problems.pdf : 34-37, 32, 41, 50

HH 1.25 p46
1.20 p33 c-half

(32) $Z_C = \frac{1}{j\omega C} = -j\,1.941\ k\Omega$ ($\omega = 2\pi \cdot 10^3$, $C = .082 \times 10^{-6}$)

$Z_L = j\omega L = j\,4.964\ k\Omega$ ($L = 79 \times 10^{-3}$)

$V_A = \frac{Z_C}{R+Z_C} V_{in} = \frac{(0, -1.941)}{(1, -1.941)} 12 = (.8889 \angle -27.3^\circ)\,12$

$= 10.67 \angle -27.3^\circ$ V

$V_B = \frac{Z_C}{R+Z_C} V_{in} = \frac{(0, .4964)}{(1, .4964)} 12 = (.4446 \angle 63.6^\circ)\,12$

$= 5.336 \angle 63.6^\circ$ V

$V_A - V_B = (7.11, -9.67) = 12 \angle -54^\circ$

$Z_{TH} = Z_C \| R + Z_L \| R = \underbrace{988\Omega}_{R} - \underbrace{8.89}_{}j\Omega = 988 \angle -.51^\circ$

$X_C = 8.89 = \frac{1}{\omega C}$

$C = \frac{1}{\omega \cdot 8.89} = 18\ \mu F$

$I = \frac{V_{TH}}{Z_{TH} + R} = \frac{(7.11, -9.67)}{(1988, -8.89)}$

$= (3.60, -4.85)$ mA $= \boxed{6.04\ mA \angle -53^\circ}$

(41) I take the following data

f	atten		
1 kHz	1	→	0 dB
8 kHz	.016	→	-35.9 dB

3 octaves

$\frac{\Delta dB = -36}{3\ octaves} = -12 \frac{dB}{oct}$

Find B:

$\frac{a_1 = A f_1^B}{a_2 = A f_2^B} \Rightarrow \frac{a_1}{a_2} = \left(\frac{f_1}{f_2}\right)^B$

$\log\left(\frac{a_1}{a_2}\right) = B \log\left(\frac{f_1}{f_2}\right)$

$1.99 = \frac{\log\left(\frac{1}{.016}\right)}{\log\left(\frac{1}{8}\right)} = \frac{\log\left(\frac{a_1}{a_2}\right)}{\log\left(\frac{f_1}{f_2}\right)} = B \approx 2$

(5c)

table

f	# oct
1	
2	1 ← ?
4	2
8	3

3 → (between 2 and 4)

$f = 2^x$

$3 = 2^x \Rightarrow x = \frac{\log 3}{\log 2} = 1.59$ octaves

square:

$V_{in} = A\left(1 \sin(\omega t) + \frac{1}{3}\sin(3\omega t)\right)$

$V_{out} = B\left(1 \sin(\omega t) + .01 \sin(3\omega t)\right)$

attenuation $= \frac{B}{A}$ $\qquad \frac{B(.01)}{A(1/3)} = \frac{B}{A\,\frac{100}{3}}$

more attenuation at 3f

$dB = 20 \log_{10}(B/A)$ $\qquad dB = 20\log\left(\frac{B}{A\frac{100}{3}}\right)$

$\Delta dB = 20\left[\log_{10}(B/A) - \log\left(B/A\,\tfrac{100}{3}\right)\right]$

$= 20\left[\log\left\{\frac{B/A}{B/A\ 100/3}\right\}\right]$

$= 20\log\left(\frac{3}{100}\right)$

$\#\, oct = 1.59$

$\Rightarrow \frac{\Delta dB}{\#\, oct} = \frac{20\log(3/100)}{1.59} = -19.2\ \frac{dB}{oct}$

Triangle

$V_{in} = A\left(1 \sin \omega t - \frac{1}{9}\sin(3\omega t)\right)$

$V_{out} = B\left(1 \sin(\omega t) - .01 \sin(3\omega t)\right)$

attenuation $= \frac{B}{A}$ $\qquad \frac{.01 \cdot B}{\frac{1}{9} A} = \frac{B}{A\,\frac{100}{9}}$

$\Delta dB = 20\log\left(\frac{9}{100}\right)$

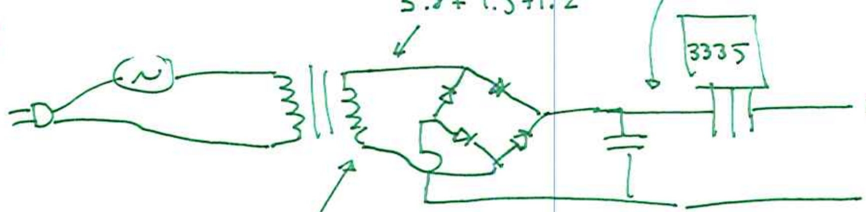
$\frac{\Delta dB}{\#\, oct} = \frac{20\log(9/100)}{1.59} = -13.2\ \frac{dB}{oct}$

old exam: 1, 2, 5, 6

(1)

$6.5 = V_o = 3.8 + 1.5 + 1.2$

$3.3 + .5$ & $\Delta V = 1.5 = \frac{IT}{C}$ ⇒ ~~C = ...~~



$C = \frac{IT}{1.5} = \frac{(.25)(\frac{1}{120})}{1.5}$

$= 1.39\,mF$

$C = 1390\,\mu F$

$V_{rms} = \frac{V_o}{\sqrt{2}} = \frac{6.5}{\sqrt{2}} = \underline{4.60\,V}$

Power $= (.5 + \frac{1}{2} 1.5)(.25) = .313\,W$

fuse: $120 \cdot I = (6.5)(.25)$ → $I = \frac{6.5 \cdot .25}{120} = .0135\,A$

Try $1/32 = .0312$

(2)

$Z_L = j\omega L = j\,62.83\,\Omega$ ($2\pi \cdot 10^4 = 6.28 \times 10^4$; $L = 10^{-3}$)

$Z_C = \frac{1}{j\omega C} = -j\,63.66\,\Omega$ ($C = .25 \times 10^{-6}$)

$Z_L \| Z_C = \frac{Z_L \cdot Z_C}{Z_L + Z_C} = \frac{(62.83)(63.66)}{j(62.83 - 63.66)}$

$= j\,4.82 \times 10^3\,\Omega$

$Z_L \| Z_C + R = 10^3 + j\,4.82 \times 10^3$ → in kΩ $(1, 4.82) = 4.92 \angle 78.3°$

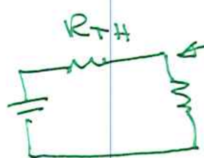
$I = \frac{V}{\ \ } = 2.03\,mA \angle -78.3°$

$V_{out} = \frac{Z_L \| Z_C}{Z_L \| Z_C + R} V_{in} = \frac{(0, 4.82)}{(1, 4.82)} 10 = 9.79\,V \angle 11.7°$

(ratio: $.979 \angle 11.7°$)

$I_C = \frac{|V_{out}|}{X_C} = \frac{9.79\,V}{63.66} = \underline{15.4\,mA}$ ← larger than total! resonance!

(5) $V_{TH} = 6\,V$



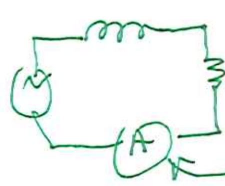
$5V = \frac{100}{R_{TH} + 100} 6$

$R_{TH} + 100 = \frac{100 \cdot 6}{5}$

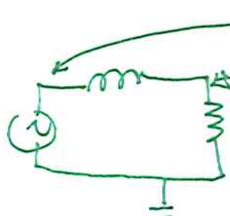
$R_{TH} = \frac{100 \cdot 6}{5} - 100 = \frac{100}{5} = 20\,\Omega$

$P = I^2 R = \left(\frac{6}{30}\right)^2 10 = \underline{.4\,W}$

(6)



should read $|3 - 4i| = 5\,mA$



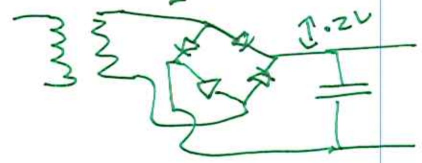
Look at phase difference

$V_R = R(3 - 4i)$ should LAG by $\tan^{-1}\left(\frac{4}{3}\right) = \underline{53°}$

Problems.pdf 34 – 37

peak = 1.2 + .2 + 6 = 7.4 V → rms = $\frac{7.4}{\sqrt{2}}$ = 5.23 V

34



$\Delta V = .2 = \frac{IT}{C}$ (I = .03, T = $\frac{1}{120}$)

$C = \frac{(.03)\frac{1}{120}}{.2}$ = 1.25 mF = 1250 μF

35) $6.3\sqrt{2} - .6$ = 8.3 V — 8.3 V

$6.3\sqrt{2} - 1.2$ = 7.7 V — $\frac{6.3}{2}\sqrt{2} - .6$ = 3.86 V

from Lab $V_{rip} = \frac{T}{2\sqrt{3}C} I$

$V_{dc} = V_0 - \frac{T}{2C} I$ (droop)

Fullwave: $\frac{\frac{1}{120}(.5)}{2\sqrt{3}\, 4.7\times10^{-3}}$ = .256 — half f: 2x .512 V

$\frac{\frac{1}{120}(.5)}{2\ 4.7\times10^{-3}}$ = .443 V — .887 V

36) Needs 2V head ie 7V so 12 required

heat = (12 − 5)(.5) = 3.5 W

37) Smaller R_{TH}

→ HH 1.20 & 1.25
p33 p46

1.20 Half-wave $T = \frac{1}{60}$

droop = $\frac{1}{2}\frac{IT}{C}$ = .05

$\Delta V = .1 = \frac{IT}{C}$ (I = .01, T = $\frac{1}{60}$) $C = \frac{.01\frac{1}{60}}{.1}$ = 1667 μF

⇒ $V_0 = 10 + .15 + .6 = V_0\sqrt{2}$ ← 7.6 V rms

1.25 caps

Series: $\frac{1}{j\omega C_T} = \frac{1}{j\omega C_1} + \frac{1}{j\omega C_2} \Rightarrow \frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2}$

parallel: $j\omega C_T = j\omega C_1 + j\omega C_2 \Rightarrow C_T = C_1 + C_2$