ECE 4620/5620 [Q_3; SP 2013]; NO: ☐

Name:

Prob 1: The power system shown below has a flat voltage profile of $1.0\angle 0$ p.u. for all $t<0$.

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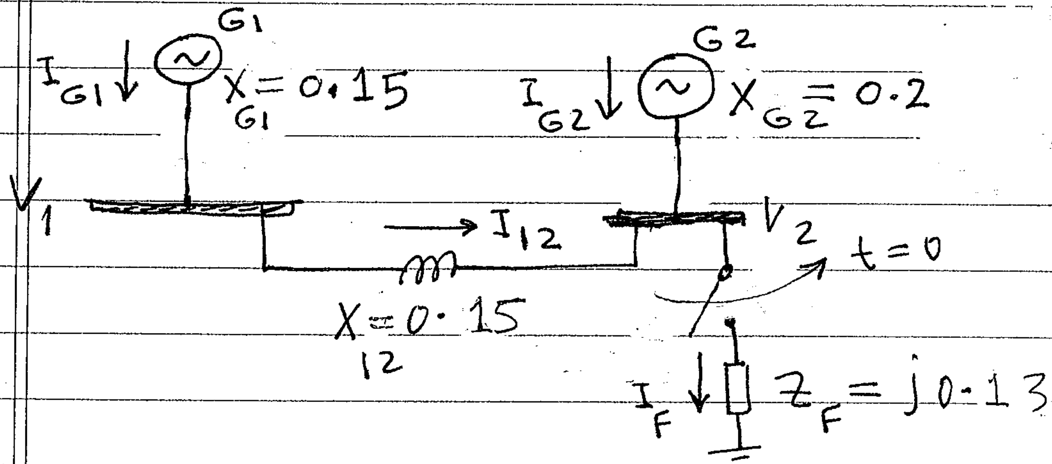

Suddenly at $t=0$ a 3-phase short circuit fault with fault impedance of $Z_F=j0.13$ occurs.

a) Find I_F, V_1, and V_2 during fault.

b) Find I_{G1}, I_{G2}, and I_{12} during fault.

Prob 2: Consider the 3-bus power system shown below. Find the Y-matrix of the system for:

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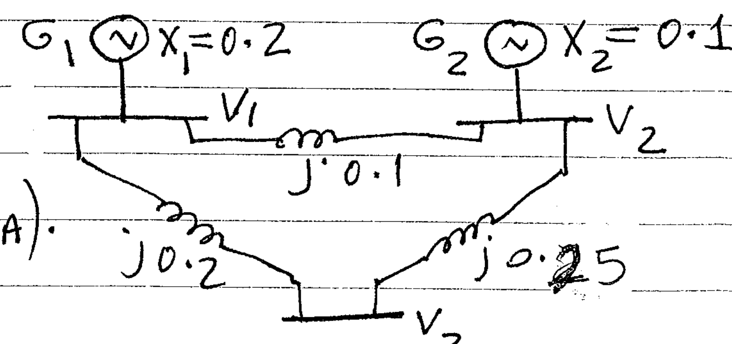
a) Power flow analysis (Y_{PF}).

b) fault analysis (Y_{FA}).



Hint: Make sure you convert the impedances to admittances.

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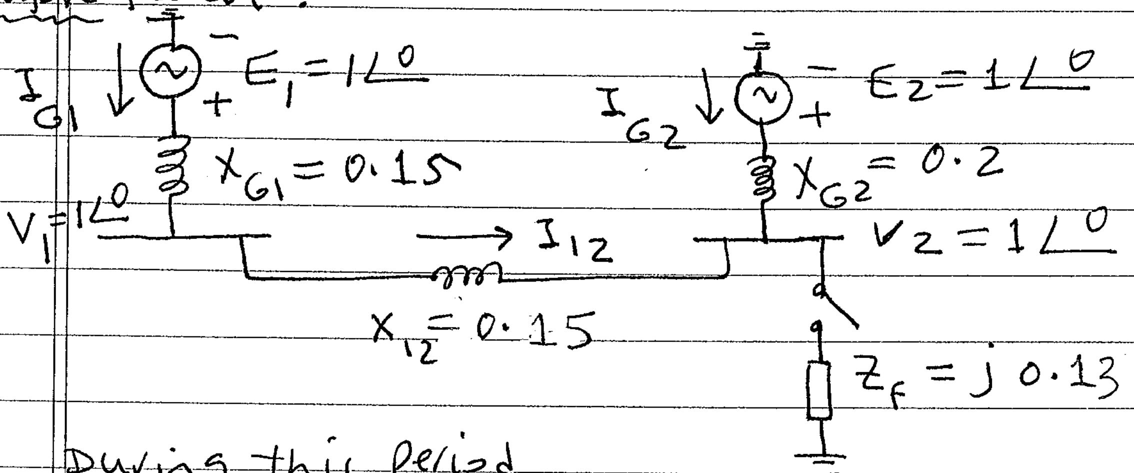
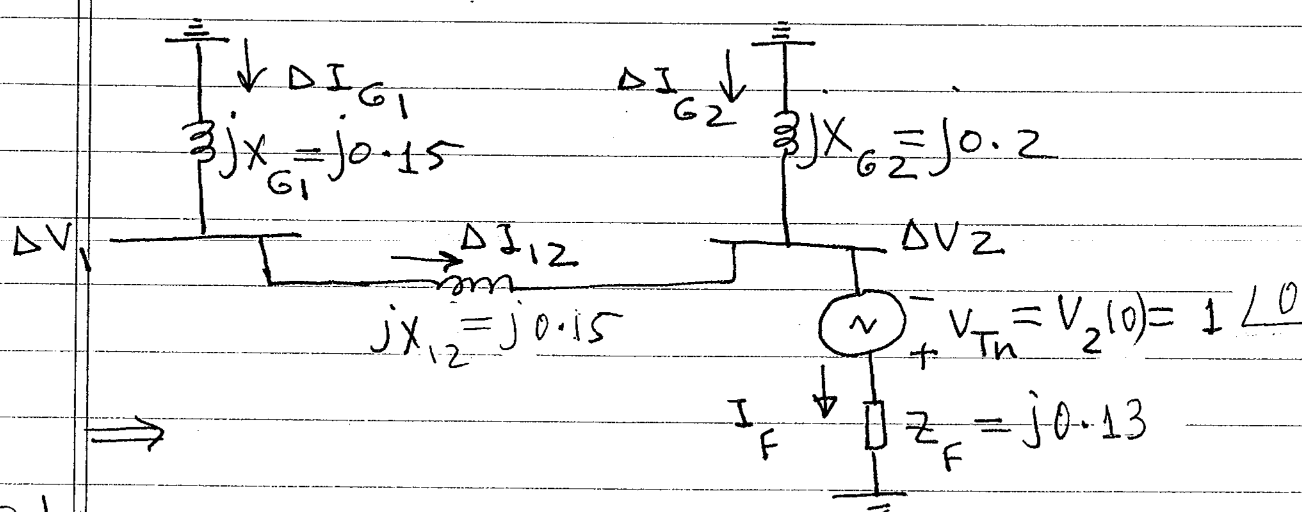
Prob 1. Due to prefault flat voltage profile, voltages at all points are the same value; this value is given $1.0\angle 0$.

Before fault:



During this period all currents are zeros, & $V_2(0) = 1\angle 0$

During fault: To find Δ-values we use Thevinin equivalent circuit:



$\Longrightarrow$

a)

$$I_F = \frac{V_{Th}}{Z_F + \underbrace{(jX_{12} + jX_{G1}) \,\|\, (jX_{G2})}_{Z_{Th}}}$$

where:

$$Z_{th} = (jX_{12} + jX_{G1}) \parallel (jX_{G2})$$

$$= (j0.15 + j0.15) \parallel (j0.2)$$

$$= (j0.3) \parallel (j0.2)$$

$$= j\frac{(0.3)(0.2)}{0.3+0.2} = j\frac{0.06}{0.5}$$

$$= j0.12$$

so,

$$I_F = \frac{V_{Th}}{Z_F + Z_{th}} = \frac{1\angle 0}{j0.13 + j0.12} = \frac{1}{j0.25} = -j4$$

now,

- $\Delta V_2 = -V_{Th} + Z_F I_F = -1\angle 0 + (j0.13)(-j4)$

$$= -1 + 0.52 = -0.48$$

- $\Delta I_{G2} = \dfrac{(X_{G1} + X_{12})}{(X_{G1} + X_{12}) + X_{G2}} \cdot I_F$; current division

$$= \frac{(0.15 + 0.15)}{(0.15 + 0.15) + 0.2} I_F$$

$$= \frac{0.3}{0.5}(-j4) = (0.6)(-j4)$$

$$= -j2.4$$

- $\Delta I_{12} = I_F - \Delta I_{G2} = -j4 - (-j2.4)$

$$= -j4 + j2.4 = -j1.6$$

$$\Delta V_1 = (j X_{G1})(-\Delta I_{G1}) \; ; \; \Delta I_{G1} = \Delta I_{12} = -j1.6$$

$$= (j\,0.15)(-(-j1.6))$$

$$= (j)^2 (0.15)(1.6) = -0.24$$

Now,

$$V_1(F) = V_1(0) + \Delta V_1 = 1\angle 0 - 0.24$$

$$= 0.76 \checkmark$$

$$V_2(F) = V_2(0) + \Delta V_2 = 1\angle 0 - 0.48$$

$$= 0.52$$

b) $\Delta I_{G1} = \Delta I_{12} = -j1.6$; was found previously

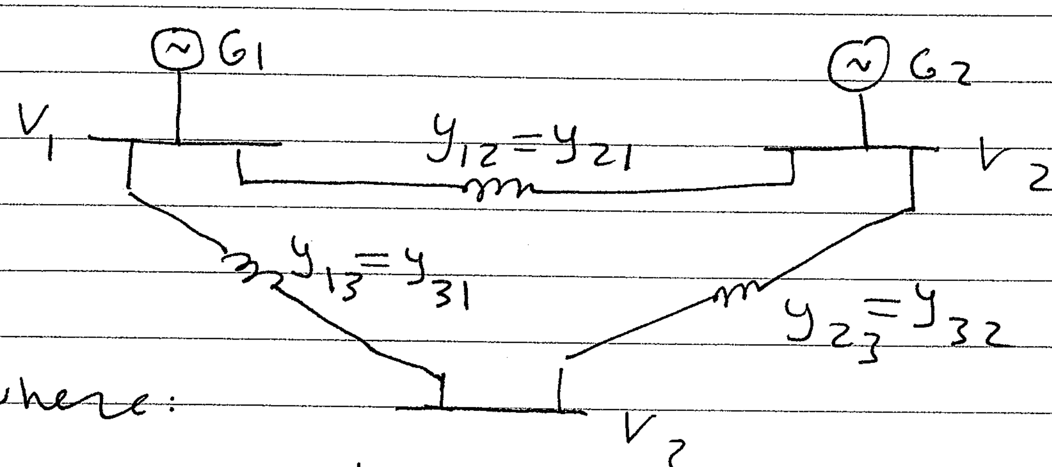
$\Delta I_{G2} = -j2.4$; was found previously

Now,

$$\begin{cases} I_{G1}(F) = I_{G1}(0) + \Delta I_{G1} = 0 - j1.6 = -j1.6 \checkmark \\ I_{12}(F) = I_{G1}(F) = -j1.6 \checkmark \\ I_{G2}(F) = I_{G2}(0) + \Delta I_{G2} = 0 - j2.4 = -j2.4 \checkmark \end{cases}$$

prob 2:

a) For power flow analysis we have:



where:

$$y_{12}=y_{21}=\frac{1}{j0.1}=-j10$$

$$y_{13}=y_{31}=1/(j0.2)=-j5$$

$$y_{23}=y_{32}=1/(j0.25)=-j4$$

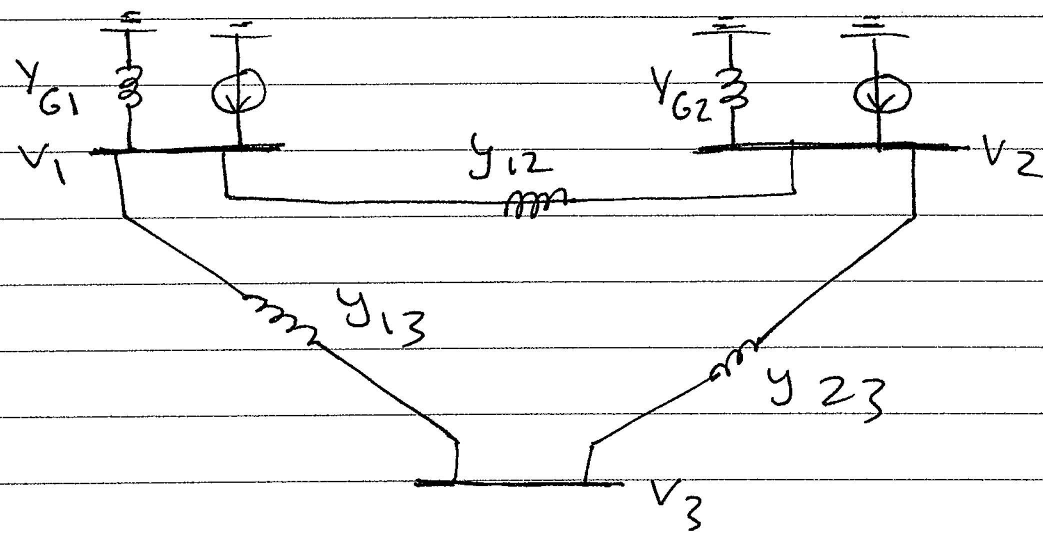
now,

$$Y_{PF}=\begin{bmatrix} y_{12}+y_{13} & -y_{12} & -y_{13} \\ -y_{21} & y_{21}+y_{23} & -y_{23} \\ -y_{31} & -y_{32} & y_{31}+y_{32} \end{bmatrix}$$

$$=\begin{bmatrix} -j15 & +j10 & +j5 \\ +j10 & -j14 & +j4 \\ +j5 & +j4 & -j9 \end{bmatrix}$$

b) (over)

b) For fault analysis we have:



where:

$$Y_{G1} = \frac{1}{jX_{G1}} = \frac{1}{j0.2} = -j5$$

$$Y_{G2} = \frac{1}{jX_{G2}} = \frac{1}{j0.1} = -j10$$

now,

All elements of Y_{FA} are the same as those of Y_{PF} except for:

$$Y_{11,FA} = Y_{11,PF} + Y_{G1} = -j15 - j5 = -j20$$

$$Y_{22,FA} = Y_{22,PF} + Y_{G2} = -j14 - j10 = -j2$$

$\Longrightarrow$

$$Y_{FA} = \begin{bmatrix} -j20 & +j10 & +j5 \\ +j10 & -j24 & +j4 \\ +j5 & +j4 & -j9 \end{bmatrix}$$