

KCL AT NODE B.

$$-I_{RF} + I_{RL} = I_{NL}$$

$$\Rightarrow I_{NL} = (0.1 + 0.4) \text{mA} = 0.3 \text{mA}$$

$$\Rightarrow V_{NL} = 2 \times I_{NL}^3 = 2 \times 0.3^3 = \underline{\underline{0.054 \text{V}}}$$

4.41

YOU MIGHT ADD AN OSCILLOSCOPE SO YOU COULD MONITOR THE RECORDING LEVEL. IN PRACTICE SPECIAL METERS CALLED "VU" METERS ARE USED FOR THIS.

IF MONEY IS NO OBJECT, USE A SEPERATE RECORDER FOR EACH MICROPHONE. THEN YOU CAN MIX THEM AFTERWARDS AS MANY TIMES AS YOU NEED TO GET RESULTS YOU LIKE.

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PROBLEMS - CH. 5

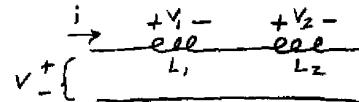
5.1

$$i = C \frac{dV}{dT}$$

$$V = \frac{1}{C} \int_0^t i(t) dt = \frac{It}{C}$$

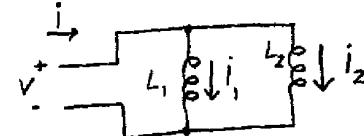
$$t = \frac{CV}{I} = 2 \text{ msec}$$

5.2



$$V = L_1 \frac{di}{dt} + L_2 \frac{di}{dt} = (L_1 + L_2) \frac{di}{dt}$$

5.3



$$\begin{aligned} \frac{di}{dt} &= \frac{di_1}{dt} + \frac{di_2}{dt} = \frac{V}{L_1} + \frac{V}{L_2} \\ &= \frac{L_1 + L_2}{L_1 L_2} V \end{aligned}$$

$$\therefore V = \left( \frac{L_1 L_2}{L_1 + L_2} \right) \frac{di}{dt}$$

$$5.4 \quad -\frac{V_A}{R} - C \frac{dV_A}{dt} = 0$$

$$5.5 \quad IR + V_C = 0$$

$$I = C \frac{dV_C}{dt} \Rightarrow V_C = \frac{1}{C} \int I dt + (\text{const})$$

$$R \frac{dI}{dt} + \frac{I}{C} = 0$$

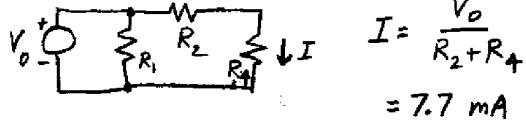
$$5.6 \quad \frac{V_{IN}}{R} + C \frac{d}{dt} V_{OUT} = 0$$

$$V_{OUT} = - \frac{1}{RC} \int_0^t V_{IN}(t') dt' + V_0$$

WHERE  $V_0$  IS  $V_{OUT}(t=0)$ . SINCE THE CAPACITOR IS INITIALLY UNCHARGED,

$$V_0 = \frac{Q(t=0)}{C} = 0$$

3 5.7 SINCE THE CURRENTS AND VOLTAGES ARE NON-TIME-VARYING, INDUCTORS ACT LIKE WIRES AND CAPACITORS LIKE OPEN CIRCUITS. THUS



$$I = \frac{V_0}{R_2 + R_4}$$

$$= 7.7 \text{ mA}$$

$$3 5.8 \quad (a) \quad C = \frac{(1.022 + .01)(.015)}{(.022 + .01) + (.015)} = 0.01 \mu F$$

(b) USING RESULTS OF PROBS 5.2-5.3

$$L = \frac{3(1+2.5)}{3+(1+2.5)} = 1.615 \text{ mH}$$

$$5.9 \quad (a) \quad v = iR + L \frac{di}{dt}$$

$$= I_0 R \cos \omega t - L I_0 \omega \sin \omega t$$

(b) THE DESIRED FORM CAN BE EXPANDED TRIGONOMETRICALLY:

$$v = A \cos(\omega t + \phi)$$

$$= A \cos \omega t \cos \phi - A \sin \omega t \sin \phi$$

THIS IS IDENTICAL WITH (a) IF

$$A \cos \phi = I_0 R \quad A \sin \phi = L I_0 \omega$$

DIVIDING ONE EXPRESSION BY THE OTHER,

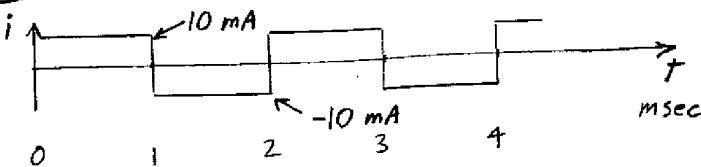
$$\tan \phi = \frac{L \omega}{R}$$

SQUARING EACH EXPRESSION & ADDING GIVES

$$A^2 \cos^2 \phi + A^2 \sin^2 \phi = I_0^2 R^2 + L^2 I_0^2 \omega^2$$

$$A^2 = I_0^2 (R^2 + \omega^2 L^2)$$

(5.10) SINCE  $i = C \frac{dV}{dt}$ ,  $i_{MAX} = 10^{-6} \frac{10}{10^{-3}}$



(5.11)  $i(t) = \frac{1}{L} \int_0^t v(t') dt' + i(t=0)$

IN THE FIRST MSEC THIS GIVES  
(ASSUMING  $i(t=0)=0$ )

$$i(t) = \frac{1}{L} \int_0^t \frac{10t'}{10^{-3}} dt' = \frac{1}{L} (5000) t^2$$

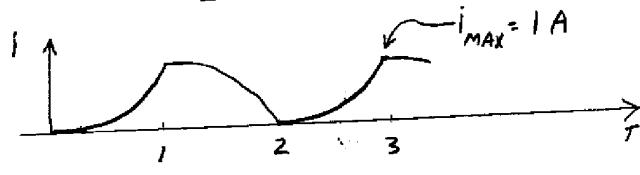
THIS REACHES A MAXIMUM OF

$$\frac{1}{5 \cdot 10^{-3}} (5000) (10^{-3})^2 = 1 \text{ AMP}$$

AT  $t=1 \text{ msec}$ . IN THE NEXT MSEC

$$i(t) = -\frac{1}{L} \int_1^2 \frac{10t'}{10^{-3}} dt' + i(t=1 \text{ msec})$$

$$= 1 - \frac{1}{L} (5000) t^2 \text{ and so on.}$$



(5.12) FROM ENERGY CONSERVATION,

$$\frac{1}{2} CV_0^2 = \frac{1}{2} L I_{MAX}^2$$

$$I_{MAX} = V_0 \sqrt{\frac{C}{L}}$$

(5.13) (a)  $p(t) = v(t)i(t)$

$$= V_0 \cos \omega t \cdot C V_0 \omega (-\sin \omega t)$$

$$= -C V_0^2 \omega \cdot \frac{1}{2} \sin 2\omega t$$

$$(b) P_{AV} = -\frac{1}{T} C V_0^2 \frac{\omega}{2} \int_0^T \sin 2\omega t dt$$

$$= -\frac{\omega^2 C V_0^2}{4\pi} \int_0^{2\pi/\omega} \sin 2\omega t dt$$

$$\text{Let } 2\omega t = u \quad dt = \frac{du}{2\omega}$$

$$= -\frac{\omega C V_0^2}{8\pi} \int_0^{4\pi} \sin u du$$

$$= \frac{\omega C V_0^2}{8\pi} (\cos 4\pi - \cos 0) = 0$$

THIS RESULT IS AS WE EXPECT BECAUSE C IS AN ENERGY-STORAGE ELEMENT. IT CAN TAKE ENERGY IN AND SPIT IT BACK OUT, BUT IT NEVER CONSUMES ANY ENERGY, SO THE  $P_{AV}$  IS ZERO.

(5.14) (a)  $i(t) = \frac{1}{L} \int_0^t V_o \cos \omega t = \frac{V_o}{\omega L} \sin \omega t$

$$P(t) = \frac{V_o^2}{\omega L} \sin \omega t \cos \omega t$$

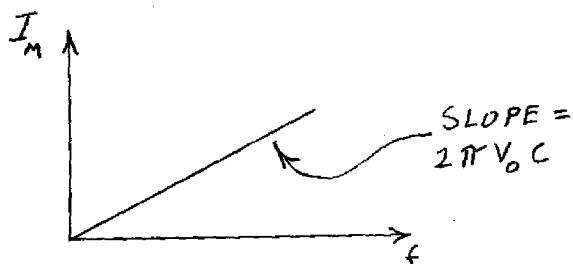
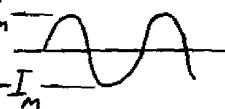
(b) THE INTEGRATION IS THE SAME AS IN PREVIOUS PROB, AND AGAIN THE RESULT IS  $P_{av} = 0$  (FOR THE SAME PHYSICAL REASON).

(5.15) (a)  $i(t) = C \frac{d}{dt} V_o \cos 2\pi f t$

$$= -V_o C 2\pi f \sin 2\pi f t$$

THE MAX. CURRENT IS

$$I_m = 2\pi V_o C f$$



## CHAPTER 6 - EXERCISES

EX.

6.1 WE MUST HAVE

$$\begin{aligned} 2 \cos \omega t + 3 \cos(\omega t - 45^\circ) &= V_o \cos(\omega t + \phi) \\ \Rightarrow [2 + 3 \cos 45^\circ] \cos \omega t + 3 \sin 45^\circ \sin \omega t & \\ &= V_o (\cos \omega t \cos \phi - \sin \omega t \sin \phi) \end{aligned}$$

FROM EXAMPLE 4.4

$$V_o^2 = (2 + 3 \cos 45^\circ)^2 + (3 \sin 45^\circ)^2$$

$$\Rightarrow V_o = 4.635$$

ALSO

$$\tan \phi = - \frac{3 \sin 45^\circ}{2 + 3 \cos 45^\circ} = \underline{\underline{-27.24^\circ}}$$