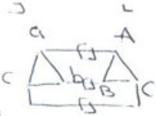
Power

(1) $V_g = 13800\,V \angle 0$

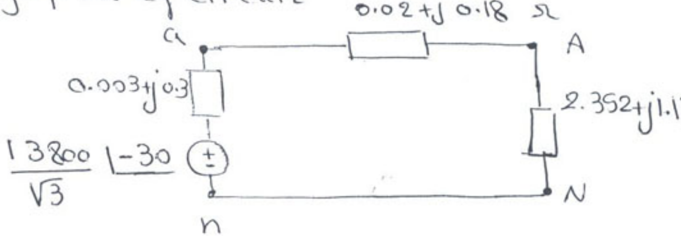


$Z_g = 0.009 + 0.9j\ \Omega/ph$

$Z_{T.L} = 0.02 + 0.18j\ \Omega/ph$

$Z_{load} = 7.056 + 3.417j\ \Omega/ph$

(a) for single phase eq. circuit



(b) $$I_{aA} = \frac{\frac{13800}{\sqrt{3}} \angle -30}{2.375 + j1.619} = \frac{\frac{13800}{\sqrt{3}} \angle -30}{2.87 \angle 34.28}$$

$$= 2776.1 \angle -64.28 \quad A$$

(c) $$V_{AN} = I_{aA} \times Z_{AN} = 2776.1 \angle -64.28 \times (2.352 + j1.13)$$

$$= 2776.1 \angle -64.28 \times (2.61 \angle 25.84)$$

$$= 7245.6 \angle -38.44 \quad \text{Volt}$$

$$|V_{L_{load}}| = |V_{AB}| = \sqrt{3} \times 7245.6 = 12549.7 \text{ volt}$$

(d) $S_{3\phi} = 3V_{an} * I_{aA}^{*}$

$$V_{an} = \frac{13800}{\sqrt{3}}\angle -30 - \left[(0.003 + j\,0.3) * 2776.1\angle -64.3\right]$$

$$= 6145.9 - 4337.2j = 7522.3\angle -35.2\,V$$

$$P = 3\,V_{an} I_{aA} \cos(\theta_V - \theta_I)$$
$$= 3 * 7522.3 * 2776.1 \cos(-35.2 - -64.28)$$
$$= 54.75 \text{ MW}$$

$$Q = 3\,V_{an}\,I_{aA} \sin(\theta_V - \theta_I) = 30.44 \text{ MVAR}$$

$$S = P + jQ = 54.75 + j\,30.44$$
$$= 62.6\,\angle 29.07 \quad \text{MVA}$$

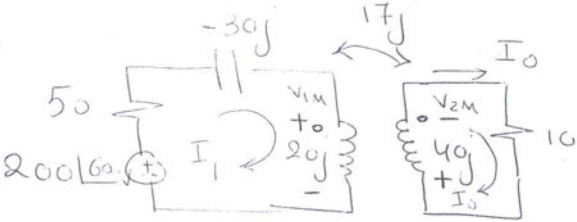
or

$$S_{3\phi} = 3 \times 7522.3\angle -35.2 * 2776.1\angle 64.28$$
$$= 62.6\,\angle 29.07 \quad \text{MVA}$$

② $M = K\sqrt{L_1 L_2}$

$$M = 0.601\sqrt{\frac{20}{2000} * \frac{40}{2000}} = 8.5\times10^{-3}\,H$$

$j\omega M = 17j$ 3



$$\left\{\begin{aligned} &200\angle60 - (50 - 30j + 20j)I_1 - V_{1M} = 0 \\ &V_{1M} = + - I_0(17j) \\ &(40j + 10)I_0 + V_{2M} = 0 \\ &V_{2M} = - + I_1(17j) \end{aligned}\right\} 7$$

$$200\angle60 - (50 - 10j)I_1 + 17j\,I_0 = 0$$

$$(40j + 10)I_0 - 17j\,I_1 = 0$$

$$I_1 = \frac{(10 + 40j)I_0}{17j} =$$

$$200\angle 0 - \frac{(50-10j)(10+40j)}{17j} I_0 + 17j\, I_0 = 0$$

$$200\angle 0 + (-111.16 + 70j)\, I_0 = 0$$

$$I_0 = \frac{200\angle 0}{111.16 - 70j} = \frac{200\angle 0}{131.87\angle -32}$$

$$= 1.52\angle +92 \text{ A}$$

$$I_1 = \frac{10+40j}{17j} I_0 = \left(\frac{10+40j}{17j}\right)(1.52\angle 92)$$

$$= (2.35 - 0.588j)(1.52\angle 92)$$

$$= 2.422\angle -14 \times (\quad)$$

$$= 3.68\angle 78 \text{ A}$$

8 $I_0 = 1.52\left(\cos\left(2000\times 10^{-3} * \frac{180}{\pi} + 92\right)\right)$

$$= -1.36 \text{ A}$$

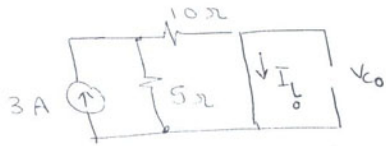
$$I_1 = 3.68 \cos\left(2000\times 10^{-3} \times \frac{180}{\pi} + 78\right)$$

$$= -3.6 \text{ A}$$

$$W = \frac{1}{2} L_1 I_1^2 + \frac{1}{2} L_2 I_0^2 - M I_1 I_0 = +0.042 \text{ J}$$

$$= \frac{1}{2}\left(\frac{20}{2000}\right)(-3.6)^2 + \frac{1}{2}\left(\frac{40}{2000}\right)(-1.36)^2 - \frac{8.5}{1000} * (-3.6)(-1.36)$$

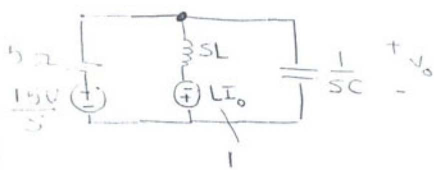
at $t < 0$ switch was opened.



$$I_{L_0} = \frac{3 * 5}{15} = 1A \qquad \text{\&} \quad V_{C_0} = 0$$

at $t \geq 0$ switch was closed.

$$\frac{V_o - \frac{15}{s}}{5} + \frac{V_o + LI_o}{sL} + V_o\, sC = 0$$



$$V_o\left(\frac{1}{5} + \frac{1}{sL} + sC\right) = \frac{3}{s} - \frac{I_o}{s} = \frac{3}{s} - \frac{1}{s} = \frac{2}{s}$$

$$\therefore V_o = \frac{2}{s\left(\frac{1}{5} + \frac{1}{sL} + sC\right)} = \frac{10}{\frac{5*}{100}s^2 + s + 5}$$

$$V_o = \frac{200}{s^2 + 20s + 100} = \frac{200}{(s+10)^2}$$

$\cancel{S_{1,2} = -20 \pm \sqrt{400-}}$

$$V_o(t) = 200t\, e^{-10t}$$

(4) $F(t) = F(-t) \longrightarrow$ even $\rightarrow b_n = .$

$$\frac{T}{2} = 2 \longrightarrow T = 4$$

$$\boxed{F(t) = 1 - t \qquad 0 < t < 2}$$

$(0,1)$ § $(2,-1)$ $\qquad \frac{y-y_1}{x-x_1} = \frac{y_2-y_1}{x_2-x_1}$

$$\frac{y-1}{x-0} = \frac{-1-1}{2-0} = \frac{-2}{2} = -1$$

$$y - 1 = -x \longrightarrow y = 1 - x \qquad f(t) = 1 - t$$

$$a_v = \frac{2}{T}\int_0^{T/2} f(t)\,dt = \frac{2}{T}\int_0^{T/2}(1-t)\,dt$$

$$= \frac{2}{T}\left(t - \frac{t^2}{2}\right)\Big|_0^{T/2} = \frac{2}{T}\left[\left(\frac{T}{2} - 0\right) - \left(\frac{T^2}{8} - 0\right)\right]$$

$$= \frac{2}{T}\left(\frac{T}{2} - \frac{T^2}{8}\right) = 1 - \frac{T}{4} = 1 - \frac{4}{4} = 0$$

$$a_n = \frac{4}{T}\int_0^{T/2} f(t)\cos n\omega_0 t\,dt \qquad \boxed{\omega_0 = \frac{2\pi}{T}}$$

$$= \frac{4}{T}\int_0^{T/2}(1-t)\cos n\omega_0 t\,dt$$

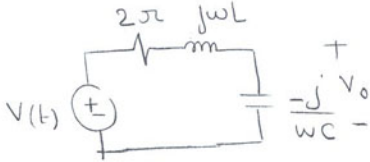
$$= \frac{4}{T}\left[\frac{\sin n\omega_0 t}{n\omega_0} - \left(\frac{1}{(n\omega_0)^2}\cos n\omega_0 t + \frac{t}{n\omega_0}\sin n\omega_0 t\right]_0^{T/2}\right.$$

$$= \frac{4}{T}\left[\frac{T}{n2\pi}\left(\sin n\frac{\pi 2}{T}\frac{T}{2} - 0\right) - \frac{T^2}{(n2\pi)^2}\left(\cos n\frac{2\pi}{T}\frac{T}{2} - 1\right)\right.$$
$$\left. + \frac{T^2}{2n2\pi}\left(\sin n\frac{2\pi}{\cancel{T}}\frac{\cancel{T}}{\cancel{2}} - 0\right)\right.$$

$$a_n = 0 - \frac{T}{(n\pi)^2}\left[\overset{(-1)^n}{\cos(n\pi)} - 1\right] + 0$$

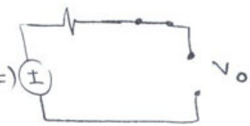
$$V(t) = \underbrace{\left(1 - \frac{\overset{4}{T}}{4}\right)}_{\text{zero}} + \sum_{n=1}^{\infty} \frac{T}{(n\pi)^2}(1 - \cos n\pi)\cos n\omega_0 t$$

$$V_o(t) = \frac{V(t)\left(\frac{-j}{wC}\right)}{2 + j\omega L - \frac{j}{wC}}$$



For DC comp:-

$$V_o = V(t) = 1 - \frac{T}{4} = 1 - \frac{4}{4} = 0$$



For AC comp:-

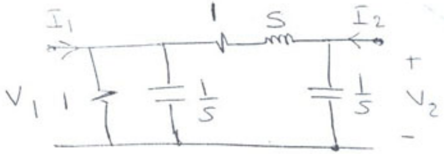
First non zero terms at $n = 1, 3, 5$

at $n=1$

$$V_o(t) = \frac{\frac{4}{\pi^2} \times (2)(-j\,1.27)}{2 + j\,\frac{2\pi}{4} \times 1 - \frac{j}{\frac{2\pi}{4} * 0.5}} = \frac{-1.03j}{2 + 1.57j - j1.27}$$

$$= \frac{-1.03\angle 90}{2 + 0.29j} = \frac{-1.03\angle 90}{2.02\angle 8.25} = -0.51\angle 81.75^\circ$$

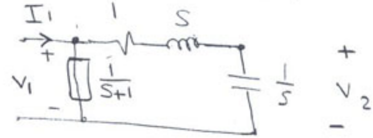
(5)



$$Z_{11} = \frac{V_1}{I_1}\Big|_{I_2=0} \; \& \; Z_{21} = \frac{V_2}{I_1}\Big|_{I_2=0}$$

$$Z_{22} = \frac{V_2}{I_2}\Big|_{I_1=0} \; \& \; Z_{12} = \frac{V_1}{I_2}\Big|_{I_1=0}$$

$\cancel{Z_{11}} =$



$$Z' = \frac{1 \times \frac{1}{S}}{1 + \frac{1}{S}} = \frac{1}{S+1}$$

$$Z_{11} = \frac{\left(S+\frac{1}{S}+1\right)\left(\frac{1}{S+1}\right)}{\left(S+\frac{1}{S}+1+\frac{1}{S+1}\right)} = \frac{S+\frac{1}{S}+1}{\left(S+\frac{1}{S}+1\right)(S+1)+1}$$

$$= \frac{S^2+S+1}{S^3+2S^2+3S+1}$$

$$V_2 = \frac{V_1 \times \frac{1}{S}}{\left(S+\frac{1}{S}+1\right)} = \frac{V_1}{S^2+S+1}$$

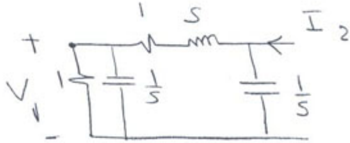
$$I_1 = \frac{V_1}{Z_{11}} = \frac{V_1\,(S^3+2S^2+3S+1)}{(S^2+S+1)}$$

$$Z_{21} = \frac{V_2}{I_1} = \frac{V_1 \quad (S^2+S+1)}{(S^2+S+1) \quad V_1\,(S^3+2S^2+3S+1)}$$

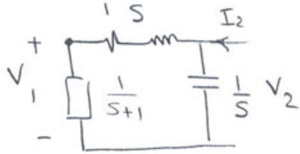
$$Z_{21} = \frac{1}{S^3+2S^2+3S+1}$$

For $Z_{22} = \frac{V_2}{I_2}$

$$Z_{22} = \left[\frac{\left(\frac{1}{s+1} + s+1\right) \times \frac{1}{s}}{\left(\frac{1}{s+1}\right) + 1 + s + \frac{1}{s}} \right]$$



$$= \frac{s(s+1)}{s(s+1)} \left[\quad \right]$$



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

$$= \frac{s^2 + 2s + 2}{s^3 + 2s^2 + 3s + 1}$$

$$V_1 = \frac{V_2 \times \left(\frac{1}{s+1}\right)}{s+1+\left(\frac{1}{s+1}\right)} = \frac{V_2}{(s+1)^2+1} = \frac{V_2}{s^2+2s+2}$$

$$I_2 = \frac{V_2}{Z_{22}} = \frac{V_2\,(s^3+2s^2+3s+1)}{(s^2+2s+2)}$$

$$Z_{12} = \frac{V_1}{I_2} = \frac{V_2 \qquad (s^2+2s+2)}{(s^2+2s+2)\; V_2\,(s^3+2s^2+3s+1)}$$

$$= \frac{1}{s^3+2s^2+3s+1}$$

$$Z = \begin{bmatrix} \frac{s^2+s+1}{s^3+2s^2+3s+1} & \frac{1}{s^3+2s^2+3s+1} \\ \frac{1}{s^3+2s^2+3s+1} & \frac{s^2+2s+2}{s^3+2s^2+3s+1} \end{bmatrix}$$