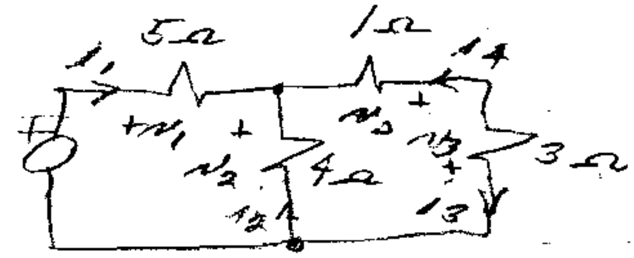
EE 332 Homework 1

1.8



a) $v_1 = 30V$ $\therefore$ $\boxed{i_1 = \frac{30}{5} = 6A}$ ←

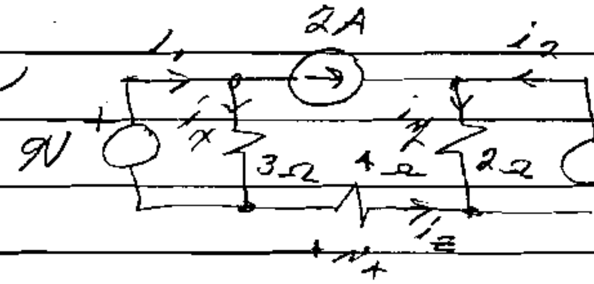
b) $v_2 = 12V$ $\therefore$ $\boxed{i_2 = -\frac{12}{4} = -3A}$ ←

c) $v_3 = -9V$ $\therefore$ $\boxed{i_3 = -\frac{-9}{3} = 3A}$ ←

d) $v_4 = -3V$ $\therefore$ $\boxed{i_4 = -3A}$

ES 332 Homework 2

1.18



a) $v_s = 2V$; $i_x = \frac{9}{3} = 3A$; $i_y = \frac{2}{2} = 1A$

$\therefore\ i_2 + 2 - i_y = 0$ or $i_2 = i_y - 2 = -1$

$i_z + i_y - i_x = 0$ or $i_z = i_2 - i_y = -2$ $\therefore\ \boxed{v_4 = -8}$

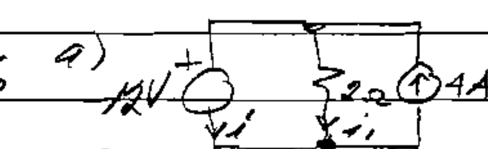
b) $v_s = 4V$; $i_y = 2A$, $i_x = 3A$

again $i_2 = i_y - 2 = 0$; $i_z = i_2 - i_y = -2A$; $\boxed{v_4 = i_z 4 = -}$

c) $v_s = 6V$; $i_x = 3A$, $i_y = 3A$

again $i_2 = i_y - 2 = 1A$; $i_z = i_2 - i_y = -2A$; $\boxed{\text{so } v_4 = -8}$

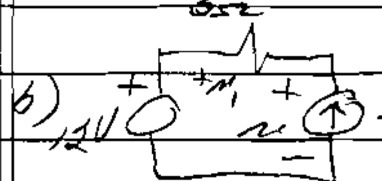
1.26 a)



$\boxed{i_1 = \frac{12}{2} = 6A}$

$i + i_1 - 4 = 0$ or $\boxed{i = 4 - 6 = -2A}$

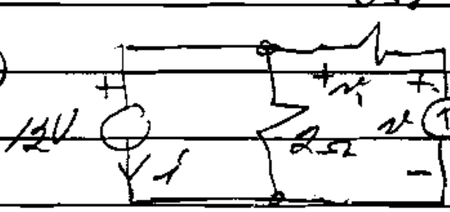
b)



$\boxed{v_1 = -(-4) \times 3 = 12V}$

$-12 + 12 + v = 0$ $\therefore\ \boxed{v = 0}$

c)

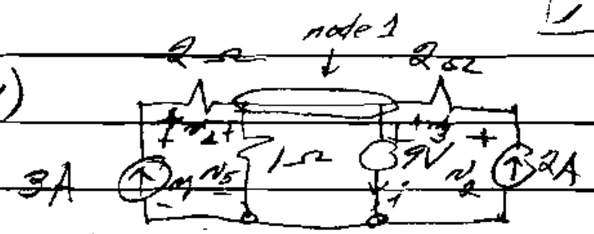


$\boxed{v_1 = -3 \times 8 = -24V}$

$-12 + v_1 + v = 0$ $\therefore\ \boxed{v = 36V}$

$\boxed{i = 8 - \frac{12}{2} = 2A}$

d)



$-9 + v_3 + v_2 = 0$ but $v_3 = -2 \times 2 = -4$

$\therefore\ \boxed{v_2 = 9 - v_3 = 13V}$

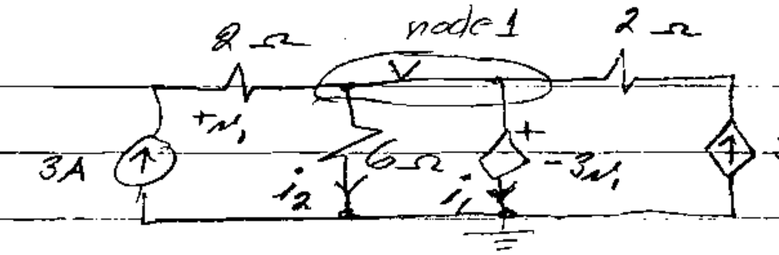
KCL @ node 1 $3 - 11 - i + 2 = 0$

$\boxed{i = -4A}$

$\begin{cases} v_4 = 2 \times 3 = 6V \\ v_5 = 11 \end{cases}$; $-v_1 + v_4 + v_3 + v_2 = 0$ $\therefore\ \boxed{v_1 = 15}$

ES 332 Homework 3

1.43 a) $K = -3$



$v_1 = 6V$ ∴ $-3v_1 = -18V$ so $i_2 = \frac{-3v_1}{6} = -3A$

KCL @ node 1 $\begin{cases} -3+i_2+i_1-3i_2=0 \\ -3-3+i_1-3(-3)=0 \end{cases}$

$\boxed{i_1 = -3A}$ ←

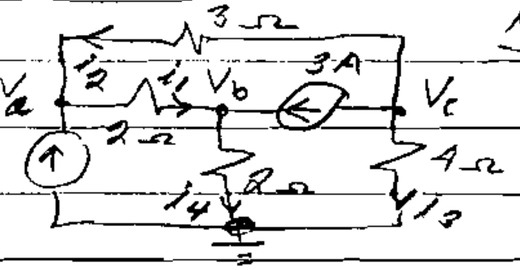
Node Voltage Solution

$-3+\frac{V}{6}+i_1-3i_2=0 \Rightarrow -3+\frac{V}{6}+i_1-3\frac{V}{6}=0$

so $i_1 = 3+V(\frac{1}{2}-\frac{1}{6}) = 3+(-3v_1)\frac{1}{3}$ but $v_1 = 6$

∴ $i_1 = 3-6 = -3A$ ←

2.1



Node Equations

$-1+\frac{V_a-V_b}{2}+\frac{V_a-V_c}{3}=0$

$\frac{V_b-V_a}{2}+\frac{V_b}{2}=3$

$\frac{V_c-V_a}{3}+\frac{V_c}{4}=-3$

or $V_a(\frac{5}{6})-\frac{1}{2}V_b-\frac{1}{3}V_c=1$

$-\frac{1}{2}V_a+V_b=3$

$-\frac{V_a}{3}+V_c(\frac{7}{12})=-3$

$\begin{cases} 5V_a-3V_b-2V_c=6 \\ -V_a+2V_b=6 \\ -4V_a+7V_c=-36 \end{cases}$

$$V_a = \frac{\begin{vmatrix} 6 & -3 & -2 \\ 6 & 2 & 0 \\ -36 & 0 & 7 \end{vmatrix}}{\begin{vmatrix} 5 & -3 & -2 \\ -1 & 2 & 0 \\ -4 & 0 & 7 \end{vmatrix}} = \frac{-36(4)+7(12+18)}{-4(4)+7(10-3)} = \frac{-144+210}{-16+49} = \frac{66}{33} = \boxed{2}$$

$$V_b = \frac{1}{33}\begin{vmatrix} 5 & 6 & -2 \\ -1 & 6 & 0 \\ -4 & -36 & 7 \end{vmatrix} = \frac{-2(36+24)+7(30+6)}{33} = \frac{-120+252}{33} = \boxed{4V}$$

$$V_c = \frac{1}{33}\begin{vmatrix} 5 & -3 & 6 \\ -1 & 2 & 6 \\ -4 & 0 & -36 \end{vmatrix} = \frac{-4(-18-12)-36(10-3)}{33} = \frac{120-252}{33} = \boxed{-4V}$$

ES. 332 Homework 3 (continued)

2.1

b) $i_1 = \frac{V_a - V_b}{2} = \boxed{-1A}$

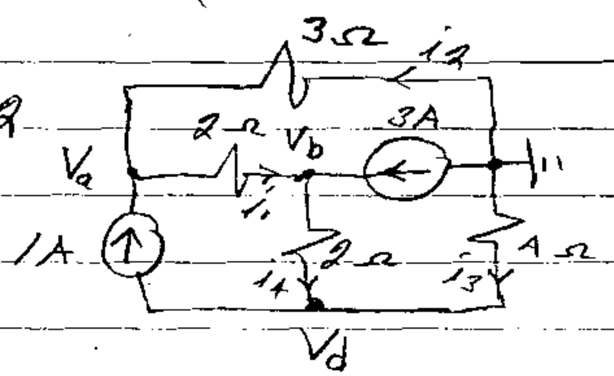
$i_2 = \frac{V_c - V_a}{3} = \frac{-6}{3} = \boxed{-2A}$

$i_3 = \frac{V_c}{4} = \boxed{-1A}$

$i_4 = \frac{V_b}{2} = \boxed{2A}$

ES 332 Homework 4

2.2



$$\frac{V_a}{3} + \frac{V_a - V_b}{2} = 1$$

$$\frac{V_b - V_a}{2} + \frac{V_b - V_d}{2} = 3$$

$$\frac{V_d - V_b}{2} + \frac{V_d}{4} = -1$$

or $V_a \frac{5}{6} - V_b \frac{1}{2} = 1$

$$-V_a \frac{1}{2} + V_b - \frac{V_d}{2} = 3$$

$$-V_b \frac{1}{2} + V_d \frac{3}{4} = -1$$

$$\left.\begin{aligned} 5V_a - 3V_b \quad &= 6 \\ -V_a + 2V_b - V_d &= 6 \\ -2V_b + 3V_d &= -4 \end{aligned}\right.$$

$$V_a = \frac{\begin{vmatrix} 6 & -3 & 0 \\ 6 & 2 & -1 \\ -4 & -2 & 3 \end{vmatrix}}{\begin{vmatrix} 5 & -3 & 0 \\ -1 & 2 & -1 \\ 0 & -2 & 3 \end{vmatrix}} = \frac{6(6-2)+3(18-4)}{5(6-2)+3(-3)} = \frac{66}{11} = \boxed{6V}$$

$$V_b = \frac{1}{11}\begin{vmatrix} 5 & 6 & 0 \\ -1 & 6 & -1 \\ 0 & -4 & 3 \end{vmatrix} = \frac{1}{11}\{5(18-4) - 6(-3)\} = \boxed{8V}$$

$$V_d = \frac{1}{11}\begin{vmatrix} 5 & -3 & 6 \\ -1 & 2 & 6 \\ 0 & -2 & -4 \end{vmatrix} = \frac{1}{11}\{5(-8+12) + 1(18+12)\} = \boxed{4V}$$

so: $i_1 = \frac{V_a - V_b}{2} = \boxed{-1A}$

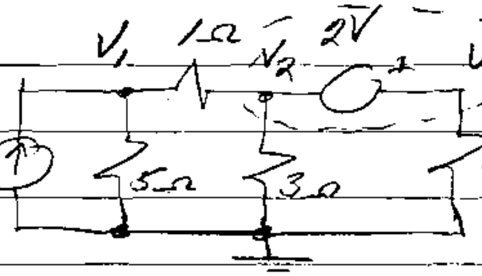
$$i_2 = -\frac{V_a}{3} = \boxed{-2A}$$

$$i_3 = -\frac{V_d}{4} = \boxed{-1A}$$

$$i_4 = \frac{V_b - V_d}{2} = \boxed{2A}$$

ES 332 Homework 4 (continued)

2.9



supernode

$V_3 - V_2 = 2$

$$\frac{V_1}{5} + \frac{V_1 - V_2}{1} = 6$$

$$\frac{V_2 - V_1}{1} + \frac{V_2}{3} + \frac{V_3}{4} = 0 \qquad = (V_2 + 2)$$

$$\frac{6}{5}V_1 - V_2 = 6$$

$$-V_1 + \underbrace{\left(\frac{4}{3} + \frac{1}{4}\right)}_{\frac{19}{12}} V_2 = -\frac{1}{2}$$

or
$$\begin{bmatrix} 6V_1 - 5V_2 = 30 \\ -12V_1 + 19V_2 = -6 \end{bmatrix}$$

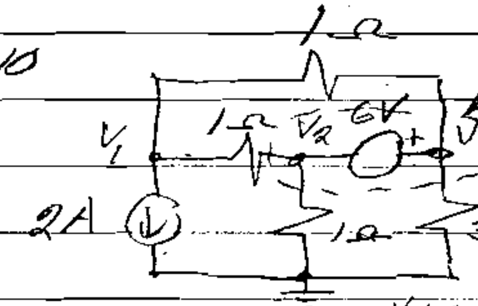
$$\therefore V_1 = \frac{\begin{vmatrix} 30 & -5 \\ -6 & 19 \end{vmatrix}}{\begin{vmatrix} 6 & -5 \\ -12 & 19 \end{vmatrix}} = \frac{540}{54} = \boxed{10V}$$

$$V_2 = \frac{\begin{vmatrix} 6 & 30 \\ -12 & -6 \end{vmatrix}}{54} = \frac{324}{54} \boxed{= 6V}$$

$$V_3 = V_2 + 2 = \boxed{8V}$$

ES 332 Homework 5

2.10



supernode $\Rightarrow V_3 - V_2 = 6$

$$\frac{V_1 - V_2}{1} + \frac{V_1 - V_3}{1} = -2$$

$$\frac{V_2 - V_1}{1} + \frac{V_2}{1} + \frac{V_3 - V_1}{1} + \frac{V_3}{3} = 0$$

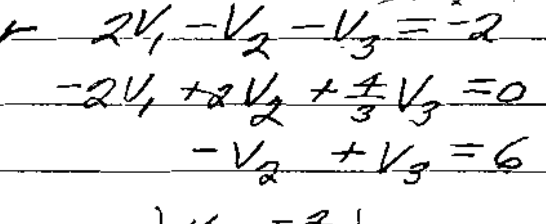
or
$$\left.\begin{aligned} 2V_1 - V_2 - \overset{\to V_2+6}{V_3} &= -2 \\ -2V_1 + 2V_2 + \tfrac{4}{3}V_3 &= 0 \\ -V_2 + V_3 &= 6 \end{aligned}\right\} \begin{aligned} 2V_1 - 2V_2 &= 4 \\ -2V_1 + \tfrac{10}{3}V_2 &= -8 \end{aligned}$$

$$V_1 = \frac{\begin{vmatrix} 4 & -2 \\ -8 & \frac{10}{3} \end{vmatrix}}{\begin{vmatrix} 2 & -2 \\ -2 & \frac{10}{3} \end{vmatrix}} = \frac{\frac{40}{3} - 16}{\frac{20}{3} - 4} = \frac{40-48}{20-12} = \frac{-8}{8} = \boxed{-1\,V}$$

$$V_2 = \frac{\begin{vmatrix} 2 & 4 \\ -2 & -8 \end{vmatrix}}{\frac{8}{3}} = \frac{-16+8}{\frac{8}{3}} = \boxed{-3\,V}$$

$$V_3 = V_2 + 6 = \boxed{3\,V}$$

2.19



$$5I_1 + 4(I_1 - I_2) = 28$$

$$4(I_2 - I_1) + 4I_2 = 0$$

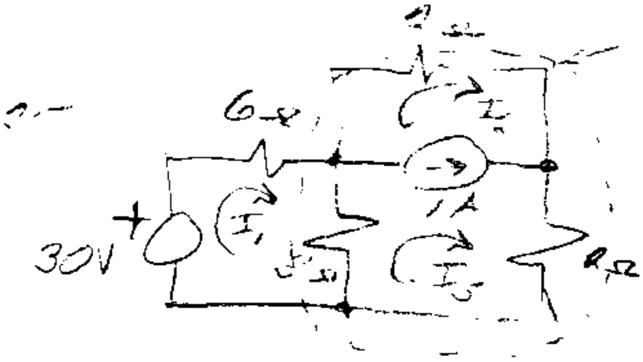
or
$$\left\{\begin{aligned} 9I_1 - 4I_2 &= 28 \\ -4I_1 + 8I_2 &= 0 \end{aligned}\right\}$$

$$I_1 = \frac{\begin{vmatrix} 28 & -4 \\ 0 & 8 \end{vmatrix}}{\begin{vmatrix} 9 & -4 \\ -4 & 8 \end{vmatrix}} = \frac{224}{72-16} = \frac{224}{56} = \boxed{4A}$$

$$I_2 = \frac{\begin{vmatrix} 9 & 28 \\ -4 & 0 \end{vmatrix}}{56} = \frac{4 \times 28}{56} = \boxed{2A}$$

EE 332   Homework 6

2.7



supermesh $\Rightarrow I_3 - I_2 = 1$

$6I_1 + 3(I_1 - I_3) = 30$

$3(I_3 - I_1) + 2I_2 + 2I_3 = 0$

$\rightarrow 1 + I_2$

or
$$9I_1 - 3I_3 = 30$$
$$-3I_1 + 2I_2 + 5I_3 = 0$$
$$-I_2 + I_3 = 1$$

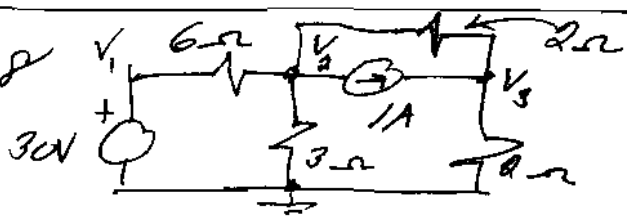
$$9I_1 - 3I_2 = 33$$
$$-3I_1 + 7I_2 = -5$$

$$I_1 = \frac{\begin{vmatrix} 33 & -3 \\ -5 & 7 \end{vmatrix}}{\begin{vmatrix} 9 & -3 \\ -3 & 7 \end{vmatrix}} = \frac{231 - 15}{63 - 9} = \frac{216}{54} = \boxed{4A}$$

$$I_2 = \frac{\begin{vmatrix} 9 & 33 \\ -3 & -5 \end{vmatrix}}{54} = \frac{-45 + 99}{54} = \boxed{1A}$$

$$I_3 = 1 + I_2 = \boxed{2A}$$

2.8



$\boxed{V_1 = 30}$

$$\frac{V_2 - 30}{6} + \frac{V_2}{3} + \frac{V_2 - V_3}{2} + 1 = 0$$

$$\frac{V_3 - V_2}{2} + \frac{V_3}{2} = 1$$

or $2V_2 - V_3 = 8$; $-V_2 + 2V_3 = 2$

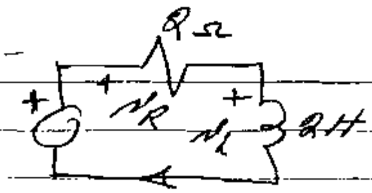
~~$4V_2 - 2V_3 = 16$~~

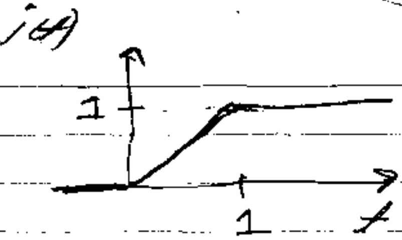
$$V_2 = \frac{\begin{vmatrix} 8 & -1 \\ 2 & 2 \end{vmatrix}}{\begin{vmatrix} 2 & -1 \\ -1 & 2 \end{vmatrix}} = \frac{16 + 2}{4 - 1} = \frac{18}{3} = \boxed{6\,V}$$

$$V_3 = \frac{\begin{vmatrix} 2 & 8 \\ -1 & 2 \end{vmatrix}}{3} = \frac{4 + 8}{3} = \frac{12}{3} = \boxed{4V}$$

ES 332 Homework 6 12 total

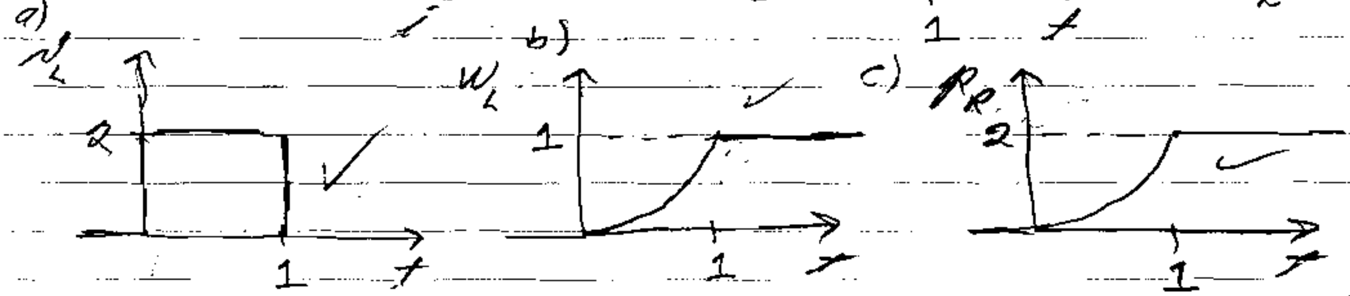
3.1

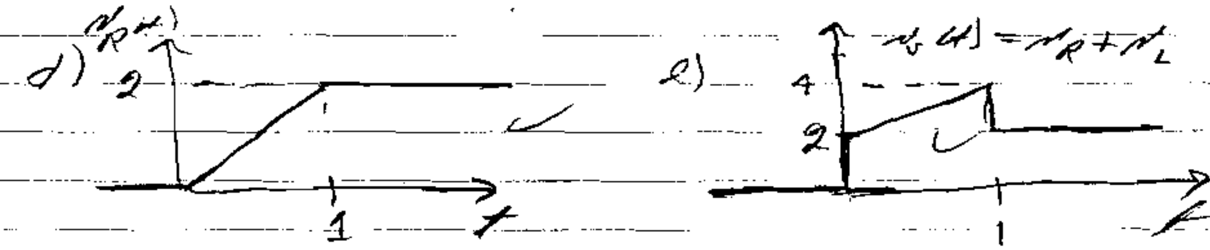




$v_L = L\frac{di}{dt}$

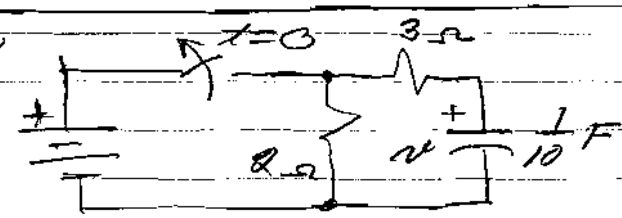
$w_L = \frac{1}{2}L i^2$





3

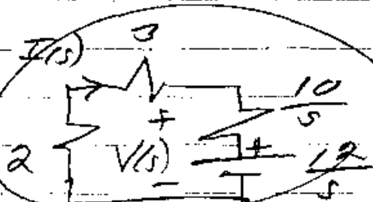
3.28



$\boxed{v(0) = 12V}$

7

s domain circuit for $t > 0$ ⇒

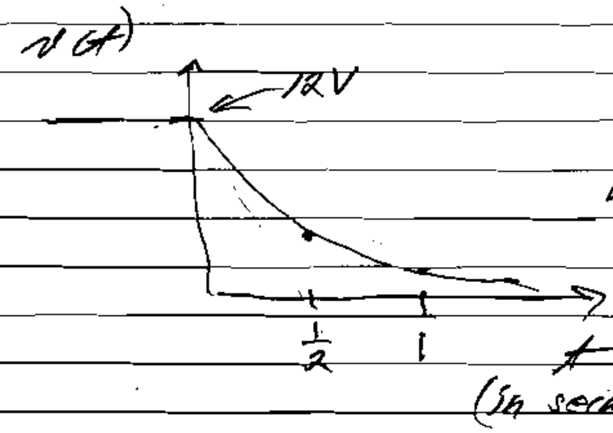


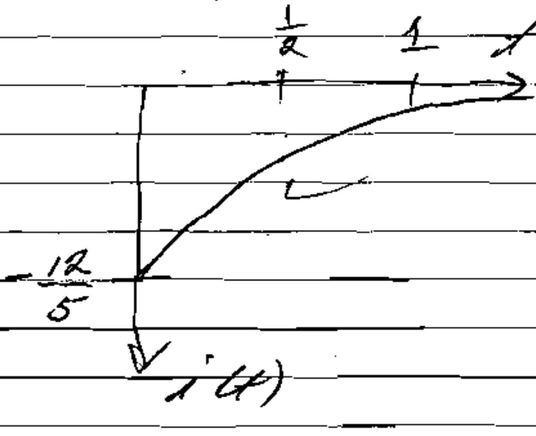
2

$$I(s)\left[5 + \frac{10}{s}\right] = -\frac{12}{s} \;;\; I(s) = -\frac{12/s}{\frac{5s+10}{s}} = -\frac{12}{5}\cdot\frac{1}{s+2}$$

$$\therefore\; i(t) = -\frac{12}{5}e^{-2t}u(t)$$

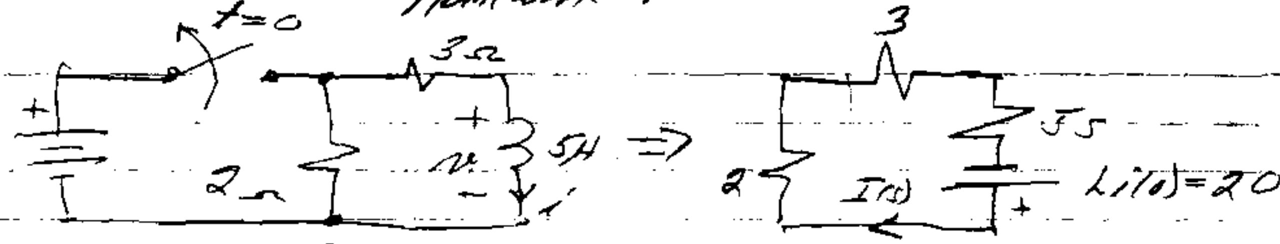
$$v(t) = \boxed{-5\,i(t)} = 12e^{-2t}u(t)$$





ES 332 Homework 7

3.29

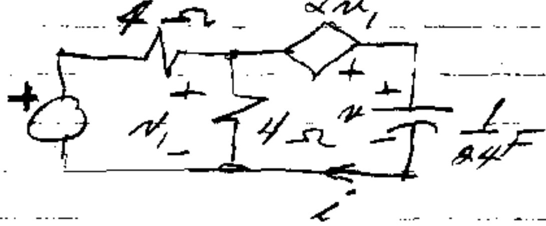


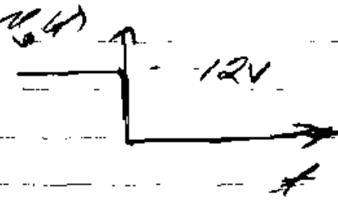
$i(0) = \frac{12}{3} = 4A$

$\therefore\ I(s)[5+5s] = 20$ or $\boxed{I(s) = \frac{4}{s+1};\ i(t) = 4e^{-t}u(t)}$

$V(s) = I(s) \times 5s - 20 = \frac{20s}{s+1} - 20 = -\frac{20}{s+1}$; $\boxed{v(t) = -20e^{-t}u(t)}$

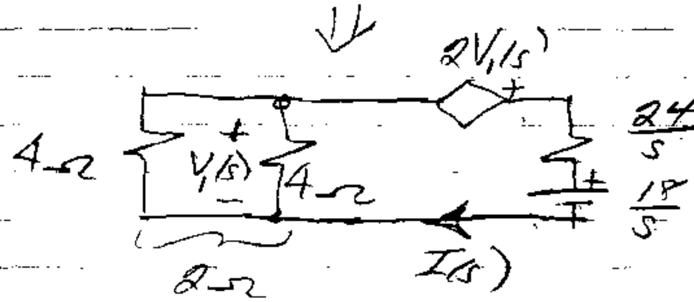
3.34





for $t<0$
$v_1 = 6V$

$\boxed{\text{so } v(0) = 3v_1(0) = 18V}$



$2I(s) - 2V_1 + \frac{24}{s}I + \frac{18}{s} = 0$

$I(s)\left\{2 + \frac{24}{s}\right\} = 2V_1 - \frac{18}{s}$

but $V_1 = -2I(s)$

$\therefore\ I(s)\left\{2 + \frac{24}{s} + 4\right\} = -\frac{18}{s}$; $I(s) = \frac{-\frac{18}{s}}{6+\frac{24}{s}} = \frac{-18}{6s+24} = \frac{-3}{s+4}$

so $\boxed{i(t) = -3e^{-4t}u(t)}$

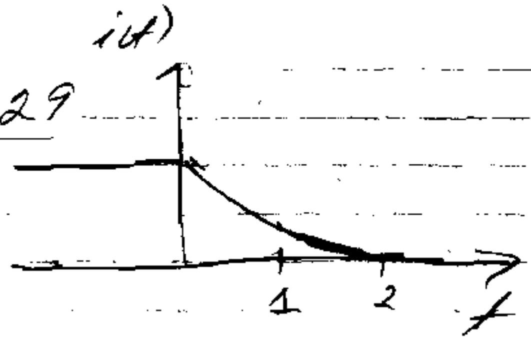
$V(s) = I(s) \times \frac{24}{s} + \frac{18}{s} = \frac{-72}{s(s+4)} + \frac{18}{s} = \cancel{-\frac{18}{s}} + \frac{18}{s+4} + \cancel{\frac{18}{s}}$

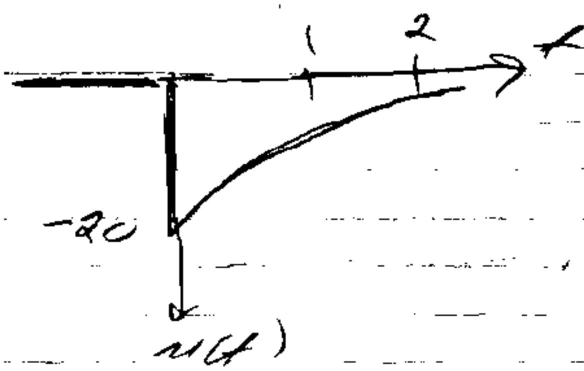
$v(t) = 18e^{-4t}u(t)$

{ sketches on next page !? }

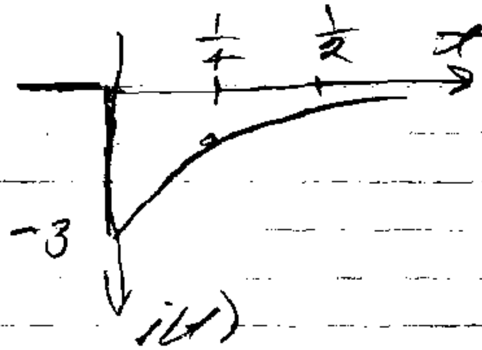
ES 332 Homework 7 (page 2)

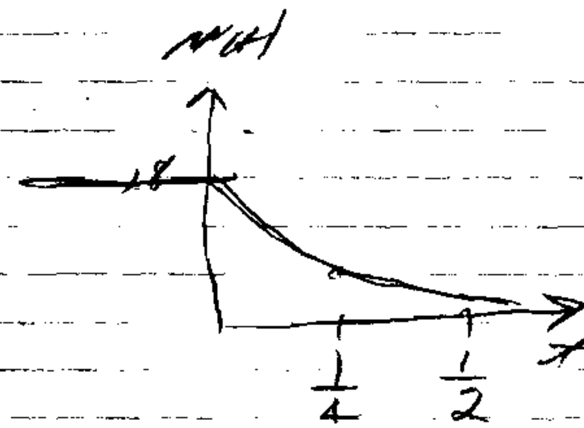
3.29





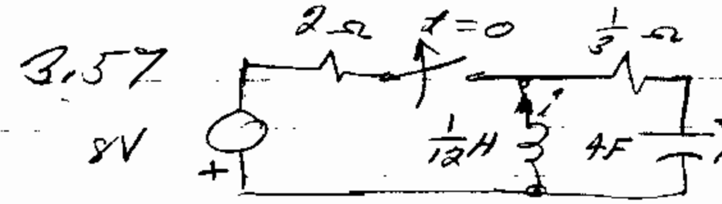
3.34



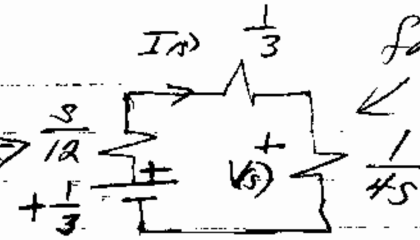


ES 332 Homework 8

3.57



$\Rightarrow$



for $t>0$

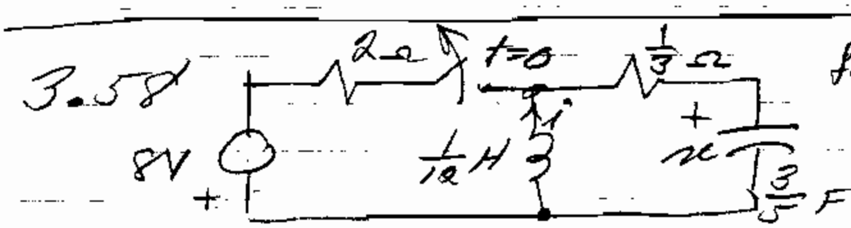
$$\boxed{i(0) = +\frac{8}{2} = +4A \ ; \ v(0) = 0}$$

$$I(s)\left[\frac{s}{12} + \frac{1}{3} + \frac{1}{4s}\right] - \frac{1}{3} = 0 \ ; \ I(s) = \frac{4s}{s^2 + 4s + 3} = \frac{4s}{(s+1)(s+3)}$$

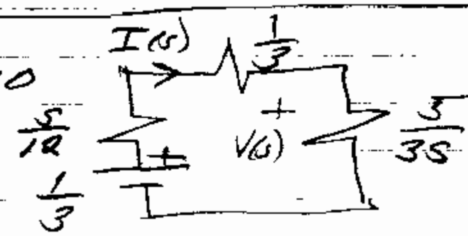
$$I(s) = \frac{-2}{s+1} + \frac{+6}{s+3} \ ; \ i(t) = \left[-2e^{-t} + 6e^{-3t}\right]u(t)$$

$$V(s) = I(s)\frac{1}{4s} = \frac{1}{(s+1)(s+3)} = \frac{\frac{1}{2}}{s+1} + \frac{-\frac{1}{2}}{s+3} \ ; \ v(t) = \frac{1}{2}\left[e^{-t} - e^{-3t}\right]u(t)$$

3.58



for $t>0$ $\Rightarrow$



$$\boxed{i(0) = 4A \ ; \ v(0) = 0}$$

$$I(s) = \frac{\frac{1}{3}}{\frac{s}{12} + \frac{1}{3} + \frac{5}{3s}} = \frac{4s}{s^2 + 4s + 20} = \frac{4(s+2) - 8}{(s+2)^2 + 16}$$

and $i(t) = \left[4e^{-2t}\cos 4t - 2e^{-2t}\sin 4t\right]$

$$V(s) = I(s) \times \frac{5}{3s} = \frac{20}{3} \cdot \frac{1}{s^2 + 4s + 20} = \frac{20}{3} \cdot \frac{1}{(s+2)^2 + 16}$$

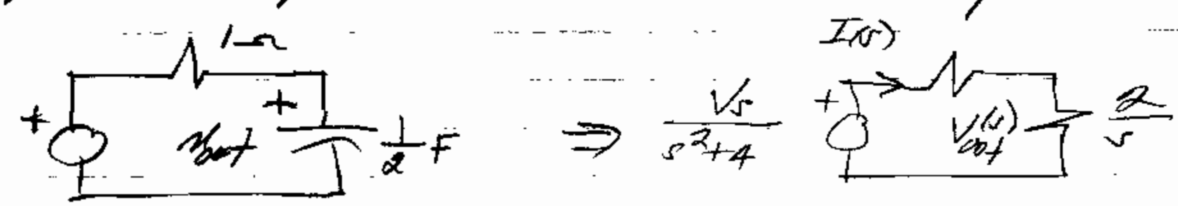
$$v(t) = \left[\frac{\cancel{20}^{5}}{3 \times \cancel{4}} e^{-2t} \sin 4t\right]u(t)$$

$$v(t) = \left[\frac{5}{3} e^{-2t} \sin 4t\right]u(t)$$

ES 332 Homework 9

Special problem

$V\cos 2t$



zero state

$$\frac{Vs}{s^2+4} = I(s)\left[1 + \frac{2}{s}\right] \quad \therefore \quad I(s) = \frac{\frac{Vs}{s^2+4}}{\frac{s+2}{s}} = \frac{Vs^2}{(s+2)(s^2+4)}$$

$$I(s) = \frac{K_1}{s+2} + \frac{K_2 s + K_3}{s^2+4} \quad ; \quad K_1 = \frac{4V}{8} = \frac{V}{2}$$

so $Vs^2 = \frac{V}{2}(s^2+4) + (K_2 s + K_3)(s+2)$

s^2 terms $\quad V = \frac{V}{2} + K_2 \quad$ or $\quad K_2 = \frac{V}{2}$

s terms $\quad 0 = 2K_2 + K_3 \quad$ or $\quad K_3 = -2K_2 = -V$

$$I(s) = \frac{V/2}{s+2} + \frac{V/2 \times s - V}{s^2+4}$$

$$\boxed{i(t) = \left[\frac{V}{2}e^{-2t} + \frac{V}{2}\cos 2t - \frac{V}{2}\sin 2t\right]u(t)} \leftarrow$$

$$V_{out}(s) = I(s)\frac{2}{s} = \frac{2sV}{(s+2)(s^2+4)} = \frac{A}{s+2} + \frac{Bs + C}{s^2+4}$$

$$A = \frac{-4V}{8} = -\frac{V}{2}$$

$$2sV = -\frac{V}{2}(s^2+4) + (Bs + C)(s+2)$$

s^2 terms $\quad 0 = -\frac{V}{2} + B \quad \therefore \quad B = \frac{V}{2}$

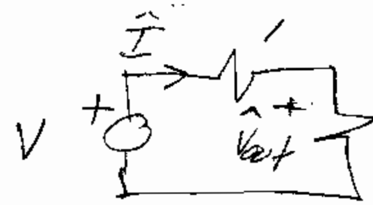
s terms $\quad 2V = C + 2B = C + V \quad \therefore \quad C = V$

and $V_{out}(s) = \frac{-V/2}{s+2} + \frac{V/2\, s + V}{s^2+4}$

$$\boxed{v_{out}(t) = \left[-\frac{V}{2}e^{-2t} + \frac{V}{2}\cos 2t + \frac{V}{2}\sin 2t\right]u(t)} \leftarrow$$

Homework 7

Sinusoidal steady state solution to special prob.



$\frac{2}{j2} = -j$

$$\hat{I} = \frac{V}{1-j} = \frac{V}{\sqrt{2}} e^{j45^\circ}$$

$$i(t) = Re\{\hat{I} e^{j2t}\} = \frac{V}{\sqrt{2}} \cos(2t+45^\circ)$$

$$\hat{V}_{out} = -j\hat{I} = e^{-j90^\circ} \frac{V}{\sqrt{2}} e^{j45^\circ}$$

so $v_{out}(t) = \frac{V}{\sqrt{2}} \cos(2t-45^\circ)$

ES 332 Homework 10 (8 total)

5.1110 $H(s) = \frac{s}{s+2}$

a) $x(t) = u(t)$ ∴ $X(s) = \frac{1}{s}$ and $Y(s) = \frac{1}{s+2}$

so $y(t) = \boxed{e^{-2t} u(t)}$

b) $x(t) = e^{-t} u(t)$; $X(s) = \frac{1}{s+1}$ and $Y(s) = \frac{s}{(s+1)(s+2)}$

so $Y(s) = \frac{-1}{s+1} + \frac{2}{s+2}$ and $\boxed{y(t) = [-e^{-t} + 2e^{-2t}] u(t)}$

c) $x(t) = (1 - e^{-t}) u(t)$; $X(s) = \frac{1}{s} - \frac{1}{s+1}$

$Y(s) = \frac{s}{s+2}\left[\frac{1}{s} - \frac{1}{s+1}\right] = \frac{1}{s+2} + \frac{1}{s+1} - \frac{2}{s+2}$

or $Y(s) = \frac{-1}{s+2} + \frac{1}{s+1}$

$\boxed{\text{and } y(t) = [e^{-t} - e^{-2t}] u(t)}$

d) $x(t) = e^{-2t} u(t)$; $X(s) = \frac{1}{s+2}$

so $Y(s) = \frac{s}{(s+2)^2} = \frac{K_1}{s+2} + \frac{K_2}{(s+2)^2}$

$K_2 = -2$

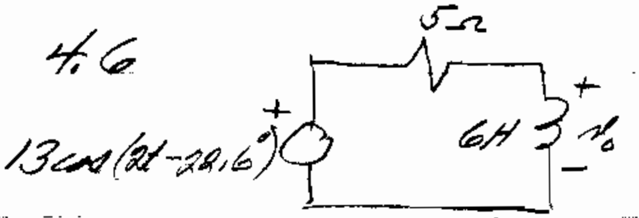
so $s = K_1(s+2) - 2$; $1 = K_1$

$Y(s) = \frac{1}{s+2} - \frac{2}{(s+2)^2}$

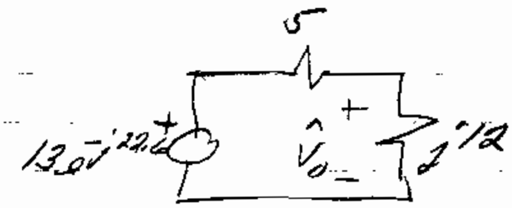
$\boxed{y(t) = [e^{-2t} - 2t\, e^{-2t}] u(t)}$

Homework 11

4.6

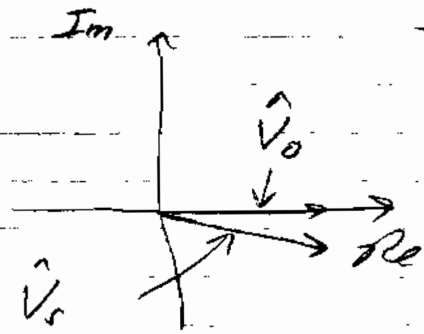


$\Rightarrow$



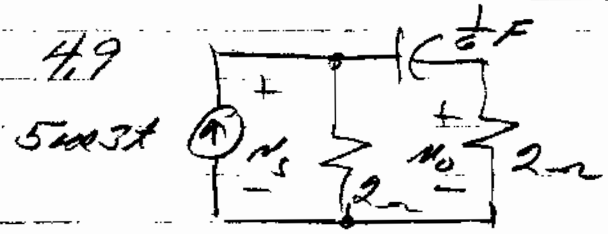
$$\hat{V}_o = \frac{13e^{-j22.6°}\times j12}{5+j12} = \frac{12\times 13\, e^{j67.4}}{13e^{j67.4}} = 12$$

so $\boxed{v_o(t) = 12\cos(2t)}$

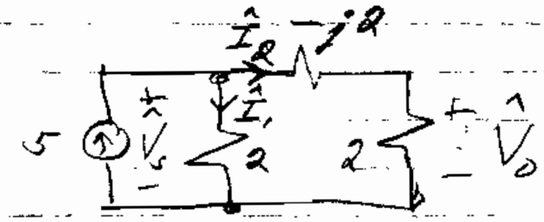


$\boxed{\hat{V}_o \text{ leads } \hat{V}_s}$

4.9



$\Rightarrow$



$$\hat{V}_s = \hat{I}_1\times 2 = 2\times 5\times\frac{2-j2}{4-j2} = 10\times\frac{2.828e^{-j45°}}{4.472e^{-j26.56°}} = 6.32e^{-j18.44}$$

$$\hat{V}_o = \hat{I}_2\times 2 = 2\times 5\times\frac{2}{4-j2} = \frac{20}{4.472e^{-j26.56°}} = 4.47e^{j26.56}$$

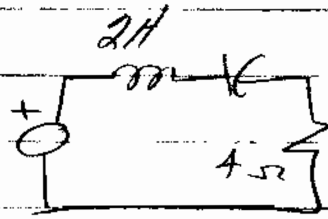
so $v_s(t) = 6.32\cos(3t-18.44°)$

$v_o(t) = 4.47\cos(3t+26.56°)$

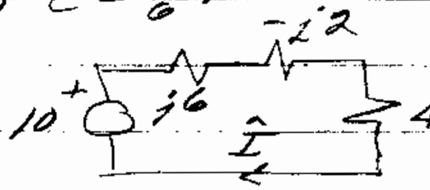
ES 332 Homework 12

4.28

$10\cos 3t$



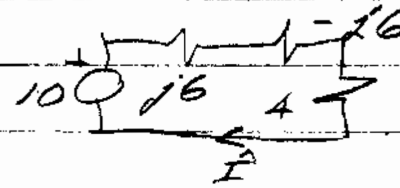
a) $C = \frac{1}{6}F$



$\hat{I} = \frac{10}{4+j4}$

$P_{ave_{4\Omega}} = \frac{1}{2}Re\left\{\frac{40}{4+j4}\times\frac{10}{4-j4}\right\} = \frac{200}{32} = \boxed{6.25 \text{ Watts}}$

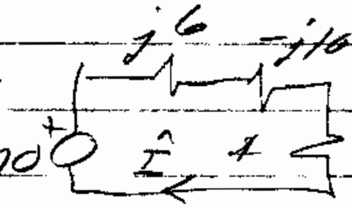
b) $C = \frac{1}{18}$



$\hat{I} = \frac{10}{4} = \frac{5}{2}$

$\boxed{P_{ave_{4\Omega}} = \frac{1}{2}\left(\frac{5}{2}\right)^2\times 4 = \frac{25}{2}W}$

c) $C = \frac{1}{30}F$

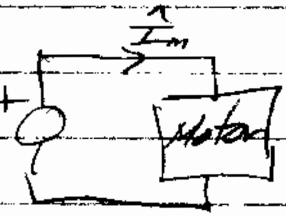


$\hat{I} = \frac{10}{4-j4}$

$\therefore \boxed{P_{ave_{4\Omega}} = 6.25W}$

4.44

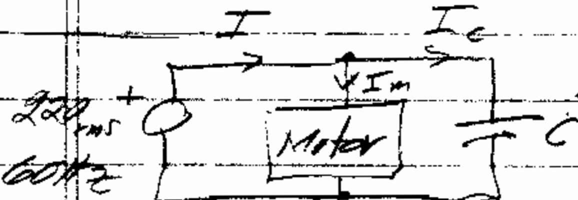
60Hz, 220_{rms}



$|\hat{I}| = 20_{rms}$, $pf = 0.75$ lagging $\Big\}\ \hat{I} = 20e^{-j41.41°}$

$P_{ave} = V_{rms}I_{rms}\times 0.75 = \boxed{3{,}300 \text{ Watts}}$

from above $\hat{I}_m = 20e^{-j41.41°} = 15 - j13.2288$



$\therefore$ for $pf = 1$

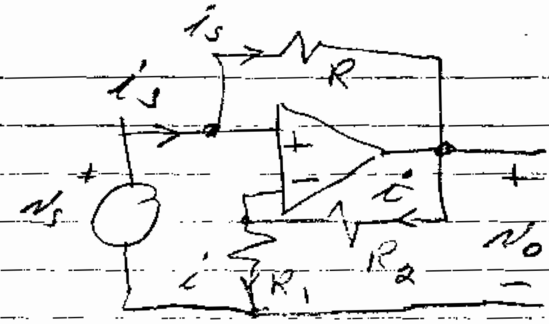
$\hat{I}_c = +j13.2288 = j220\times 2\pi\times 60\, C$

or $C = \frac{13.2288}{2\pi\times 60\times 220} = \boxed{1.59\times 10^{-4} F}$

ES 332 Homework 13

2.30

4



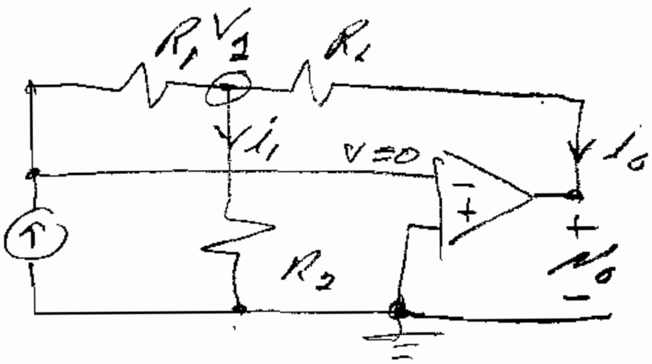
$i = \frac{v_s}{R_1}$; $v_o = i(R_1+R_2) = v_s\left(1+\frac{R_2}{R_1}\right)$ } 2

$i_s = \frac{v_s - v_o}{R} = \frac{v_s}{R} - \frac{v_s}{R}\left(1+\frac{R_2}{R_1}\right) = v_s\left(\cancel{\frac{1}{R}} - \cancel{\frac{1}{R}} - \frac{R_2}{RR_1}\right)$

or $\frac{v_s}{i_s} = -R\left(\frac{R_1}{R_2}\right)$ } 2

ES 332 Homework 14

2.28



$$V_1 = -i_s R_1 \quad (1)$$

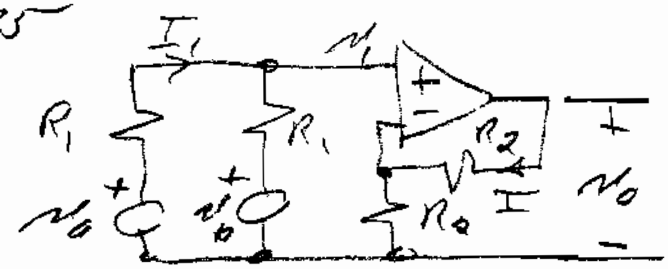
@ node 1 $\quad \frac{V_1}{R_2} + \frac{V_1 - v_o}{R_L} + \frac{V_1}{R_1} = 0 \qquad (2)$

combining (1) and (2) $\quad -i_s R_1 \left[\frac{1}{R_2} + \frac{1}{R_L} + \frac{1}{R_1}\right] = \frac{v_o}{R_L}$

$$\therefore \; v_o = -i_s \left[\frac{R_L R_1}{R_2} + R_1 + R_L\right] \longleftarrow$$

$$i_o = \frac{V_1 - v_o}{R_L} = \frac{-\cancel{i_s R_1}}{\cancel{R_L}} + i_s\left[\frac{R_1}{R_2} + \cancel{\frac{R_1}{R_L}} + 1\right] = i_s\left[1 + \frac{R_1}{R_2}\right] \longleftarrow$$

2.35



$$\left\{ \begin{array}{l} I = \frac{v_o}{2R_2} \\ v_1 = I R_2 = \frac{v_o}{2} \end{array} \right\}$$

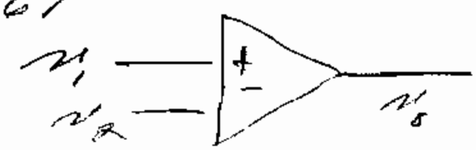
$-v_a + I_1 R_1 + I_1 R_1 + v_b = 0 \qquad$ so $\; I_1 = \frac{v_a - v_b}{2R_1}$

$$v_1 = I_1 R_1 + v_b = \frac{v_a - v_b}{2} + v_b = \frac{v_a + v_b}{2}$$

$$\text{so } \boxed{v_o = 2v_1 = v_a + v_b} \longleftarrow$$

ES 352 Homework 15

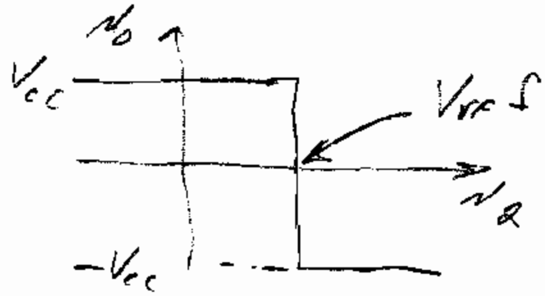
10.67



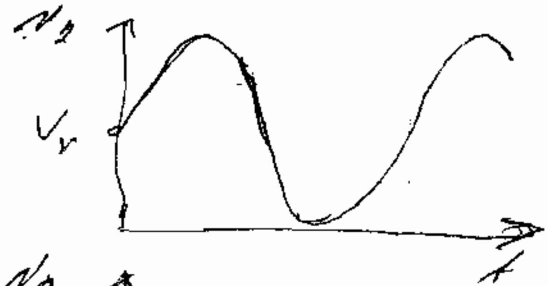
$v_1 = V_{ref} > 0$

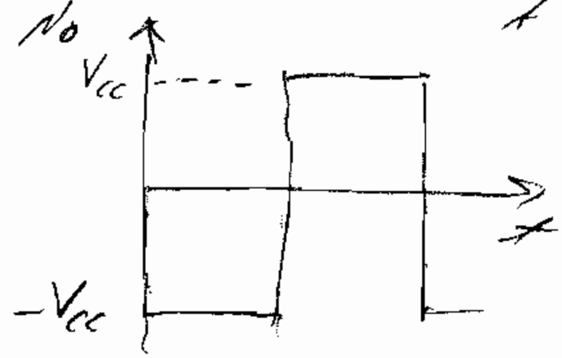
$v_2 = \text{input}$

a)



b) $v_2 = V_r + V_r \sin\omega t$

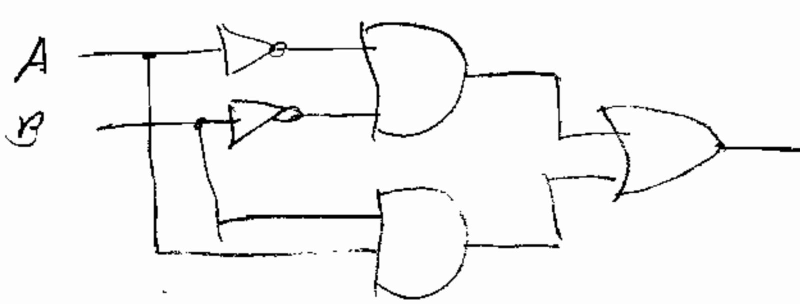




11.26

A	B	$A \odot B$
0	0	1
0	1	0
1	0	0
1	1	1

$= \bar{A}\cdot\bar{B} + AB$



$A \odot B = \overline{A \oplus B}$

ES-332 Homework 16

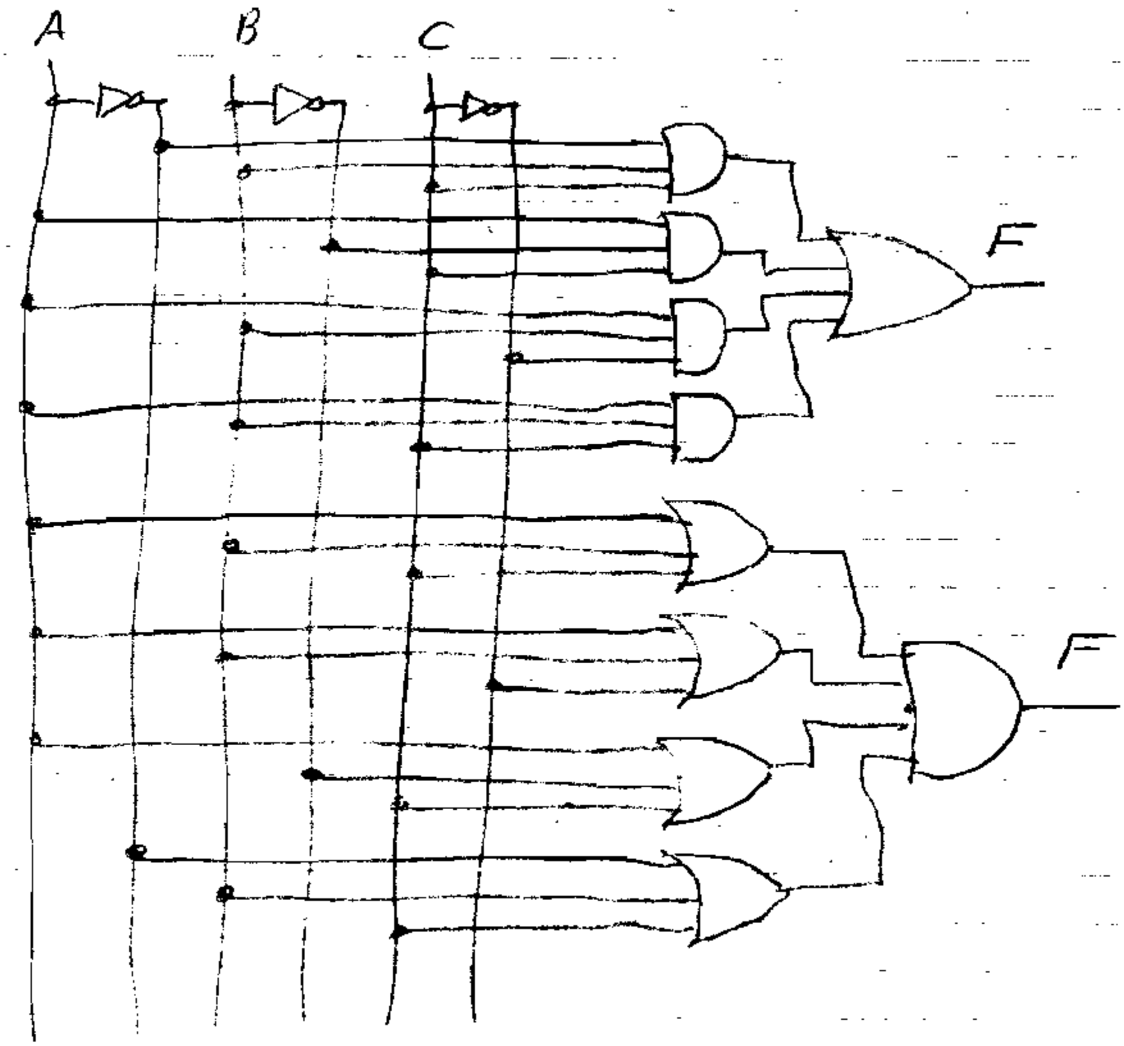
11.44

A	B	C	F	
0	0	0	0	m_0
0	0	1	0	m_1
0	1	0	0	m_2
0	1	1	1	m_3
1	0	0	0	m_4
1	0	1	1	m_5
1	1	0	1	m_6
1	1	1	1	m_7

(Majority Logic)

$F = m_3 + m_5 + m_6 + m_7 = \bar{A}BC + A\bar{B}C + AB\bar{C} + ABC$

$F = M_0 \cdot M_1 \cdot M_2 \cdot M_4 = (A+B+C)\cdot(A+B+\bar{C})(A+\bar{B}+C)(\bar{A}+B+C)$



11.53 a)

A \ BC	00	01	11	10
0	0	1	1	1
1	1	1	0	0

$$\boxed{F = A\bar{B} + \bar{B}C + \bar{A}B}$$

b)

A \ BC	00	01	11	10
0	0	0	0	1
1	1	0	1	1

$$\boxed{F = A\bar{C} + AB + B\bar{C}}$$

c)

A \ BC	00	01	11	10
0	1	1	1	1
1	0	1	0	1

$$\boxed{F = \bar{A} + \bar{B}C + B\bar{C}}$$

ES 332 — Homework 17

11.57 a)

AB \ CD	00	01	11	10
00	0	0	0	0
01	1	1	1	1
11	0	1	1	1
10	0	0	0	1

$F = \bar{A}B + BD + AC\bar{D}$

b)

AB \ CD	00	01	11	10
00	0	1	1	1
01	0	0	0	1
11	0	1	0	1
10	0	1	1	1

$F = \bar{B}D + C\bar{D} + A\bar{C}D$

c)

AB \ CD	00	01	11	10
00	1	0	1	0
01	0	0	1	1
11	0	1	0	1
10	1	0	0	1

$F = \bar{B}\bar{C}\bar{D} + AB\bar{C}D + \bar{A}CD + BC\bar{D}$

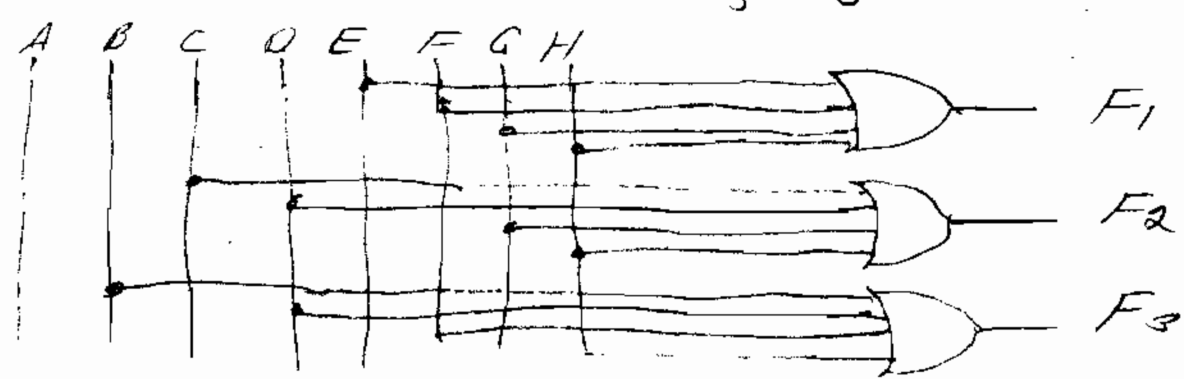
$+ AC\bar{D}$

(or other combinations

12.14

A	B	C	D	E	F	G	H	F_1	F_2	F_3
1	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	1
0	0	1	0	0	0	0	0	0	1	0
0	0	0	1	0	0	0	0	0	1	1
0	0	0	0	1	0	0	0	1	0	0
0	0	0	0	0	1	0	0	1	0	1
0	0	0	0	0	0	1	0	1	1	0
0	0	0	0	0	0	0	1	1	1	1

$F_1 = E + F + G + H$, $F_2 = C + D + G + H$; $F_3 = B + D + F + H$



ES 332 Homework 18

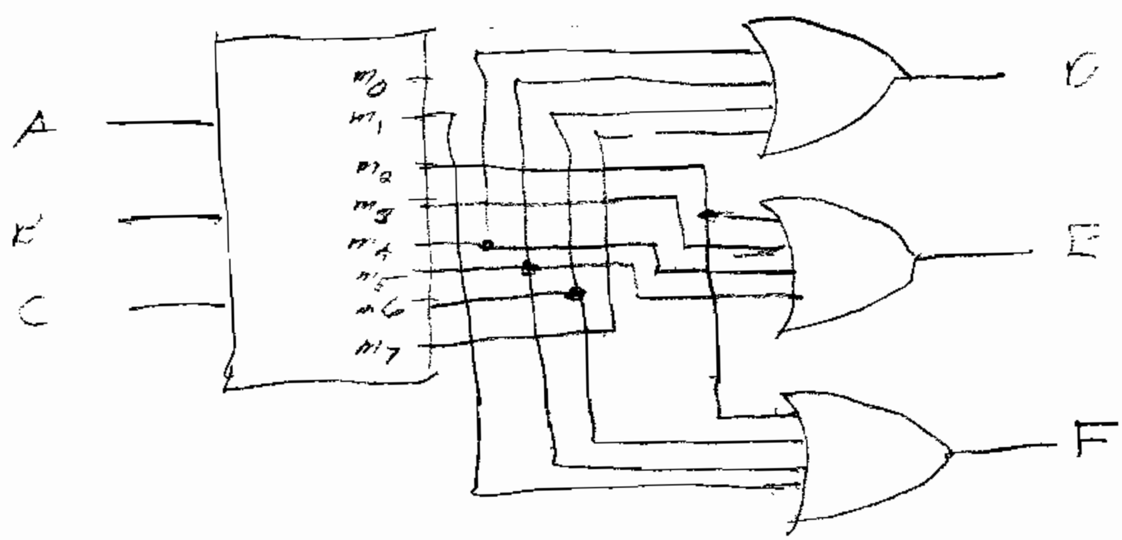
18.17

A	B	C	D	E	F
0	0	0	0	0	0
0	0	1	0	0	1
0	1	0	0	1	1
0	1	1	0	1	0
1	0	0	1	1	0
1	0	1	1	1	1
1	1	0	1	0	1
1	1	1	1	0	0

$D = m_4 + m_5 + m_6 + m_7$

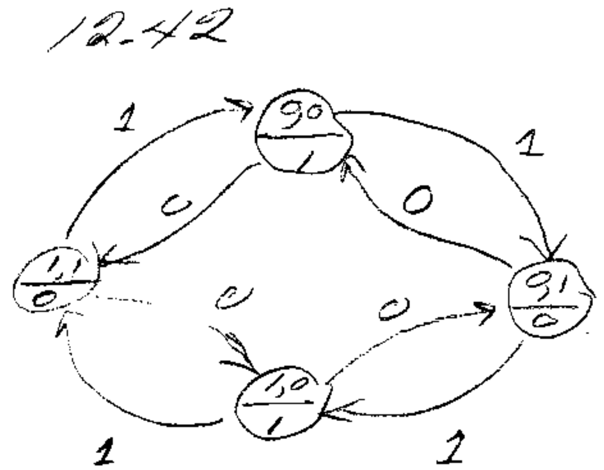
$E = m_2 + m_3 + m_4 + m_5$

$F = m_1 + m_2 + m_5 + m_6$



ES 332 Homework 19

12-42



	Present		Next				
X	Q_1 Q_2		Q_1^+ Q_2^+		Y	D_1	D_2
0	00		11		1	1	1
0	01		00		0	0	0
0	10		01		1	0	1
0	11		10		0	1	0
1	00		01		1	0	1
1	01		10		0	1	0
1	10		11		1	1	1
1	11		00		0	0	0

D_1

$X \backslash Q_1Q_2$	00	01	11	10
0	1	0	1	0
1	0	1	0	1

D_2

$X \backslash Q_1Q_2$	00	01	11	10
0	1	0	0	1
1	1	0	0	1

$$\boxed{D_2 = \overline{Q_2}}$$

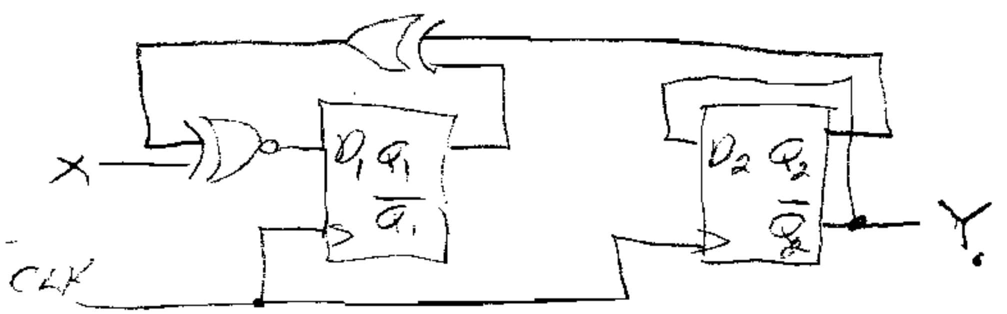
Y

$Q_1 \backslash Q_2$	0	1
0	1	0
1	1	0

$$\boxed{Y = \overline{Q_2}} \longleftarrow$$

$$D_1 = \bar{X}\bar{Q}_1\bar{Q}_2 + X\bar{Q}_1Q_2 + \bar{X}Q_1Q_2 + XQ_1\bar{Q}_2 = \bar{X}(\bar{Q}_1\bar{Q}_2 + Q_1Q_2) + X(\bar{Q}_1Q_2 + Q_1\bar{Q}_2)$$

$$D_1 = \bar{X}\cdot(\overline{Q_1 \oplus Q_2}) + X(Q_1 \oplus Q_2) = X \oplus (Q_1 \oplus Q_2)$$



Modulo 3 counter using D flip-flops

Present	Next	
Q_1 Q_0	Q_1^+ Q_0^+	D_1 D_0
0 0	0 1	0 1
0 1	1 0	1 0
1 0	0 0	0 0

$$D_1 = \bar{Q}_1 Q_0 \;;\; D_0 = \bar{Q}_1\bar{Q}_0$$