<u>SOLUTIONS</u>

Solution of pre-tutorial:

Let the output be ‘P’

x	y	z	P
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

$$\therefore P = \overline{x}yz + x\overline{y}z + xy\overline{z} + xyz$$

$$= \overline{x}yz + x\overline{y}z + xy(z + \overline{z})$$

$$= \overline{x}yz + x[y + \overline{y}z]$$

$$= \overline{x}yz + xy + xz$$

$$= z(x + \overline{x}y) + xy$$

$$= xy + yz + zx$$

Solution of problem 2:

From the timing diagram, we obtain the truth table as follows.

A	B	C	f
0	0	0	1
1	1	1	0
0	1	1	0
1	0	1	1
0	1	0	0
0	0	1	1
1	0	0	0
1	1	0	0

$$\therefore f = \overline{A}\,\overline{B}\,\overline{C} + A\overline{B}C + \overline{A}\,\overline{B}C$$

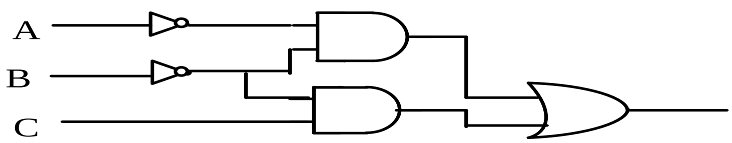
$$= \overline{A}\,\overline{B}[C + \overline{C}] + A\overline{B}C$$

$$= \overline{B}[\overline{A} + AC]$$

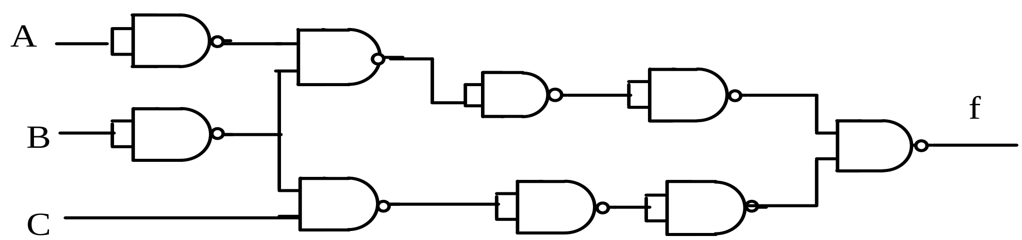
$$= \overline{B}[(\overline{A} + A)(\overline{A} + C)]$$

$$= \overline{A}\,\overline{B} + \overline{B}C$$

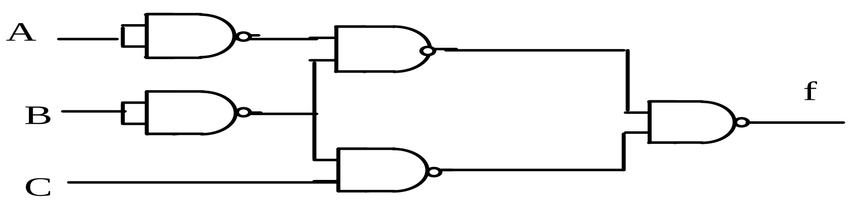
Implementation using basic gates



Implementation using two input NAND gates



By removing all the groups of two series NOT gates, we get



Solution of problem 3:

(a) $v = A+B+E$

$w=C$

$x=A+D$

$y=B+C$

$z=D+E$

For the safe to be opened $f(A,B,C,D,E)=v\ w\ x\ y\ z=1$

$f(A,B,C,D,E)=(A+B+E)C(A+D)(B+C)(D+E)$

$= (AC+BC+CE)(A+D)(BD+BE+CD+CE)$

$= (AC+ACD+ABC+BCD+ACE+CDE)(BD+BE+CD+CE)$

= *(AC+BCD+CDE)(BD+BE+CD+CE)*

= *ABCD+ABCE+ACD+ACE+BCD+BCDE+BCD+BCDE+BCDE+BCDE+CDE+CDE*

= *ACD+ACE+BCD+CDE*

From the above Boolean expression, it is clear that a minimum of three executives are required to open the safe.

(b). The combinations of three executives required to open the safe are *ACD, ACE, BCD* and *CDE*.

(c). As all the combinations contain *C*, the "essential executive'' is *C*.

Solution of problem 4:

The apparent power drawn by the load $=\frac{\mathbf{1200\ W}}{\mathbf{0.8}} = \mathbf{1500\ VA}$

$$3 \times |V_{ph}| \times |I_{ph}| = 1500\ VA$$

$$\Rightarrow \ |\boldsymbol{I_{ph}}| = \frac{\mathbf{1500}}{\mathbf{3\times\frac{300}{\sqrt{3}}}} = \mathbf{2.886\ A}$$

Magnitude of phase impedance $= \frac{|\boldsymbol{V_{ph}}|}{|\boldsymbol{I_{ph}}|} = \frac{\frac{\mathbf{300}}{\sqrt{\mathbf{3}}}}{\mathbf{2.866}} = \mathbf{60}\ \Omega$

Phase impedance = $\boldsymbol{Z_{ph}} = \mathbf{60}\angle\boldsymbol{\theta} = \mathbf{60}\times\boldsymbol{cos\,\theta} + \boldsymbol{j60}\times\boldsymbol{sin\,\theta} = \mathbf{60}\ \times\mathbf{0.8} + \boldsymbol{j60}\ \times\mathbf{0.6}$

$$= \mathbf{48} + \boldsymbol{j36}\ \Omega$$

Solution of problem 5:

The wattmeter $\boldsymbol{W_1}$ is connected between lines A and C, it will show

$$\boldsymbol{W_1} = \boldsymbol{V_{AC}I_A}\mathbf{cos}(\mathbf{30^0} - \boldsymbol{\theta}) = \boldsymbol{V_L I_L}\mathbf{cos}(\mathbf{30^0} - \boldsymbol{\theta})$$

The wattmeter $\boldsymbol{W_2}$ is connected between lines B and C, it will show

$$\boldsymbol{W_2} = \boldsymbol{V_{BC}I_B}\mathbf{cos}(\mathbf{30^0} + \boldsymbol{\theta}) = \boldsymbol{V_L I_L}\mathbf{cos}(\mathbf{30^0} + \boldsymbol{\theta})$$

Hence, $\boldsymbol{W_1} > \boldsymbol{W_2}$. So, $\frac{\sqrt{\mathbf{3}}\,(\boldsymbol{W_1}-\boldsymbol{W_2})}{\mathbf{W1 + W2}} = \mathbf{tan}(\boldsymbol{\theta})$, where $\boldsymbol{\theta}$ is the p.f. angle.

$$\frac{\sqrt{\mathbf{3}}\,(\boldsymbol{W_1}-\boldsymbol{W_2})}{\mathbf{W1 + W2}} = \mathbf{tan}(\mathbf{cos^{-1}}(\mathbf{0.8})) \Rightarrow \boldsymbol{W_2} = \mathbf{5.93}\ \boldsymbol{kW}$$

(a) Real power consumed by the load = $\boldsymbol{W_1 + W_2} = \sqrt{\mathbf{3}}\,|\boldsymbol{V_L}| \times |\boldsymbol{I_L}|\,\boldsymbol{cos(\theta)} = \mathbf{20.93}\ \boldsymbol{kW}$

$$\Rightarrow\ |\mathrm{V_L}| = 503.5\ V$$

(b) Load resistance per phase = $\boldsymbol{R_{ph}} = \frac{\boldsymbol{real\ power\ consumed}}{|\boldsymbol{I_L}|^2} = \frac{\mathbf{20.93}\ \boldsymbol{kW}}{\mathbf{30^2}} = \mathbf{23.25}\ \Omega$

(c) Load reactance per phase = $\boldsymbol{X_{ph}} = \frac{\boldsymbol{reactive\ power\ consumed}}{|\boldsymbol{I_L}|^2} = \frac{\sqrt{\mathbf{3}}(\boldsymbol{W_1 - W_2})}{|\boldsymbol{I_L}|^2} = \frac{\mathbf{15.71}\ \boldsymbol{kVA}}{\mathbf{30^2}} =$

$$= \mathbf{17.455}\ \Omega$$