{+j\omega t}\right)^* = P + jQ$$

for C; $\left(I \cdot e^{j\omega t}\right) = C\frac{d}{dt}Ve^{j\omega t} = (Cj\omega V)e^{j\omega t}$

Thus $\quad P_c = V\cancel{e^{j\omega t}}(-j\omega)CV^*/2\,\cancel{e^{-j\omega t}}$

$$= -j\underbrace{\frac{VV^*}{2}}_{\text{Real}}\omega C = jQ$$

Note By <u>defining</u> <u>Complex</u> <u>power</u> we can discuss L and C. Reactive power just relates to the energy stored.

Also we see that $P_c = \underbrace{P}_{\text{Real power}} + jQ$

Forget examples 5.8 and 5.9 but 5.9 is interesting!

Do. 5.6 just use $r(p)|_{p=j\omega}$ once again

Forget 5.7. - interesting though (and practical)

Chapter 6 Look at 6.4 - You did this with RC and LTSpice $f_B = 1/RC$

Forget 6.5

6.6 to 6.8 → Read

6.9 DSP is interesting - ignore for exam

Chapts 7-9 - Will cover portions after midterm

Chapt 10 10.1-10.6 (Ideal Diode)

Chapt 11 : This is basically Analysis with Dependent Sources. Neglect 11.6 to end of Chapter. Concentrate on the assigned homework problem from this chapter

Chapt 12 FETS. (Not on Midterm)

12.1 - 12.3

Read 12.7

Chapt 13 (Not on midterm)

13.1 - 13.5

Chapt 14 (Op Amps)

14.1 - 14.4

14.8, 14.9

Problem Sets 3 and 4