SOLUTIONS

Solution of pre-tutorial:

1. Single phase motors are not able to start by themselves. This requires a polyphase source. 3-phase generators, motors and transformers are simpler, cheaper and more efficient. 3-phase transmission lines deliver more power for a given cost or for a given weight of conductor. Voltage regulation of a 3-phase system is inherently better. In case of star-connected source, the line voltage is √3 times the phase voltage. This helps in transmitting and distributing power with a higher voltage. The number of conductors required for transmission and distribution is reduced thus helps reducing the cost in case of a balanced three-phase system.

$$v_{ab} = v_{an} - v_{bn}$$

$$= V_P \angle 20^0 - V_p \angle -100^0$$

$$= V_P \sin(\omega t + 20^0) - V_P \sin(\omega t - 100^0)$$

$$= V_p \times 2\sin\left(\frac{\omega t + 20^0 - \omega t + 100^0}{2}\right) \cos\frac{\omega t + 20^0 + \omega t - 100^0}{2}$$

$$= V_p \times 2\sin(60^0)\cos(\omega t - 40^0)$$

$$= \sqrt{3}V_p \cos(\omega t - 40^0)$$

$$= \sqrt{3}V_p \cos\left(90^0 - (\omega t + 50^0)\right)$$

$$= \sqrt{3}V_p \sin(\omega t + 50^0)$$

$$v_{ab} = \sqrt{3}V_p \sin(\omega t + 50^0) = V_L \angle 50^0$$

$$v_{bc} = \sqrt{3}V_p \sin(\omega t - 70^0) = V_L \angle -70^0$$

$$v_{ca} = \sqrt{3}V_p \sin(\omega t - 190^0) = V_L \angle -190^0$$

2.

(a) $\boldsymbol{Z_P = 12 + j5}\ \Omega$

$\boldsymbol{I_{bB} = 20\angle 0^0}$

P.F. angle = $\boldsymbol{\cos^{-1}(0.935) = 20.770^0}$

$\boldsymbol{\tan^{-1}\left(\frac{5}{12+R_w}\right) = 20.77^0 \ \Rightarrow \frac{5}{12+R_w} = 0.38 \ \Rightarrow 13.18 = 12 + R_w}$

$\boldsymbol{\Longrightarrow R_w = 1.18}\ \Omega$

(b) $\boldsymbol{V_{bn} = I_{bB}(Z_P + R_W) = 20\angle 0^0\ (12 + j5 + 1.18)}$ = $\boldsymbol{20\ (13.18\ + j5)}$

$\boldsymbol{= 263.6 + j\ 100 = 282\angle 20.77^0}$ V

(c) $\boldsymbol{V_{BN} = I_{bB}(Z_P) = 20\angle 0^0\ (12 + j5)}$ = $\boldsymbol{260\angle 22.62^0}$ V

$\boldsymbol{V_{BC} = \sqrt{3}V_{BN}\angle 30^0 = 450.33\angle 52.62^0}$

$\boldsymbol{V_{AB} = V_{BC}\angle 120^0 = 450.33\angle 172.62^0}$ V

(d) Line voltage at the source $\boldsymbol{V_L = \sqrt{3}|V_{bn}| = 488.44}$ V, $\boldsymbol{I_L = |I_{bB}| = 20}$

Total apparent power supplied by the source = $\boldsymbol{\sqrt{3}\ V_L I_L = 16.92}$ **KVA**

3.

(a) $\boldsymbol{V_{cn}}$, is the phase voltage.

So, $\boldsymbol{V_{cn}}$=$\boldsymbol{\frac{400}{\sqrt{3}}\angle -270^0 = 230.94\angle -270^0}$ V

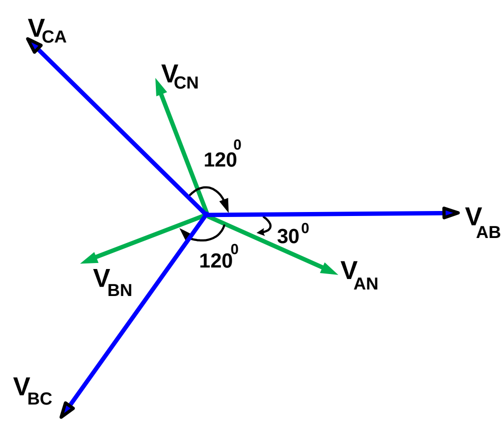


Fig. Q1

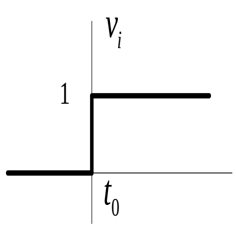
(b) $\boldsymbol{Z_{AN}} = (-\boldsymbol{j}\mathbf{100})||(\mathbf{100})||(\mathbf{50} + \boldsymbol{j}\mathbf{50})$

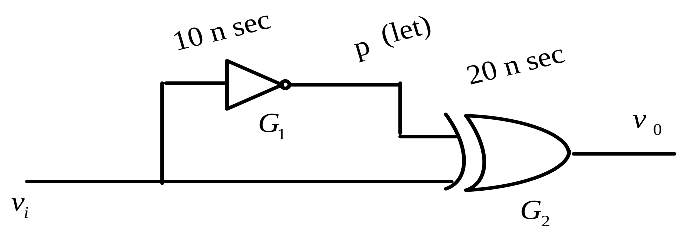
$$= \frac{-j100 \times 100 \times (50+j50)}{-j100\times 100+100(50+j50) - j100\times(50+j50)} = \mathbf{50}\ \Omega$$

$$\boldsymbol{I_{aA}} = \frac{230.94\angle -30^0}{50} = \mathbf{4.62}\angle - \mathbf{30^0}\ \mathbf{A}$$

(c) Real power drawn by the load is = $\mathbf{3} \times \boldsymbol{V_{ph}} \times \boldsymbol{I_{ph}}$ = 3.2 kW

4.

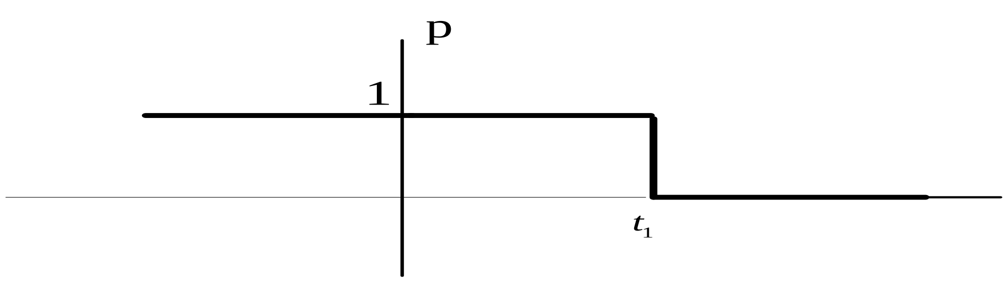




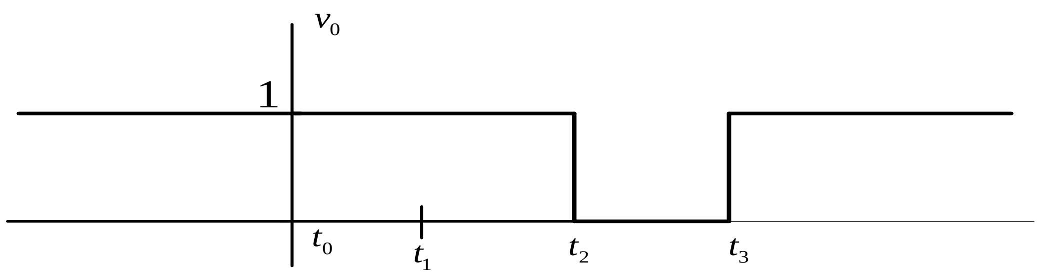
Let $t_1 = t_0 + 10$ nsec

$t_2 = t_0 + 20$ nsec

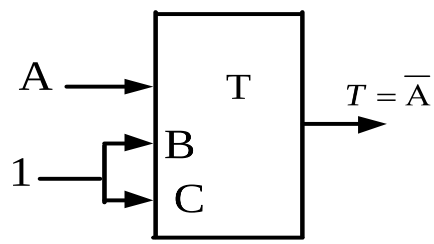
$t_3 = t_0 + 30$ nsec



v_0 at t=t_0 depends on the inputs of G2 at t=t_0 -20 nsec,at $t = t_1$ depends on inputs $t = t_1$-20 nsec and so on



5 . **NOT Gate Implementation :**

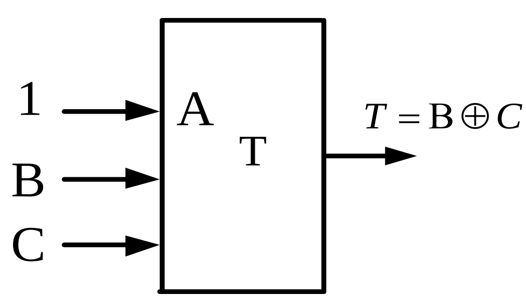


XOR gate:

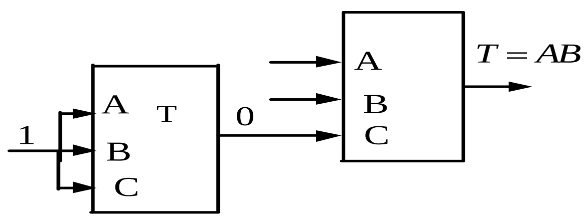
$T = AB\overline{C} + A\overline{B}C + \overline{A}BC$

$= A[B \oplus C] + \bar{A}BC$

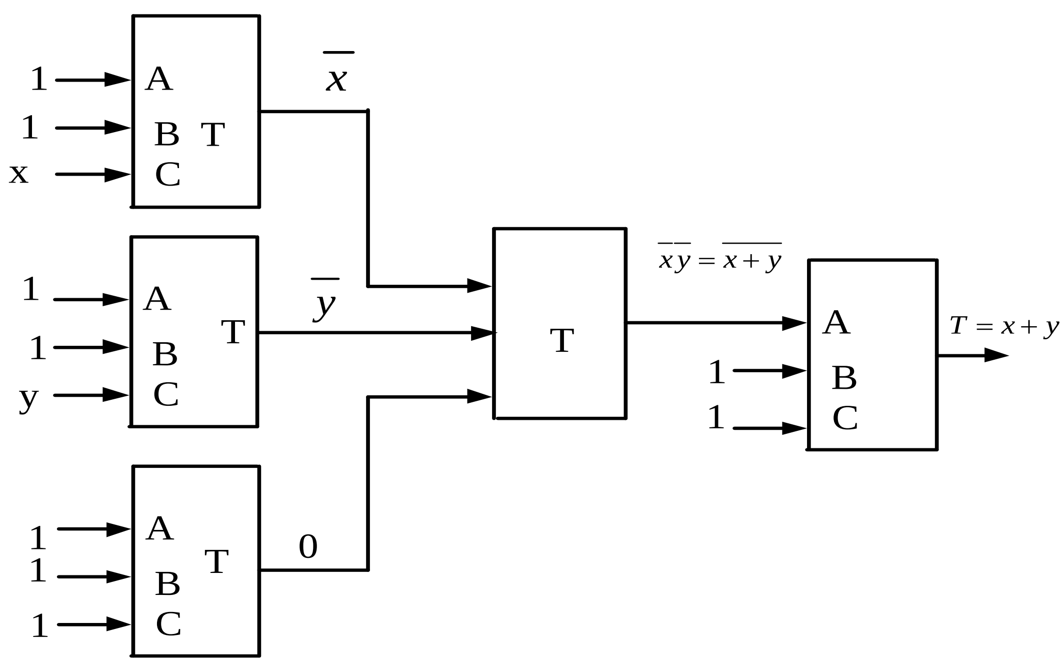
if A=1 $\Longrightarrow T = B \oplus C$



AND Gate



OR Gate:



- T Gate plus the logical value 1 act as a universal gate.