Lec 15 - Chap 30

3. $i = \frac{|\mathcal{E}|}{R}$, $|\mathcal{E}| = \frac{\Phi_{B,f} - \Phi_{B,i}}{\Delta t} \cdot N$

and $\Phi_{B,final} = 0$ (since $i_f = 0$)

$\Phi_{B,initial} = B_{initial} \cdot \text{Area}$

$= (\mu_0 i n)(\pi r^2)$

$= \mu_0 (1.5)(22000)(\pi)(0.016)^2$

$\rightarrow$ $i = 30$ mA

7. $\Phi_B = 6t^2 + 7t$

$|\mathcal{E}| = \frac{\partial \Phi_B}{\partial t} = 12t + 7$

$|\mathcal{E}| @ t = 2 \rightarrow \underline{31 \times 10^{-3} \text{ V}}$

9. $B = \mu_0 i n = \mu_0 (85400) \sin \omega t \cdot (1.28)$

$\Phi_B = B \cdot \pi r^2$

$|\mathcal{E}| = \frac{\partial \Phi_B}{\partial t} = \mu_0 (85400)\, \omega \cdot 1.28 \cos(\omega t) \cdot \text{Area}$

11. $|\mathcal{E}| = N \frac{\partial \Phi_B}{\partial t}$ and $\Phi_B = B \cdot A$

not $\sin \omega t$ since then $\Phi_B = 0$ at $t = 0$

Area $= a \cdot b \cdot \cos \omega t$

so $|\mathcal{E}| = \frac{N Bab \cos \omega t}{\partial t} = \underline{NBab\, \omega \sin(\omega t)}$, $\omega = 2\pi f$

15. $B = 0.042 - 0.87t$, Area $= \frac{2.2}{2} = 2m^2$

$$\mathcal{E}^{ind} = -\frac{d\Phi_B}{dt} = -\frac{2(0.042 - 0.87t)}{dt} = 2(0.87)$$

$\vec{B}$ is ⊙ and decreasing $\bar{c}$ time, so induced $\vec{B}$ must increase with time and is ⊙, too.

$\hookrightarrow$ ∴ current is c.c.w.

and $\mathcal{E}^{net} = \mathcal{E}_{bat} + \mathcal{E}_{ind}$

$= 21.7\ V$

27. $\Phi_B = B \cdot \text{Area}$

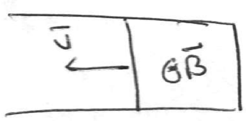
a) $= \int_0^{0.02} (4t^2 y)(0.02)\, dy$ ← the x value of area

$= (0.04t^2)(0.02)^2$

$$|\mathcal{E}| = \frac{d\Phi_B}{dt} = 2(0.04t)(0.02)^2 = 80\ \mu V$$

b) $\vec{B}$ is ⊙ and increasing (↑)

so B^{ind} is ⊗ and ↑ $\Longrightarrow$ i is clockwise

29. 

a) $|\mathcal{E}| = \frac{d\Phi_B}{dt} = BLv = 0.048\ V$

b) $i = \frac{|\mathcal{E}|}{R} = 2.7mA$

c) $P = i^2 R = 1.3 \times 10^{-4}\ W$

33.
$$\Phi = \oint_S \bar{B} \cdot d\bar{S}$$

$$= x \int_a^{a+L} \frac{\mu_0 I}{2\pi R} \, dR$$

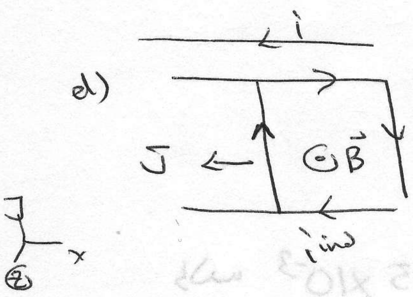
$$= \frac{x \mu_0 I}{2\pi} \ln\left(\frac{a+L}{a}\right)$$

a) $|\mathcal{E}| = \frac{\partial \Phi_B}{\partial t} = \frac{\mu_0 I}{2\pi} \ln\left(\frac{a+L}{a}\right) \cdot v = 240 \mu V$

b) $i = \frac{|\mathcal{E}|}{R} = 0.6 mA$ e) $P = i^2 R$

$= 0.14 \mu W$

d)



flux $\uparrow$ as rod moves ($\because$ Area $\uparrow$)

so induced $\bar{B}$ should be <u>into</u> page

$\hookrightarrow$ i is <u>c.w</u>

$$\vec{F} = \underbrace{i}_{\text{induced } i} d\bar{l} \times \bar{B}$$

$$\therefore \vec{F} = i \cdot \int_a^{a+L} d\bar{l} \left(\frac{\mu_0 I}{2\pi L}\right) \hat{x}$$

$$= \frac{i \mu_0 I}{2\pi} \ln\left(\frac{a+L}{a}\right)$$

$= 2.87 \times 10^{-8}$ N (apply in $-$ve $\hat{x}$)

e) $P = \bar{F} \cdot \bar{v} = 0.144 \mu W$

35. a) $|\mathcal{E}| = B \cdot L \cdot v = 0.6\ V$ (38)

b) flux ↑ so B_{ind} is ⊗ and i_{ind} is c.w

c) $i = \frac{\mathcal{E}}{R} = 1.5\ A$

d) c.w

e) $P = (i^2)R = 0.9W$

f) $F = I\, d\bar{l} \times \bar{B}$
$= \frac{|\mathcal{E}|}{R} L \cdot B = 0.18\ N$

g) $P = F \cdot v = 0.9W$

40. $L = \frac{N \Phi_B}{i}$

$8\,mH = \frac{(400)\,\Phi_B}{5\,mA}$

$\Phi_B = 0.1\ \mu Wb$

41. a) Area $= \pi r^2 = 0.03\ m^2$

flux through N turns is $N B \cdot A = 2.45 \times 10^{-3}$ wb

b) $L = \frac{N \Phi_B}{i}$ and $|N \Phi_B| = 2.45 \times 10^{-3}$ (to cancel original flux)

$= 0.65\ mH$

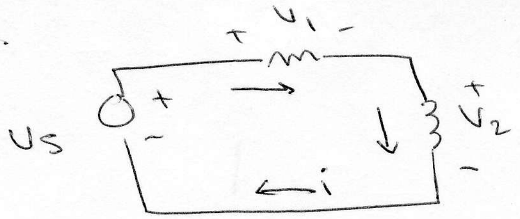
45. $\mathcal{E} = -L \frac{di}{dt}$ a) $\frac{di}{dt}$ is -ve, so $\mathcal{E}$ is +ve

(i.e i is ↓ so $\mathcal{E}$ opposes that decrease)

b) $|17| = L\,(25\ kA/s)$

$L = 0.68\ mH$

47.



KUL

$$-V_s + V_1 + V_2 = 0$$

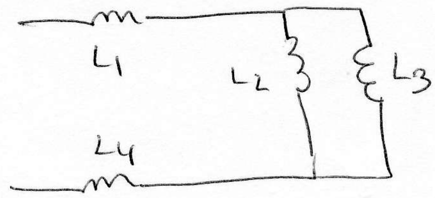
$$V_s = L_1 \frac{\partial i}{\partial t} + L_2 \frac{\partial i}{\partial t}$$

$$= (L_1 + L_2) \frac{\partial i}{\partial t}$$

$$= L_{eq} \frac{\partial i}{\partial t}$$

i.e $L_{eq} = L_1 + L_2 + \ldots + L_n$

49.



$$L_{eq} = L_1 + L_2 // L_3 + L_4$$

$$= L_1 + \left(\frac{1}{L_2} + \frac{1}{L_3}\right)^{-1} + L_4$$

Irwin

Chap 1

3. $i = \frac{dq}{dt} \rightarrow 30{,}000 = \frac{q}{50 \times 10^{-6}} \rightarrow q = 1.5\ C$

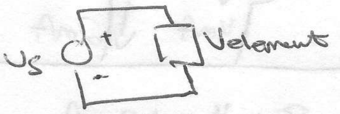
8. in time T, $i = \frac{q}{T}$ and energy $w = p \cdot T$

$\therefore \quad p = iv$

$\frac{w}{T} = \frac{q}{T} v$

$v = -24\ V$

–ve since have



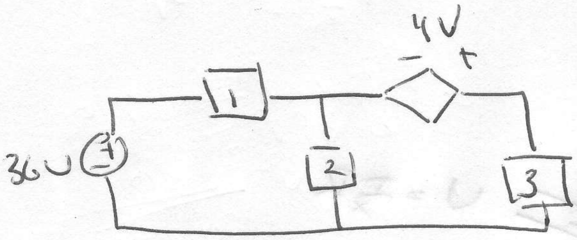
and $V_s + V_{elem} = 0$

26. $p = iv$

$i = \frac{72}{18}$

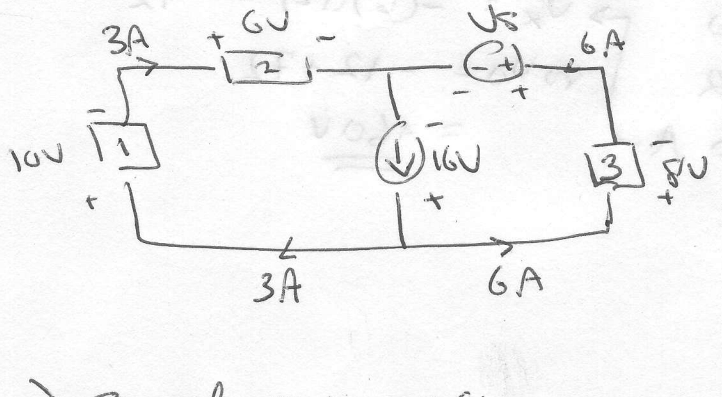
$= 4A$

33.



	Absorbed	Supplied
①	$p = iv = (4)(12)$	$P_{I_x} = -(I_x)(2A)$
②	$p = (2)(24)$	$P_{36V} = -(36)(4)$
③	$p = (2)(28)$	

42.



$P_1 = 30\ W$

$P_2 = 18\ W$

$P_3 = 48\ W$

$P_{9A} = (9)(-16) = -144$

and sum of power $= 0$

$P_1 + P_2 + P_3 + P_{9A} + P_{VS} = 0 \longrightarrow P_{VS} = 48\ W$ (supplied)

so $V_s = 48/6 = 8\ V$

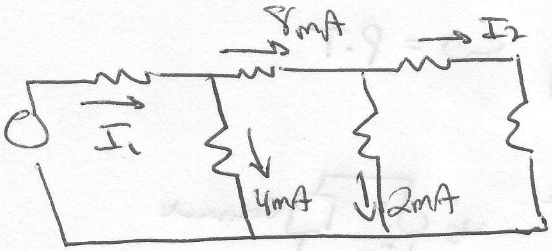
Chap 3

3. $V = IR = 24\,V$

$P = I^2 R = 48\,W$

7. $P = \dfrac{V^2}{R} = \dfrac{(2 \times 1.5)^2}{1} = 9\,W$

12



$I_1 = 8 + 4 = 12\,mA$

$8\,mA = I_2 + 2$

$I_2 = 6\,mA$

24. $V_{ad} = -3 - 2 + 12 = +7\,V$

25. $V_{fb} = 2 + 2 - 12 = -8\,V$

$V_{ec} = 1 + 2 + 2 - 12 + 1 = -6\,V$

32. $V_o = -12 - V_x$ and $V_x = \cancel{\dfrac{I_x}{12}}$ $\quad V = I_x R$

Sum of voltages in loop must be 0:

$-2I_x + 4I_x - 12 - V_x + V_x = 0$

$2I_x = 12$

$I_x = 6\,A$

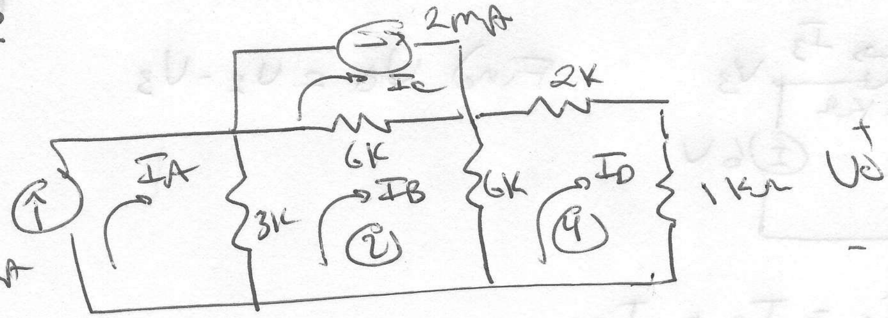
$V_x = -(6)(12) = -72$

so $V_o = -12 + 72$

$= \underline{+60\,V}$

Chap 3

6.



$V_o = (1K) I_D$

② KUL $\quad 3K(I_B - I_A) + 6K(I_B - I_C) + 6K(I_B - I_D) = 0$

and $\quad I_A = 12mA \quad , \quad I_C = 2mA$

$\therefore \quad 15K\, I_B - 6K I_D - 36 - 12 = 0$

④ KUL $\quad 6K(I_D - I_B) + 2K I_D + 1K I_D = 0$

↳ $I_B = \frac{3}{2} I_D$ sub in above

and $\quad 15K\left(\frac{3}{2} I_D\right) - 6K I_D = 48$

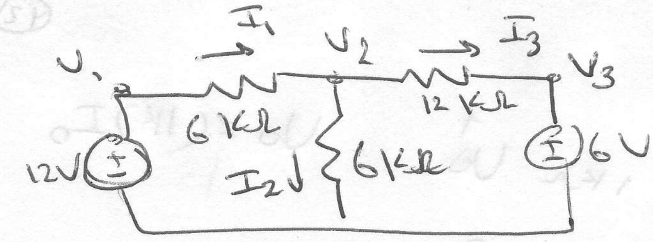
$I_D = 2.9\, mA \rightarrow I_B = 4.4\, mA$

↳ $V_o = (1K) I_D = \underline{\underline{2.9V}}$

then $\quad V_1 = 3K(I_A - I_B) = (3K)(12mA - 4.4mA)$

$= \underline{\underline{22.8V}}$

12



Find $V_o = V_2 - V_3$

at node V_2: $I_1 = I_2 + I_3$

$$\frac{V_1 - V_2}{6k\Omega} = I_2 + \frac{V_2 - V_3}{12k\Omega}$$

and $V_1 = 12V$
$V_3 = 6V$
$V_2 = 6k\,I_2$

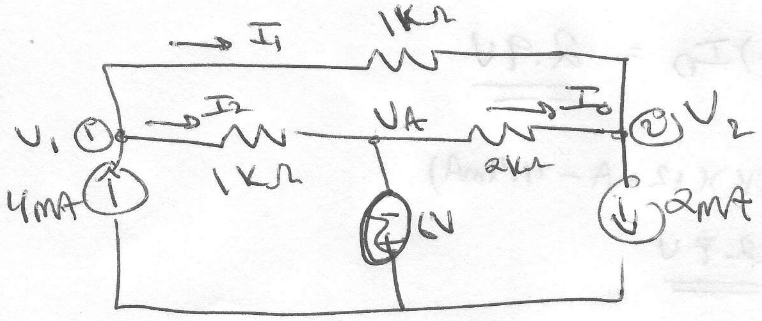
$$\frac{12}{6k} - \frac{V_2}{6k} = I_2 - \frac{6}{12k} + \frac{V_2}{12k}$$

$$2.5mA = 2.5 I_2$$

$$I_2 = 1mA \longrightarrow V_2 = 6V$$

and $V_o = V_2 - V_3 = \underline{0}$

15.



$V_A = -6V$

$$I_o = \frac{V_A - V_2}{2K}$$

$4mA = I_1 + I_2$

$= \frac{V_1 - V_A}{1K} + \frac{V_1 - V_2}{1K}$

$4 = 2V_1 + 6 - V_2$

$-2 = 2V_1 - V_2$ ①

$2mA = I_o + I_1$

$$2mA = \frac{V_A - V_2}{2K} + \frac{V_1 - V_2}{1K}$$

$4 = V_A - V_2 + 2V_1 - 2V_2$

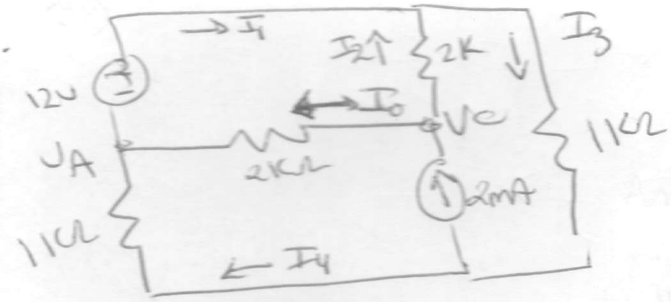
$10 = +2V_1 - 3V_2$ ②

② − ①: $+12 = -2V_2$

$V_2 = -6V \longrightarrow I_o = \frac{V_A - V_2}{2K}$

$= 0$

19.



① $2mA = I_o + I_2$

$$= \frac{V_C - V_A}{2K} + \frac{V_C - (V_A + 12)}{2K}$$

$$16 = 2V_C - 2V_A$$

② $I_1 = I_o + I_4$, $I_1 + I_2 = I_3$ $\}$ $I_3 - I_2 - I_o - I_4 = 0$

$$I_4 = \frac{-V_A}{1K}$$

$$\frac{V_A + 12}{1K} - \frac{V_C - (V_A + 12)}{2K} - \frac{(V_C - V_A)}{2K} + \frac{V_A}{1K} = 0$$

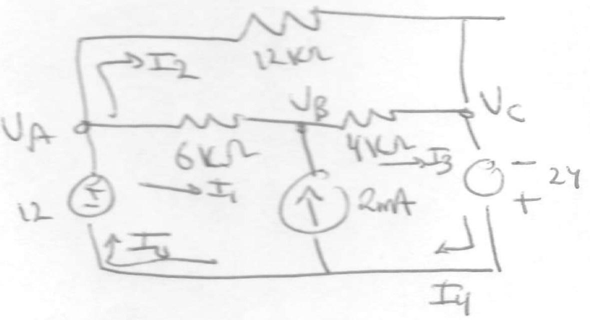
$$-36 = 6V_A - 2V_C$$

① + ② $-20 = 4V_A$

$V_A = -5 \longrightarrow V_C = +3$

$\hookrightarrow I_o = \dfrac{V_C - V_A}{2K} = 4mA$ (to left)

25.



$V_A = 12V$, $V_C = -24V$ $\}$ $I_2 = \dfrac{V_A - V_C}{12K} = -3mA$

① $I_o = I_1 + I_2$ ② $I_3 + I_2 = I_4$ ③ $I_4 = 2mA + I_o$

② = ③ $2mA + I_o = I_3 - 3mA$

$I_3 - I_o = 5mA$

① $I_1 - I_o = +3mA$

Subtract $I_3 - I_1 = 2mA$

$$I_3 = \frac{V_B - V_C}{4K} \qquad I_1 = \frac{V_A - V_B}{6K}$$

So, get $\frac{V_B + 24}{4K} - \frac{(12 - V_B)}{6K} = 2mA$

$$V_B = -\frac{24}{5} V$$