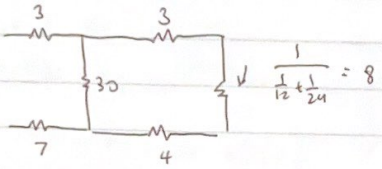
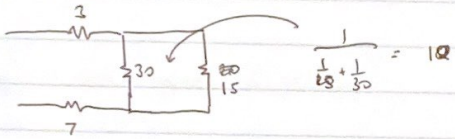
EE 100 HW 2

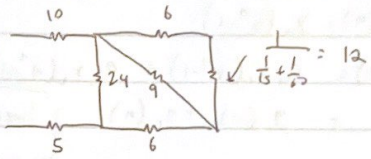
1. a)

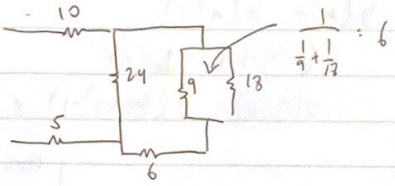


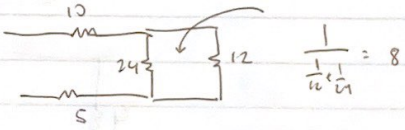


$3+10+7 = \boxed{20\,\Omega}$

b)







$10+5+8 = \boxed{23\,\Omega}$

2) $12 \parallel 6 \rightarrow \frac{1}{\frac{1}{12}+\frac{1}{6}} = 4\,\Omega$

$4 - R \rightarrow 4+R$

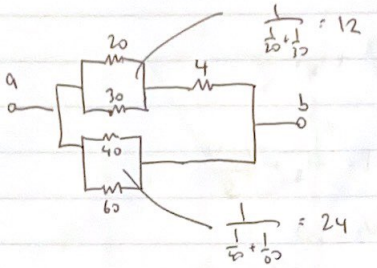
$4+R \parallel 80 \rightarrow \frac{1}{\frac{1}{4+R}+\frac{1}{80}} = \frac{80(4+R)}{84+R}$

$\frac{80(4+R)}{84+R} - 7 \rightarrow \frac{80(4+R)}{84+R} + 7 = 23 \Rightarrow \frac{80(4+R)}{84+R} = 16$

$320+80R = 1344+16R$

$64R = 1024 \rightarrow R = \boxed{16\,\Omega}$

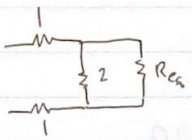
3.



$12+4=16$

$\frac{1}{\frac{1}{16}+\frac{1}{24}} = \frac{48}{5} = \boxed{9.6\,\Omega}$

4.



$1+\frac{2R_{eq}}{2+R_{eq}}+1 = R_{eq}$

$4+2R_{eq}+2R_{eq} = 2R_{eq}+R_{eq}^2 \rightarrow x^2-2x-4=0$

$R_{eq} = \frac{2\pm\sqrt{4+16}}{2} = 1\pm\sqrt{5} \neq \boxed{1+\sqrt{5}\,\Omega} \approx \boxed{3.24\,\Omega}$

5. $R_{eq} = (((((10-10)\|20)\|20)\|20)-20)\|25-5$

$= 17.5\,\Omega$

$V = 8 \cdot 17.5 = \boxed{140\,V}$

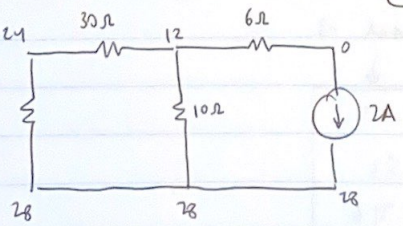
$140-5.8=100V$

$100-20.4=20V$

$i = 20V/20\Omega = \boxed{1A}$

6. $\frac{1}{\frac{1}{40}+\frac{1}{10}} = 8\,\Omega$ $\quad 8+6=14\,\Omega$

$2 \cdot 14 = 28V$ $\quad \boxed{V_s = 28V}$



$\boxed{V_1 = 24-28 = -4V}$

$\boxed{V_2 = 28-12 = 16V}$

$\boxed{i_2 = \frac{V_2}{10} = 1.6A}$

7) $\frac{V_2 - V_1}{10} + \frac{V_2}{5} = 2$ $\qquad$ $\frac{V_1 - V_2}{10} + \frac{V_1}{20} = 1$

$V_2 - V_1 + 2V_2 = 20$ $\qquad$ $2V_1 - 2V_2 + V_1 = 20$

$V_1 + 20 = 3V_2$ $\qquad$ $3V_1 - 2V_2 = 20$

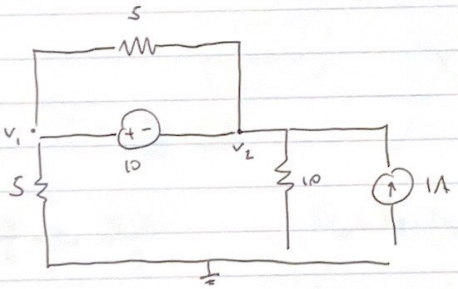
$3V_1 + 60 = 9V_2$

$80 = 7V_2$ $\qquad V_2 = 11.428\,V$

$V_1 = 14.285\,V$

$i_1 = \frac{V_2 - V_1}{10} = 0.857A$

8)



$V_1 = V_2 + 10$

$\frac{V_1 - 0}{5} + \frac{V_1 - V_2}{5} + i_s = 0$

$\frac{V_2 - V_1}{5} + \frac{V_2}{10} - i_s - 1A = 0$

$V_1 + V_1 - V_2 + 5i_s = 0$

$2V_2 - 2V_1 + V_2 - 10i_s - 10 = 0$

$2V_1 + 5i_s = V_2$

$3V_2 = 10 + 10i_s + 2V_1$

$V_2 = V_1 - 10$

$V_1 + 5i_s = -10$

$V_1 - 30 = 10 + 10i_s$

$40 + 10i_s = -5i_s - 10$

$15i_s = -50$

$i_s = \frac{-10}{3} = -3.33A$

$V_1 = -5i_s - 10 = \frac{20}{3} = 6.67\,V$

$V_2 = V_1 - 10 = \frac{-10}{3} = -3.33V$

9.

$$\frac{V_1-V_3}{9}+\frac{V_1-V_2}{6}+\frac{V_1-0}{21}=0 \qquad \left(\frac{1}{9}+\frac{1}{6}+\frac{1}{21}\right)V_1-\frac{1}{6}V_2-\frac{1}{9}V_3=0$$

$$\frac{V_2-V_1}{6}+\frac{V_2-0}{28}-3=0 \qquad -\frac{1}{6}V_1+\left(\frac{1}{6}+\frac{1}{28}\right)V_2=3$$

$$\frac{V_3-V_1}{9}+\frac{V_3}{6}+3=0 \qquad -\frac{1}{9}V_1+\left(\frac{1}{6}+\frac{1}{9}\right)V_3=-3$$

```
>> A = [1/9+1/6+1/21 -1/6 -1/9; -1/6 1/6+1/28 0; -1/9 0 1/6+1/9]

A =

    0.3254   -0.1667   -0.1111
   -0.1667    0.2024         0
   -0.1111         0    0.2778

>> b = [0;3;-3]

b =

     0
     3
    -3

>> A \ b

ans =

    8.8421
   22.1053
   -7.2632
```

$$\begin{bmatrix} \frac{1}{9}+\frac{1}{6}+\frac{1}{21} & -\frac{1}{6} & -\frac{1}{9} \\ -\frac{1}{6} & \frac{1}{6}+\frac{1}{28} & 0 \\ -\frac{1}{9} & 0 & \frac{1}{6}+\frac{1}{9} \end{bmatrix} \begin{bmatrix} 0 \\ 3 \\ -3 \end{bmatrix}$$

A b

Matlab: A \ b → $\begin{bmatrix} 8.8421 \\ 22.1053 \\ -7.2632 \end{bmatrix}$

$$\begin{bmatrix} " & " & " \\ & & \\ & & \end{bmatrix} \begin{bmatrix} " \\ -3 \\ 3 \end{bmatrix}$$

A b

```
>> b = [0;-3;3]

b =

     0
    -3
     3

>> A \ b

ans =

   -8.8421
  -22.1053
    7.2632
```

Matlab A \ b → $\begin{bmatrix} -8.8421 \\ -22.1053 \\ 7.2632 \end{bmatrix}$

magnitudes of volts are same but signs are diff b/c all current flows in the opposite direction

10.

$$\frac{V_1-0}{20} + \frac{V_1-V_2}{10} + 5 = 0 \rightarrow \left(\frac{1}{20}+\frac{1}{10}\right)V_1 - \frac{1}{10}V_2 + 5 = 0$$

$$\frac{V_2-0}{8} + \frac{V_2-V_1}{10} + \frac{V_2-V_3}{4} = 0 \qquad \left(-\frac{1}{10}\right)V_1 + \left(\frac{1}{8}+\frac{1}{10}+\frac{1}{4}\right)V_2 - \frac{1}{4}V_3 = 0$$

$$\frac{V_3-0}{20} + \frac{V_3-V_2}{4} - 5 = 0 \qquad -\frac{1}{4}V_2 + \left(\frac{1}{20}+\frac{1}{4}\right)V_3 = 5$$

$$A: \begin{bmatrix} \frac{1}{20}+\frac{1}{10} & -\frac{1}{10} & 0 \\ -\frac{1}{10} & \frac{1}{8}+\frac{1}{10}+\frac{1}{4} & -\frac{1}{4} \\ 0 & -\frac{1}{4} & \frac{1}{20}+\frac{1}{4} \end{bmatrix} \quad b: \begin{bmatrix} -5 \\ 0 \\ 5 \end{bmatrix}$$

$$A \backslash b \rightarrow \begin{bmatrix} -30.556 \\ 4.167 \\ 20.139 \end{bmatrix} \begin{matrix} V_1 \\ V_2 \\ V_3 \end{matrix}$$

```
>> A = [1/20+1/10 -1/10 0; -1/10 1/8+1/10+1/4 -1/4; 0 -1/4 1/20+1/4]

A =

    0.1500   -0.1000         0
   -0.1000    0.4750   -0.2500
         0   -0.2500    0.3000

>> b = [-5;0;5]

b =

    -5
     0
     5

>> A \ b

ans =

  -30.5556
    4.1667
   20.1389

>>
```