EE 332 Homework 1

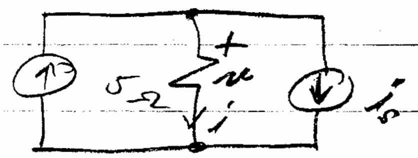
1.7 a) $v_1 = 5i_1 = 20V$

b) $v_2 = -4i_2 = 8V$

c) $v_3 = -3i_3 = -6V$

d) $v_4 = 1 \times i_4 = -2V$

1.16



a) $i_s = 1$ ∴ $v = 5V$

b) $i_s = 2$; $v = 0$

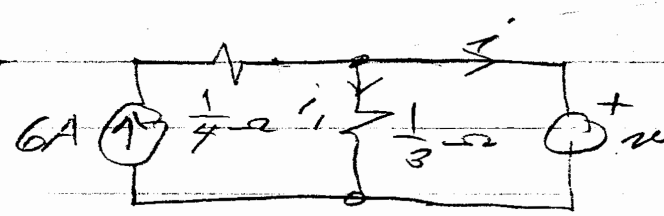
c) $i_s = 3$; $v = -5V$

$2 = i + i_s$ or $i = 2 - i_s$

∴ $\boxed{v = 5i = 10 - 5i_s}$

Homework 2

1.17



$6 = i + i_1$

$i_1 = 3v$

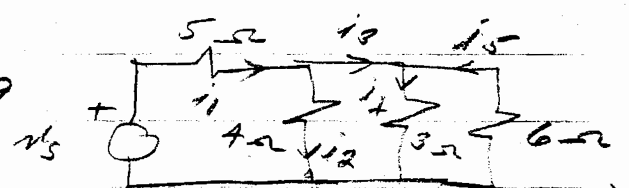
∴ $i = 6 - i_1 = 6 - 3v$

a) $i = 6 - 3(1) = 3A$

b) $i = 6 - 3(2) = 0A$

c) $i = 6 - 3(3) = -3A$

1.19



for $i_1 = 6A$

Using current division $R_{eq} = \frac{3(6)}{9} = 2$

$i_2 = 6 \frac{2}{6} = 2A$

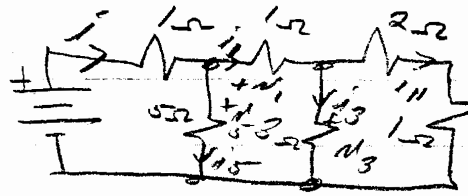
$i_3 = 6 \frac{4}{6} = 4A$

$i_4 = i_3 \frac{6}{9} = \frac{24}{9} = \frac{8}{3}A$

$i_5 = -i_3 \frac{3}{9} = -\frac{12}{9} = -\frac{4}{3}A$

ES 332 Homework 3

1.33



a) $v_1 = 2V$; $i_{11} = 2A$

$v_3 = 6V$; $i_3 = 2A$

$i_1 = i_3 + i_{11} = 4A$

$v_5 = v_1 + v_3 = 4 + 6 = 10V$

$i = i_1 + i_5 = 4 + 2 = 6A$ ∴ $\boxed{V_s = 6 + 10 = 16V}$ ←

b) $i_3 = 3A$; $v_3 = 9V$; $i_{11} = 3A$; $i_1 = 6A$; $v_5 = 6 + 9 = 15V$

$i = 6 + 3 = 9A$ so $\boxed{V_s = 9 + 15 = 24V}$ ←

c) $i_5 = 4A$; $v_5 = 20V$; $i_1 = \frac{20}{1 + 1.5} = 8$; $i = 12$

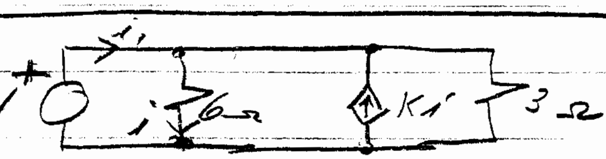
$\boxed{V_s = 12 + 20 = 32V}$ ←

d) a) $R_{eq} = \frac{V_s}{i} = \frac{8}{3}\Omega$

b) $R_{eq} = \frac{8}{3}\Omega$

c) $R_{eq} = \frac{8}{3}\Omega$

1.42



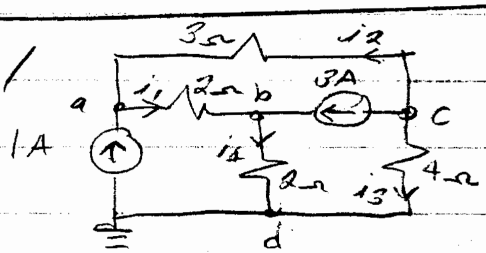
$i = \frac{12}{6} = 2A$

a) $K = 2$ KCL $\boxed{i_1 = 2 + 4 - 4 = 2A}$ ←

b) $K = 3$ $\boxed{i_1 = 2 + 4 - 6 = 0A}$ ←

c) $K = 4$ $\boxed{i_1 = 2 + 4 - 8 = -2A}$ ←

2.1



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

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

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

$V_a\overbrace{\left(\frac{1}{2} + \frac{1}{3}\right)}^{5/6} - V_b\frac{1}{2} - V_c\frac{1}{3} = 1$

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

$-V_a\frac{1}{3} + V_c\overbrace{\left(\frac{1}{3} + \frac{1}{4}\right)}^{7/12} = -3$

$-4V_a + 7V_c = -36$

$5V_a - 3V_b - 2V_c = 6$

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

$V_c = \frac{-36 + 4V_a}{7}$

from above: $5V_a - 3\left(3 + \frac{V_a}{2}\right) - 2\left(\frac{-36 + 4V_a}{7}\right) = 6$

$V_a\left(5 - \frac{3}{2} - \frac{8}{7}\right) = 6 + 9 - \frac{72}{7}$

$V_a\left(\frac{70 - 21 - 16}{14}\right) = \frac{210 - 144}{14} \Rightarrow V_a = \frac{66}{33} = \underline{\underline{2}}$

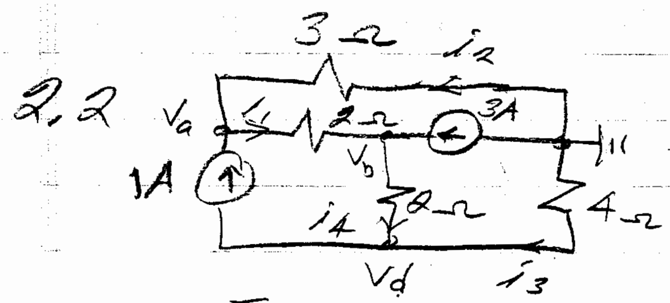
$V_b = 3 + \frac{V_a}{2} = \underline{\underline{4}}$

$V_c = \frac{-36 + 8}{7} = \underline{\underline{-4}}$

$$\left.\begin{aligned} i_1 &= \frac{V_a - V_b}{2} = -1\ A \\ i_2 &= \frac{V_c - V_a}{3} = -2\ A \\ i_3 &= \frac{V_c}{4} = -1\ A \\ i_4 &= \frac{V_b}{2} = 2\ A \end{aligned}\right\}$$

ES 332 Homework 3 (page 3)

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

$$\left\{\begin{aligned} V_a\underbrace{\left(\tfrac{1}{3}+\tfrac{1}{2}\right)}_{\frac{5}{6}} - V_b\tfrac{1}{2} &= 1 \\ -V_a\tfrac{1}{2} + V_b - \tfrac{V_d}{2} &= 3 \\ -V_b\tfrac{1}{2} + V_d\left(\tfrac{3}{4}\right) &= -1 \end{aligned}\right\}$$

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

$$V_a = \frac{\begin{vmatrix} 6 & -3 & 0 \\ 6 & 2 & -1 \\ -4 & -2 & 3 \end{vmatrix}}{\begin{vmatrix} 5 & -3 & 0 \\ -1 & 2 & -1 \\ 0 & -2 & 3 \end{vmatrix}} = \frac{6(6-2)+3(18-4)}{5(6-2)+3(-3)} = \frac{24+42}{20-9} = \frac{66}{11} = \underline{6}$$

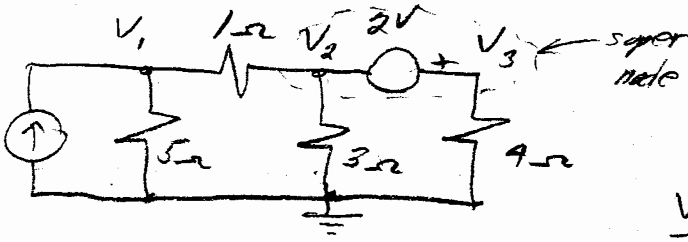
$$V_b = \frac{\begin{vmatrix} 5 & 6 & 0 \\ -1 & 6 & -1 \\ 0 & -4 & 3 \end{vmatrix}}{11} = \frac{5(18-4)-6(-3)}{11} = \frac{70+18}{11} = \underline{8V}$$

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

$$\left.\begin{aligned} i_1 &= \frac{V_a - V_b}{2} = -1 \\ i_2 &= -\frac{V_a}{3} = -2 \\ i_3 &= -\frac{V_d}{4} = -1 \\ i_4 &= \frac{V_b - V_d}{2} = 2 \end{aligned}\right\} \leftarrow$$

ES 332 Homework 4

2.9



$V_3 = V_2 + 2$

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

$$\frac{V_2 - V_1}{1} + \frac{V_2}{3} + \frac{V_3}{4} = 0$$

giving:

$$\frac{6}{5}V_1 - V_2 = 6$$
$$-V_1 + V_2\underbrace{\left(1 + \frac{1}{3} + \frac{1}{4}\right)}_{\frac{19}{12}} = -\frac{1}{2}$$

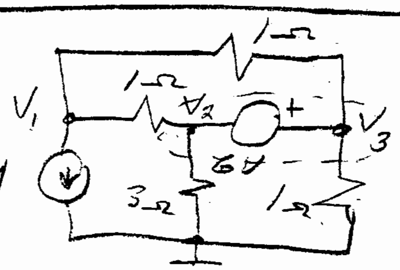
$$\left.\begin{array}{l} 6V_1 - 5V_2 = 30 \\ -12V_1 + 19V_2 = -6 \end{array}\right.$$

$$V_1 = \frac{\begin{vmatrix} 30 & -5 \\ -6 & 19 \end{vmatrix}}{\begin{vmatrix} 6 & -5 \\ -12 & 19 \end{vmatrix}} = \frac{570 - 30}{114 - 60} = \frac{540}{54} = \boxed{10 \text{ Volts}}$$

$$V_2 = \frac{\begin{vmatrix} 6 & 30 \\ -12 & -6 \end{vmatrix}}{54} = \frac{-36 + 360}{54} = \frac{324}{54} = \boxed{6 \text{ Volts}}$$

$$\boxed{V_3 = V_2 + 2 = 8 \text{ Volts}}$$

2.10



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

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

$$V_3 - V_2 = 6$$

giving:

$$2V_1 - V_2 - V_3 = -2$$
$$-2V_1 + V_2\left(1 + \frac{1}{3}\right) + 2V_3 = 0$$
$$-V_2 + V_3 = 6$$

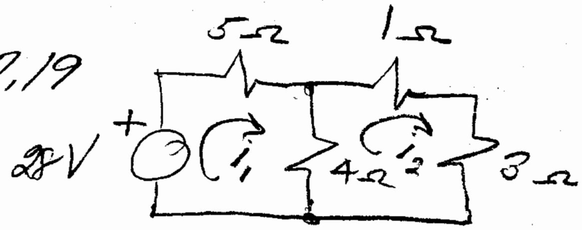
$$\left.\begin{array}{l} 2V_1 - V_2 - V_3 = -2 \\ -6V_1 + 4V_2 + 6V_3 = 0 \\ -V_2 + V_3 = 6 \end{array}\right.$$

$$V_1 = \frac{\begin{vmatrix} -2 & -1 & -1 \\ 0 & 4 & 6 \\ 6 & -1 & 1 \end{vmatrix}}{\begin{vmatrix} 2 & -1 & -1 \\ -6 & 4 & 6 \\ 0 & -1 & 1 \end{vmatrix}} = \frac{-2(4+6) + 6(-6+4)}{2(4+6) + 6(-1-1)} = \frac{-20 - 12}{20 - 12} = -\frac{32}{8} = \boxed{-4V}$$

$$V_2 = \frac{\begin{vmatrix} 2 & -2 & -1 \\ -6 & 0 & 6 \\ 0 & 6 & 1 \end{vmatrix}}{8} = \frac{2(-36) + 6(-2+6)}{8} = \frac{-72 + 36}{8} = \frac{24}{8} = \boxed{3V}$$

$$\boxed{V_3 = V_2 + 6 = 9V}$$

2.19



$$5i_1 + 4(i_1 - i_2) = 28$$
$$4(i_2 - i_1) + 4i_2 = 0$$

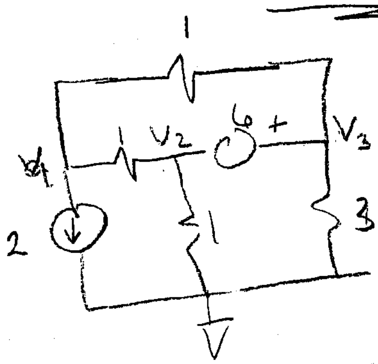
or

$$\left.\begin{aligned} 9i_1 - 4i_2 &= 28 \\ -4i_1 + 8i_2 &= 0 \end{aligned}\right\} \quad \begin{aligned} 9i_1 - 4i_2 &= 28 \\ -i_1 + 2i_2 &= 0 \end{aligned}$$

$$i_1 = \frac{\begin{vmatrix} 28 & -4 \\ 0 & 2 \end{vmatrix}}{\begin{vmatrix} 9 & -4 \\ -1 & 2 \end{vmatrix}} = \frac{56}{18-4} = \frac{56}{14} = \boxed{4\,A} \longleftarrow$$

$$i_2 = \frac{\begin{vmatrix} 9 & 28 \\ -1 & 0 \end{vmatrix}}{14} = \frac{28}{14} = \boxed{2\,A} \longleftarrow$$

2.10 (corrected)



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

$$V_3 - V_2 = 6$$

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

$$2V_1 - V_2 - V_3 = -2$$

$$-2V_1 + 2V_2 + \tfrac{4}{3}V_3 = 0$$

$$0V_1 - V_2 + V_3 = 6$$

$$\Delta = \begin{vmatrix} 2 & -1 & -1 \\ -2 & 2 & 4/3 \\ 0 & -1 & 1 \end{vmatrix} = \frac{8}{3}$$

$$\Delta_1 = \begin{vmatrix} -2 & -1 & -1 \\ 0 & 2 & 4/3 \\ 6 & -1 & 1 \end{vmatrix} = -\frac{8}{3}$$

$$\Delta_2 = \begin{vmatrix} 2 & -2 & -1 \\ -2 & 0 & 4/3 \\ 0 & 6 & 1 \end{vmatrix} = -8$$

$$\Delta_3 = \begin{vmatrix} 2 & -1 & -2 \\ -2 & 2 & 0 \\ 0 & -1 & 6 \end{vmatrix} = 8$$

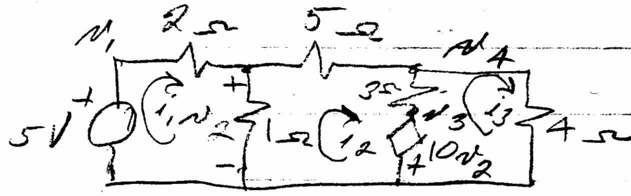
$$V_1 = \frac{\Delta_1}{\Delta} = -1$$

$$V_2 = \frac{\Delta_2}{\Delta} = -3$$

$$V_3 = \frac{\Delta_3}{\Delta} = 3$$

ES 332 Homework 5 (22)

2.20



$v_2 = (i_1 - i_2)$

$i_1 2 + (i_1 - i_2)1 = 5$

$(i_2 - i_1)1 + i_2 5 + (i_2 - i_3)3 - 10v_2 = 0$

$10v_2 + (i_3 - i_2)3 + i_3 4 = 0$

$3i_1 - i_2 = 5$

$-11i_1 + 19i_2 - 3i_3 = 0$

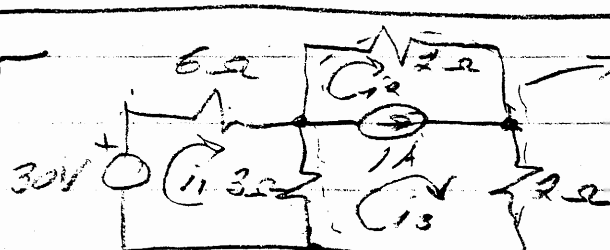
$10i_1 - 13i_2 + 7i_3 = 0$

$$i_1 = \frac{\begin{vmatrix} 5 & -1 & 0 \\ 0 & 19 & -3 \\ 0 & -13 & 7 \end{vmatrix}}{\begin{vmatrix} 3 & -1 & 0 \\ -11 & 19 & -3 \\ 10 & -13 & 7 \end{vmatrix}} = \frac{5(133-39)}{3(133-39)+1(-77+30)} = \frac{470}{\underbrace{282-47}_{235}} = \boxed{2A}$$

$$i_2 = \frac{\begin{vmatrix} 3 & 5 & 0 \\ -11 & 0 & -3 \\ 10 & 0 & 7 \end{vmatrix}}{235} = \frac{-5(-77+30)}{235} = \boxed{1A}$$

$$i_3 = \frac{\begin{vmatrix} 3 & -1 & 5 \\ -11 & 19 & 0 \\ 10 & -13 & 0 \end{vmatrix}}{235} = \frac{5(143-190)}{235} = \boxed{-1A}$$

2.25



→ supermesh

$i_3 - i_2 = 1$ or $\boxed{i_3 = 1 + i_2}$

$i_1 6 + (i_1 - i_3)3 = 30$

$(i_3 - i_1)3 + i_2 2 + i_3 2 = 0$

$9i_1 - 3i_2 = 33$

$-3i_1 + 7i_2 = -5$

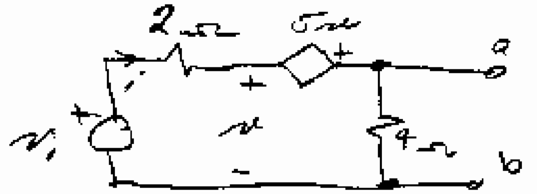
$$i_1 = \frac{\begin{vmatrix} 33 & -3 \\ -5 & 7 \end{vmatrix}}{\begin{vmatrix} 9 & -3 \\ -3 & 7 \end{vmatrix}} = \frac{231-15}{63-9} = \frac{216}{54} = \boxed{4A}$$

$$i_2 = \frac{\begin{vmatrix} 9 & 33 \\ -3 & -5 \end{vmatrix}}{54} = \frac{-45+99}{54} = 1A$$

$\boxed{i_3 = 2A}$

ES 332 Homework 6 (15 total)

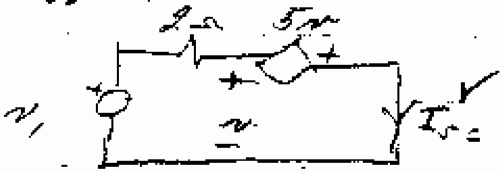
2.44 (6)



$v = v_1 - 2i$ ✓

$v_1 = 2i - 5v + 4i$ ✓

$\therefore v_1 = 6i - 5(v_1 - 2i)$ V or $6v_1 = 16i$; $i = \frac{3}{8}v_1$; $\boxed{V_{Th} = 4i = \frac{3}{2}v_1}$

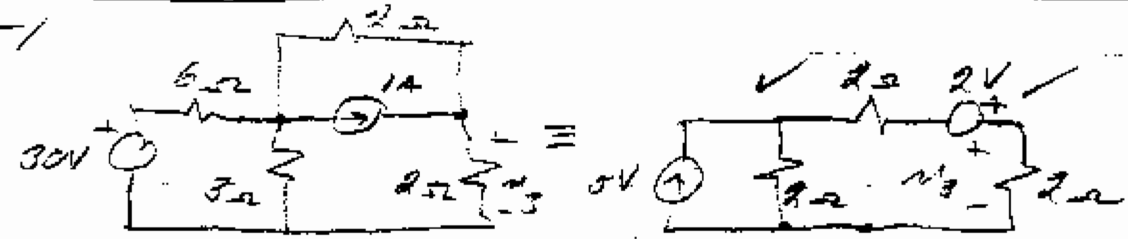


$v_1 = 2I_{sc} - 5v = 2I_{sc} - 5(v_1 - 2I_{sc})$

$\therefore 6v_1 = 12I_{sc}$ or $I_{sc} = \frac{1}{2}v_1$

$\boxed{R_{Th} = \frac{V_{Th}}{I_{sc}} = \frac{\frac{3}{2}v_1}{\frac{1}{2}v_1} = 3\,\Omega}$ ✓

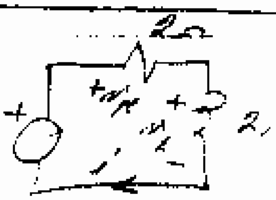
2.51 (4)

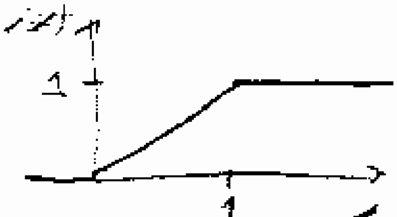


$12 = 6i$ or $i = 2A$ ✓

$\boxed{\therefore v_3 = 2i = 4V}$

3.1 (5)



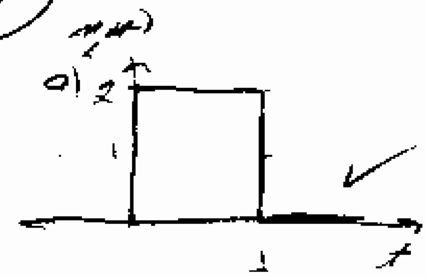


$v_L(t) = L\frac{di}{dt}$

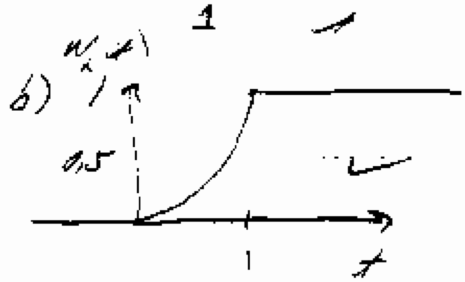
$w_L = \frac{1}{2}Li^2$

$p_R(t) = i^2 R$

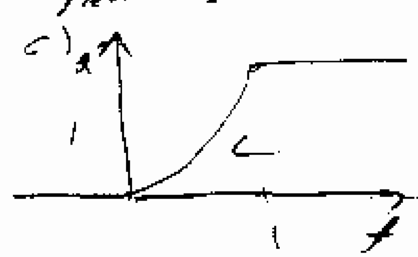
a)



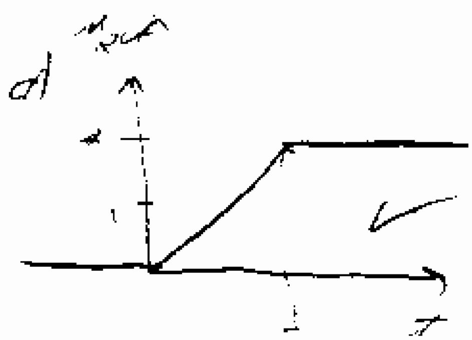
b)



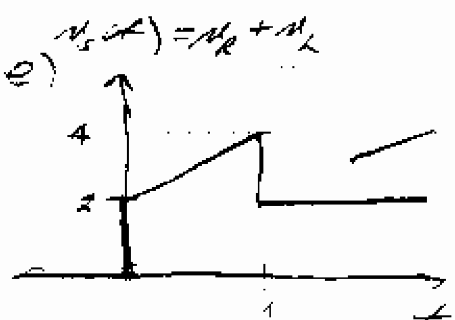
c)



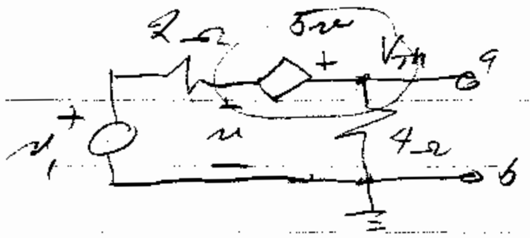
d)



e) $v_s(t) = v_R + v_L$

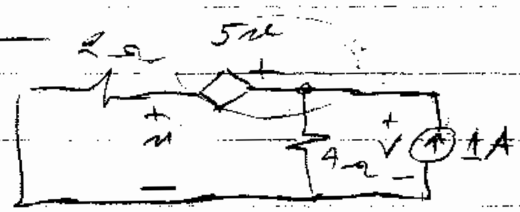


2.44 again



$$\frac{v-v_1}{2}+\frac{V_{Th}}{4}=0 \qquad 5v = V_{Th}-v \Rightarrow 6v = V_{Th}$$

$$\therefore \frac{v_{Th}}{12}-\frac{v_1}{2}+\frac{V_{Th}}{4}=0 \;;\; V_{Th}\left(\frac{1}{3}\right)=\frac{v_1}{2} \;\therefore\; \boxed{V_{Th}=\frac{3}{2}V_1}$$

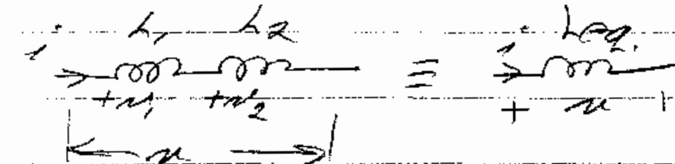


$$\frac{v}{2}+\frac{V}{4}=1$$

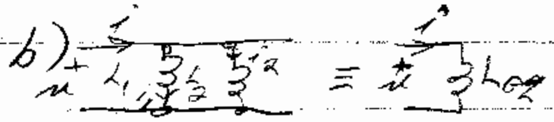
$$V-v=5v \Rightarrow V=6v$$

$$\therefore \frac{V}{12}+\frac{V}{4}=1 \;;\; \frac{1}{3}V=1 \;;\; V=3 \;;\; \boxed{R_{Th}=\frac{V}{1}=3\,\Omega}$$

ES 332 Homework 7

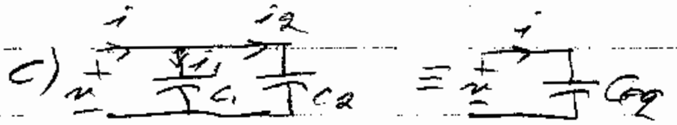
3.15 a)  $v = L_{eq}\frac{di}{dt}$

but $v = v_1 + v_2 = L_1\frac{di}{dt} + L_2\frac{di}{dt} = (L_1+L_2)\frac{di}{dt}$ $\therefore$ $\boxed{L_{eq} = L_1 + L_2}$

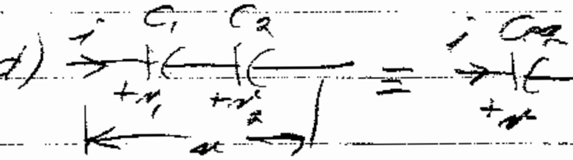
b)  $i = \frac{1}{L_{eq}}\int_0^t v\,dt + i(0)$

$i_1 = \frac{1}{L_1}\int_0^t v\,dt + i_1(0)$; $i_2 = \frac{1}{L_2}\int_0^t v\,dt + i_2(0)$

$\therefore$ $i = i_1 + i_2 = \left(\frac{1}{L_1} + \frac{1}{L_2}\right)\int_0^t v\,dt + i(0)$ so $\boxed{\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2}}$

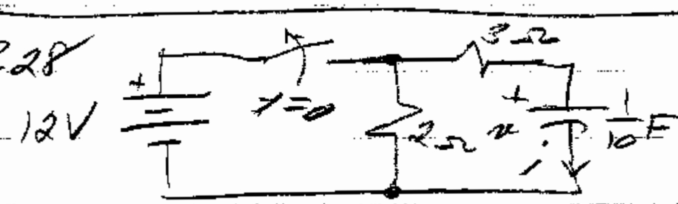
c)  $i = C_{eq}\frac{dv}{dt}$

$i = i_1 + i_2 = C_1\frac{dv}{dt} + C_2\frac{dv}{dt} = (C_1 + C_2)\frac{dv}{dt}$ $\therefore$ $\boxed{C_{eq} = C_1 + C_2}$

d)  $v = \frac{1}{C_{eq}}\int_0^t i\,dt + v(0)$

$v = v_1 + v_2 = \frac{1}{C_1}\int_0^t i\,dt + v_1(0) + \frac{1}{C_2}\int_0^t i\,dt + v_2(0) = \left(\frac{1}{C_1} + \frac{1}{C_2}\right)\int_0^t i\,dt + v(0)$

$\therefore$ $\boxed{\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}}$

3.28  $v_c(0) = 12$ Volts

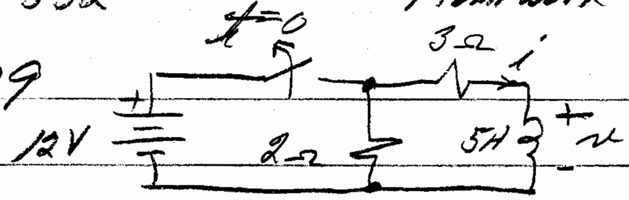
a) $\frac{v}{5} + \frac{1}{10}\frac{dv}{dt} = 0$ for $t > 0$

$v = Ae^{st}$ so $2 + s = 0 \Rightarrow s = -2$; $\boxed{v = 12e^{-2t}}$

$\boxed{i = C\frac{dv}{dt} = \frac{1}{10}(-24)e^{-2t} = -2.4e^{-2t}}$

ES 332 Homework 8

3.29



$i(0) = \frac{\cancel{12}^{2} \times \cancel{5}}{\cancel{6}} \cdot \frac{2}{\cancel{5}} = 4$

$5i + 5\frac{di}{dt} = 0 \qquad i = Ae^{st} \qquad \therefore S = -1$

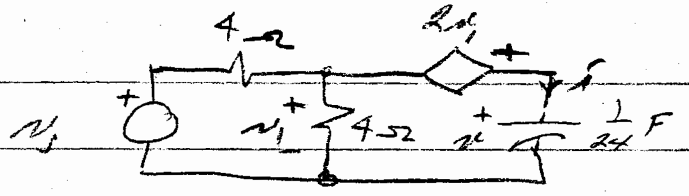
$i(t) = A_1 e^{-t} \qquad$ but $i(0) = 4 \qquad \therefore \boxed{i(t) = 4e^{-t}}$

$\boxed{v(t) = -5i = -20e^{-t}}$

or $v(t) = 5\frac{di}{dt} = -20e^{-t}$ check

ES 332 Homework 9

3.34

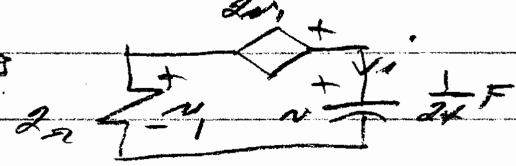


$v_s(t) = 12$ for $t < 0$

$v_s(0) = 0$ for $t > 0$

for $t < 0$ $v_1 = 6$ and $v = 3v_1 = 18$ V

for $t > 0$ circuit becomes



(1) $2i - 2v_1 + 24\int_0^t i\,dt + 18 = 0$ but $v_1 = -2i$

∴ $6i + 24\int_0^t i\,dt + 18 = 0$

or $\frac{di}{dt} + 4i = 0$; $i = Ae^{st} \Rightarrow s = -4$

$i(t) = Ae^{-4t}$

from (1) $6i(0) = -18$ or $i(0) = -3$

∴ $\boxed{i(t) = -3e^{-4t}}$

$\boxed{v = 3v_1 = -6i = 18e^{-4t}}$

ES 332 Homework 10

4.1 a) $4+j7 = 8.06\,e^{j60.25^\circ}$ f) $-5 = 5\,e^{j180^\circ}$

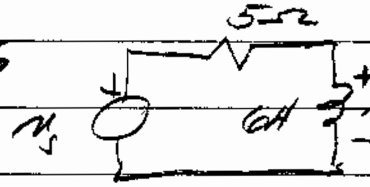
b) $3-j5 = 5.83\,e^{-j59.04}$ g) $j7 = 7\,e^{j90^\circ}$

c) $-2+j3 = 3.6\,e^{j123.7^\circ}$ h) $-j2 = 2\,e^{-j90^\circ}$

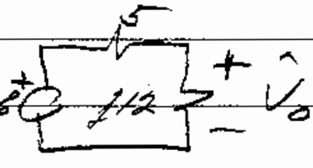
d) $-1-j6 = 6.08\,e^{j260.5^\circ}$

e) $4 = 4\,e^{j0^\circ}$

4.6



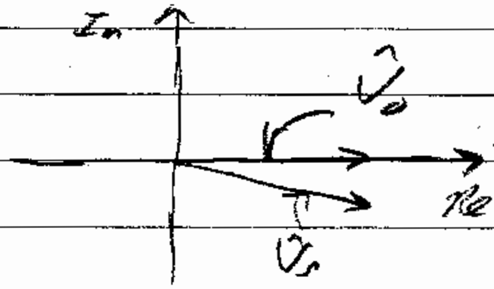
$\Rightarrow$



$v_s(t) = 13\cos(2t - 22.6^\circ)$ $\hat{V}_o = \dfrac{j12}{5+j12} \cdot 13\,e^{-j22.6^\circ}$

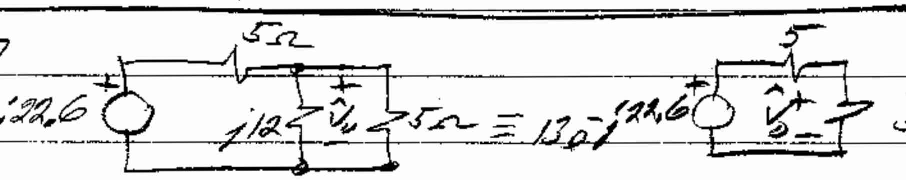
or $\hat{V}_o = \dfrac{156\,e^{j67.4^\circ}}{13\,e^{j67.38^\circ}} = 12\,e^{j.02^\circ} \approx 12$

$\therefore$ $\boxed{v_o(t) = 12\cos(2t + 0^\circ)}$ $\longrightarrow$



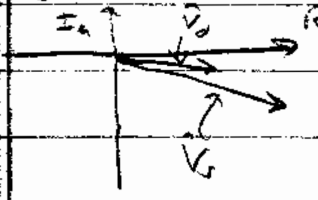
$\boxed{\hat{V}_o \text{ leads } \hat{V}_s}$

4.7



$\hat{V}_o = \dfrac{\frac{j60}{5+j12}}{5 + \frac{j60}{5+j12}} \cdot 13\,e^{-j22.6^\circ} = \dfrac{j60 \times 13\,e^{-j22.6^\circ}}{25 + j120} = \dfrac{780\,e^{j67.4^\circ}}{122.58\,e^{j78.23^\circ}}$

$\hat{V}_o = 6.36\,e^{-j10.83^\circ}$ so $\boxed{v_o(t) = 6.36\cos(2t - 10.83^\circ)}$ $\longleftarrow$

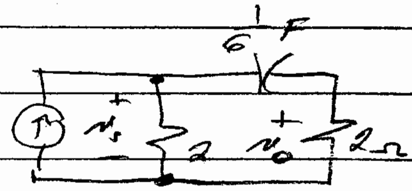


$\boxed{\hat{V}_o \text{ leads } \hat{V}_s}$ $\longleftarrow$

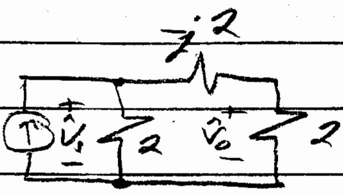
ES 332 Homework 11

4.9

$i_s = 5\cos 3t$



$\Rightarrow 5$

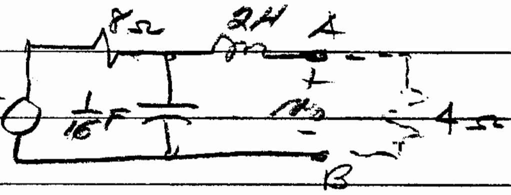


$$\hat{V}_0 = 5\,\frac{2\times 2}{2-j2+2} = \frac{20}{4.472\,e^{-j26.56^\circ}}$$ $\boxed{\therefore v_0(t) = 4.472\cos(3t+26.56^\circ)}$

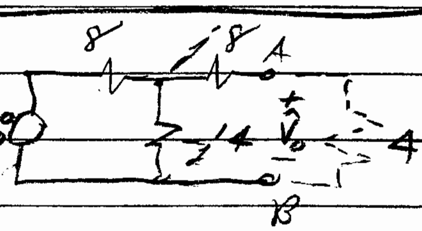
$$\hat{V}_1 = \frac{10\,(2-j2)}{4-j2} = \frac{10\times 2\times 1.414\,e^{-j45^\circ}}{4.472\,e^{-j26.56^\circ}}$$ $\boxed{\therefore v_1(t) = 6.32\cos(3t-18.4^\circ)}$

4.17

$4\cos(4t-60^\circ)$



$\Rightarrow 4e^{-j60^\circ}$



@ A-B $$\hat{V}_{Th} = \frac{4e^{-j60^\circ}(-j4)}{8-j4} = \frac{e^{-j60^\circ}\,4e^{-j90^\circ}}{2.236\,e^{-j26.56^\circ}} = 1.789\,e^{-j123.44^\circ}$$

$$Z_{Th} = j8 + \frac{8(-j4)}{8-j4} = \frac{64j+32-j32}{8-j4} = \frac{32+j32}{8-j4} = \frac{32\times 1.414\,e^{j45^\circ}}{4\times 2.236\,e^{-j26.56}} = 5.059\,e^{j71.56}$$

8.944

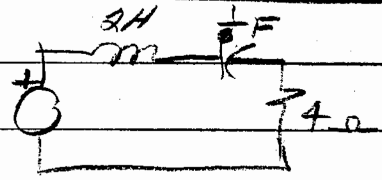
or $Z_{Th} = 1.6 + j4.799$

so $$\hat{V}_0 = \frac{1.789\,e^{-j123.44^\circ}\times 4}{(5.6+j4.799)} = \frac{4\times 1.789\,e^{-j123.44^\circ}}{7.375\,e^{j40.6^\circ}} = 0.97\,e^{-j164^\circ}$$

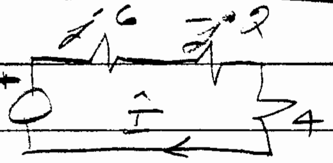
$\boxed{\text{or } v_0(t) = 0.97\cos(4t-160^\circ)}$

4.28

$10\cos 3t$



$\Rightarrow 10$

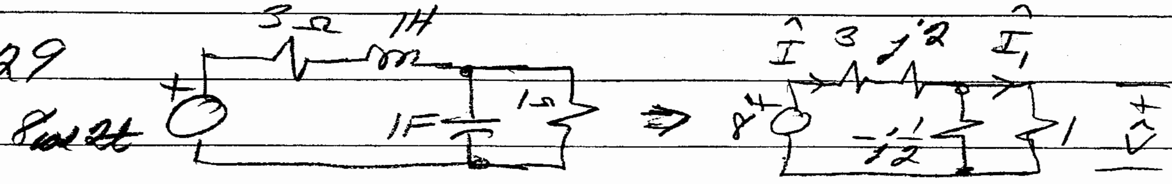


$$\hat{I} = \frac{10}{4+j4} = \frac{5}{2+j2} = \frac{5\,e^{-j45^\circ}}{2\sqrt{2}}$$

$$P_{ave_{4\Omega}} = \frac{1}{2}|\hat{I}|^2 4 = 2\,\frac{25}{8} = \frac{25}{4} = 6.25\text{ Watts}$$

ES 332 Homework 12

4.29



$$\hat{I} = \frac{8}{3+j2+\frac{-j\frac{1}{2}}{1-j\frac{1}{2}}} = \frac{8(1-j\frac{1}{2})}{3-j\frac{3}{2}+j2+1-j\frac{1}{2}} = \frac{8-j4}{4} = 2-j$$

$$\text{or } \boxed{\hat{I} = \sqrt{5}\, e^{-j26.56^\circ}}$$

$$\boxed{\hat{I}_1 = \hat{I}\,\frac{-j\frac{1}{2}}{1-j\frac{1}{2}} = (2-j)\,\frac{-j}{2-j} = -j}$$

$$\boxed{P_{3\Omega} = \frac{1}{2}|\hat{I}|^2 3 = \frac{15}{2} W}$$

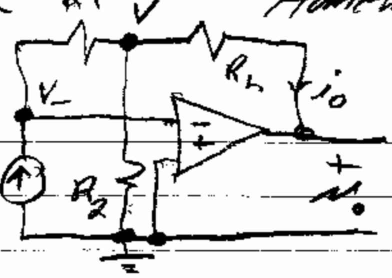
$$\boxed{P_{1\Omega} = \frac{1}{2}|I_1|^2 \times 1 = \frac{1}{2} W}$$

$$\boxed{P_{1H} = P_{1F} = 0}$$

$$\boxed{P_{source} = -8 \times \frac{\sqrt{5}}{2} \cos(26.56^\circ) = -8\,\text{Watts}}$$

ES 332 Homework 13

2.28



$\boxed{V_- = 0}$

KCL @ V gives:

$$\frac{V}{R_1} + \frac{V}{R_2} + \frac{V - v_o}{R_L} = 0$$

but $\frac{V}{R_1} = -i_s$ $\therefore$ $-i_s R_1\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_L}\right) = \frac{v_o}{R_L}$

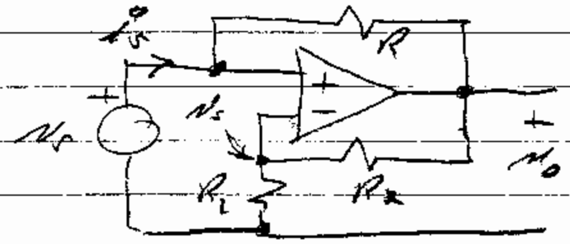
or $v_o = -i_s R_1 R_L\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_L}\right)$

$$v_o = -i_s\left(\frac{R_2 R_L + R_1 R_L + R_1 R_2}{R_1 R_2 R_L}\right) R_1 R_L$$

$$\boxed{v_o = -i_s\left(R_L + \frac{R_1}{R_2} R_L + R_1\right)}$$

$$\boxed{i_o = \frac{V - v_o}{R_L} = \frac{-i_s R_1 - v_o}{R_L} = i_s\left(1 + \frac{R_1}{R_2}\right)}$$

2.30



$$\frac{v_s}{R_1} + \frac{v_s - v_o}{R_2} = 0$$

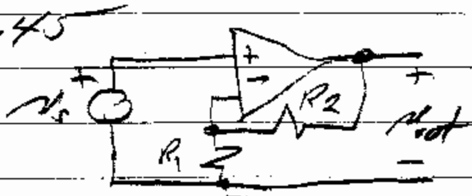
$$v_s\left(\frac{1}{R_1} + \frac{1}{R_2}\right) = \frac{v_o}{R_2}$$

$\therefore$ $\boxed{v_o = v_s\left(1 + \frac{R_2}{R_1}\right)}$

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

$$\boxed{\frac{v_s}{i_s} = -\frac{R_1}{R_2}(R)}$$

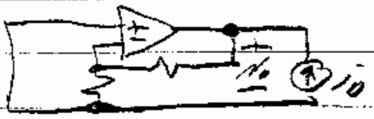
2.45



$$\frac{v_s}{R_1} + \frac{v_s - v_{out}}{R_2} = 0$$

$$v_s\left(\frac{1}{R_1} + \frac{1}{R_2}\right) = \frac{v_{out}}{R_2}$$

$\therefore$ $\boxed{v_{out} = v_{Th} = v_s\left(1 + \frac{R_2}{R_1}\right)}$



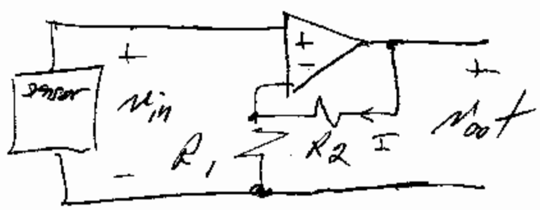
$v_o = 0$ for any i_o $\therefore$ $\boxed{R_{Th} = 0}$

ES 332 Spring 2007
Assignment 14

A temperature sensor has an output of 0.01 volts per degree Fahrenheit from T = 0 to T = 100°F (at T = 0 V_{out} = 0). Design an Op-Amp circuit using this sensor that will provide an output voltage of 0 to 10 Volts for a temperature variation of 0 to 100°F.

$0.01 \times 100 = 1$ volt from sensor @ $T = 100°F$

$\therefore$ need a gain of +10



$I = \dfrac{v_{out}}{R_1 + R_2}$; $v_{in} = I R_1$

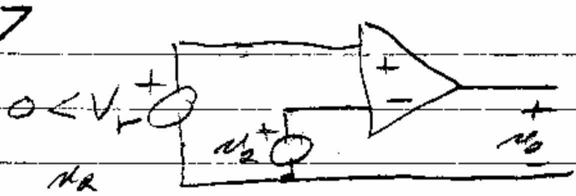
$\therefore \quad v_{out} = (R_1 + R_2)\dfrac{v_{in}}{R_1} = \dfrac{R_1 + R_2}{R_1} v_{in}$

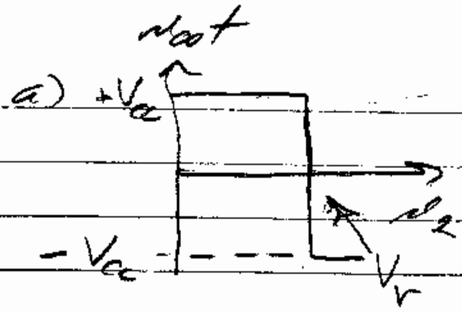
so for our design $\dfrac{R_1 + R_2}{R_1} = 10$ ←

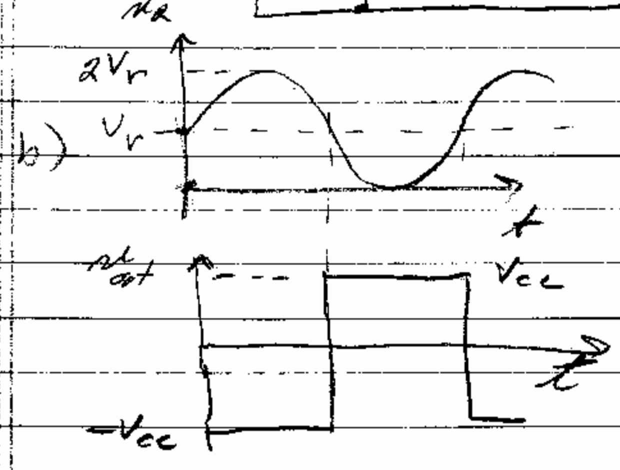
or $\dfrac{R_2}{R_1} = 9$ ←

ES 332 Homework 15

10.67

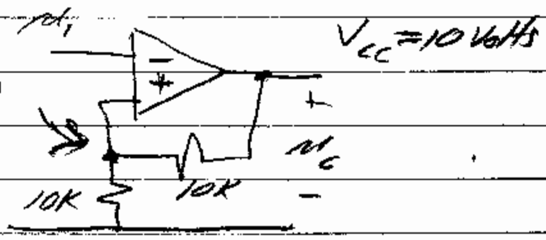


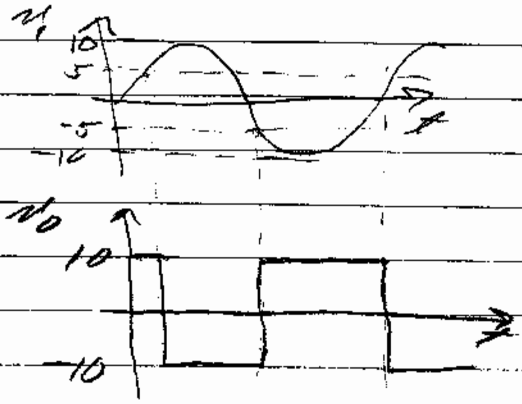




10.68

$\boxed{v_2 = \pm \frac{V_{cc}}{2}}$





10.79 for 555 timer $f = \frac{1.44}{(R_1 + 2R_2)C}$

a) $f_o = \frac{1.44}{(15\times10^3)\times10^{-7}} = \boxed{960\text{ Hz}}$

b) $1.6\times10^3 = \frac{1.44}{15\times10^3\, C}$ $\therefore C = \frac{1.44}{15\times10^3\times1.6\times10^3} \boxed{= 0.06\,\mu F}$

c) $10^4 = \frac{1.44}{(R_1 + 2\times10^4)5\times10^{-9}}$ $\therefore R_1 = \frac{1.44}{5\times10^{-5}} - 2\times10^4 = \boxed{8.8 K\Omega}$

d) $10^4 = \frac{1.44}{(10^4 + 2R_2)5\times10^{-9}}$ $\therefore R_2 = \left(\frac{1.44}{5\times10^{-5}} - 10^4\right)\frac{1}{2} = \boxed{9.4 K\Omega}$

ES 332 Homework 16

11.2 a) $11011_2 = 16+8+2+1 = 27$

b) $101011 = 32+8+2+1 = 43$

c) $0.11011 = \frac{1}{2}+\frac{1}{4}+\frac{1}{16}+\frac{1}{32} = 0.84375$

d) $0.10101 = \frac{1}{2}+\frac{1}{8}+\frac{1}{32} = 0.65625$

e) $10100.011 = 16+4+\frac{1}{4}+\frac{1}{8} = 20.375$

f) $10011.101 = 16+2+1+\frac{1}{2}+\frac{1}{8} = 19.625$

11.3 a) $43 = 101011$

b) $27 = 11011$

c) $0.84375 = 0.11011$ see above

d) $0.65625 = 0.10101$ " "

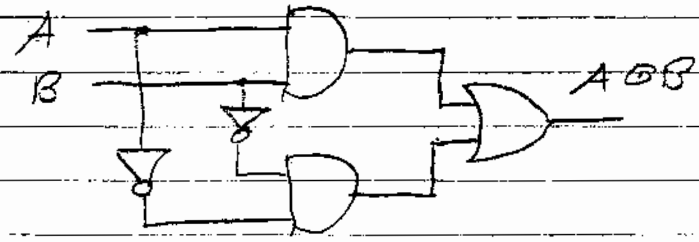
e) $19.625 = 10011.101$ " "

f) $20.375 = 10100.011$

11.26

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

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



ES 332 Homework 17

11.44

A	B	C	F
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

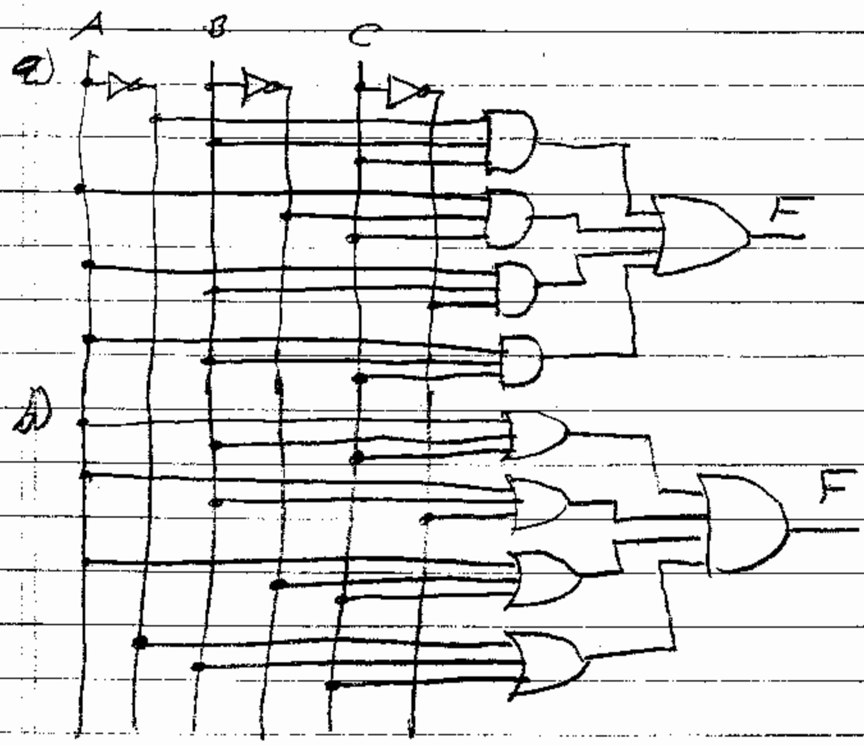
a) $F = \bar{A}BC + A\bar{B}C + AB\bar{C} + ABC$

$F = m_3 + m_5 + m_6 + m_7$

b) $\bar{F} = \bar{A}\bar{B}\bar{C} + \bar{A}\bar{B}C + \bar{A}B\bar{C} + A\bar{B}\bar{C}$

$F = (A+B+C)(A+B+\bar{C})(A+\bar{B}+C)(\bar{A}+B+C)$

or $F = M_0 M_1 M_2 M_4$



11.53

a)

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

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

b)

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

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

c)

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

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

ES332 Homework 18

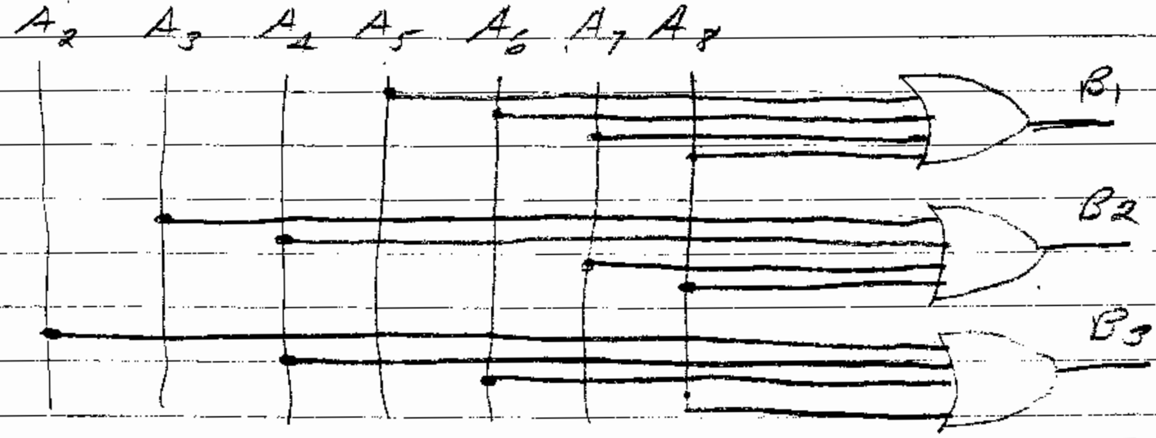
12.14 8x3 encoder

A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	B_1	B_2	B_3
1								0	0	0
	1							0	0	1
		1						0	1	0
			1					0	1	1
				1				1	0	0
					1			1	0	1
						1		1	1	0
							1	1	1	1

$B_1 = A_5 + A_6 + A_7 + A_8$

$B_2 = A_3 + A_4 + A_7 + A_8$

$B_3 = A_2 + A_4 + A_6 + A_8$



12.17

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

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

$\boxed{\therefore\ D = A}$

E

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

$\boxed{E = A\bar{B} + \bar{A}B}$

F

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

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

ES 332   Homework 18   (page 2)

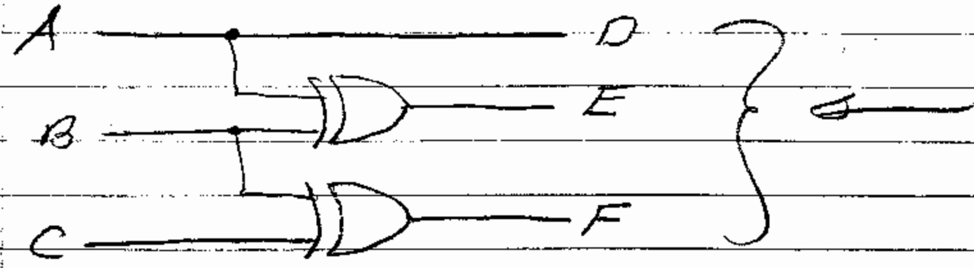
have results of form $F = X\bar{Y} + \bar{X}Y$

truth table for this function is:

X	Y	F
0	0	0
0	1	1
1	0	1
1	1	0

This is exclusive OR $X \oplus Y$

so we can realize our converter as follows



ES 332

Homework 19

12.4

A_i	B_i	R_i	D_i	R_{i+1}	$B_i \oplus R_i$
0	0	0	0	0	0
0	0	1	1	1 ✓	1
0	1	0	1	1 ✓	1
0	1	1	0	1 ✓	0
1	0	0	1	0	0
1	0	1	0	0	1
1	1	0	0	0	1
1	1	1	1	1 ✓	0

D_i

A_i \ B_iR_i	00	01	11	10
0	0	1	0	1
1	1	0	1	0

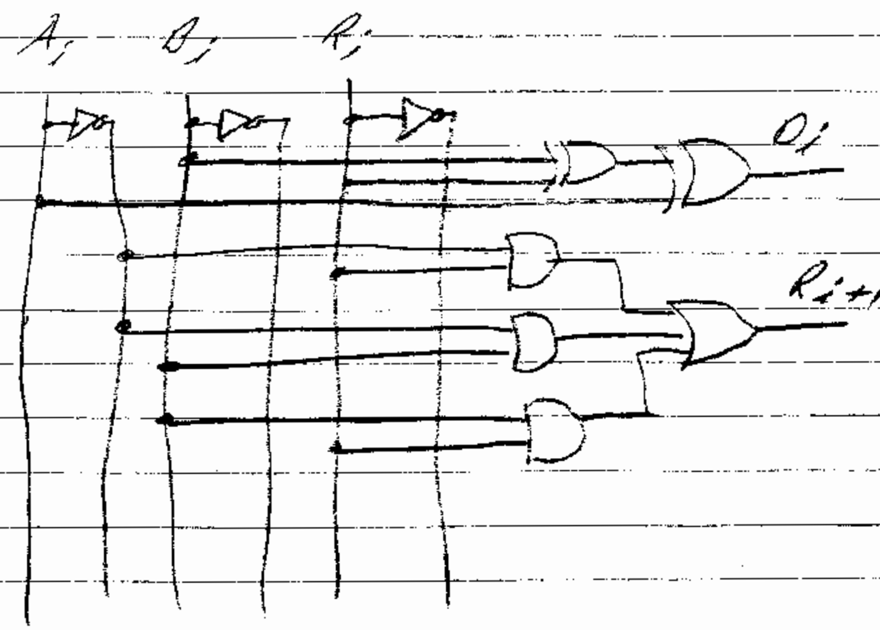
$$D_i = \overline{A_i}\,\overline{B_i}\,R_i + \overline{A_i}\,B_i\,\overline{R_i} + A_i\,\overline{B_i}\,\overline{R_i} + A_i\,B_i\,R_i$$

$$D_i = \overline{A_i} \cdot (B_i \oplus R_i) + A_i \cdot \left(\overline{B_i \oplus R_i}\right) = A_i \oplus (B_i \oplus R_i)$$

R_{i+1}

A_i \ B_iR_i	00	01	11	10
0	0	1	1	1
1	0	0	1	0

$$R_{i+1} = \overline{A_i}\,R_i + \overline{A_i}\,B_i + B_i\,R_i$$



12.19

A	B	C	F
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

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

$$F = \bar{A}BC + A\bar{B}C + AB \cdot 1 + \bar{A}\bar{B} \cdot 0$$