ELC-30524
Sistemas de Potencia II

Anexo 1.3
Matrices en Sistemas de Potencia y Calculo de Fallas

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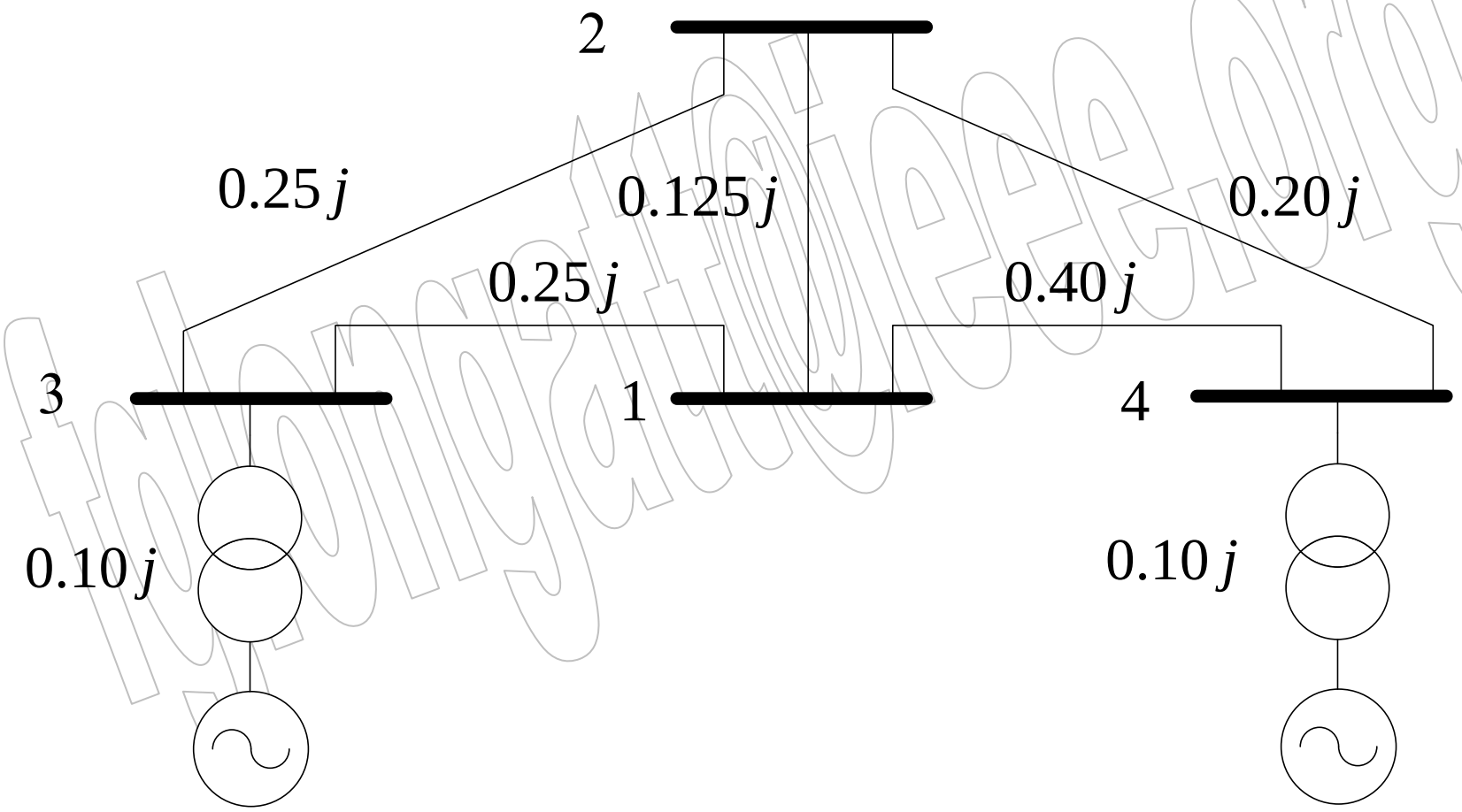
1. Ejemplo

- Considere el sistema de 4 barras que se muestra.



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1. Ejemplo

- Ambas maquinas posee reactancias subtransitorias de 0.20 p.u.
- Se puede combinar la reactancia del transformador con la del generador.

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1. Ejemplo

- Construir la matriz $\mathbf{Y_{bus}}$ de esta red (debe ser una matriz 4x4)
- Considere que hay una falla trifasica en la barra 2.
- Use la descomosicion LU para obtener la 2da columna de la matriz $\mathbf{Z_{bus}}$.
- Calcule la corriente subtransitoria de falla.
- Determine los voltajes durante la falla.
- Determine las corrientes subtransitorias en las lineas 3-2, 1-2 y 4-2.

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1. Ejemplo

- Construir la matriz $\mathbf{Y_{bus}}$ de esta red (debe ser una matriz 4x4)

$$Y_{bus} = \begin{bmatrix} \frac{1}{j.25}+\frac{1}{j.125}+\frac{1}{j.40} & \frac{-1}{j.125} & \frac{-1}{j.25} & \frac{-1}{j.4} \\ \frac{-1}{j.125} & \frac{1}{j.25}+\frac{1}{j.125}+\frac{1}{j.2} & \frac{-1}{j.25} & \frac{-1}{j.2} \\ \frac{-1}{j.25} & \frac{-1}{j.25} & \frac{1}{j.25}+\frac{1}{j.25}+\frac{1}{j.3} & 0 \\ \frac{-1}{j.4} & \frac{-1}{j.25} & 0 & \frac{1}{j.2}+\frac{1}{j.3}+\frac{1}{j.40} \end{bmatrix}$$

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1. Ejemplo

- Construir la matriz $\mathbf{Y_{bus}}$ de esta red (debe ser una matriz 4x4)

$$Y_{bus} = \begin{bmatrix} -j14.5 & j8 & j4 & j2.5 \\ j8 & -j17 & j4 & j5 \\ j4 & j4 & -j11.3333 & 0 \\ j2.5 & j5 & 0 & -j10.83333 \end{bmatrix}$$

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1. Ejemplo

- Use la decomposition LU para obtener la 2da columna de la matriz $\mathbf{Z_{bus}}$.

$$Y_{bus} Z_{bus} = I$$

$$Y_{bus} Z_2 = \begin{bmatrix} 0 \\ 1 \\ 0 \\ 0 \end{bmatrix}$$

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1. Ejemplo

- Se efectuo la descomposicion LU en Matlab.
- y1 es la matriz aumentada

```
>>             y1=[-14.5i,8i,4i,2.5i,0;8i,-17i,4i,5i,1;4i,4i,-11.33333i,0,0;2.5i,5i,0,-
    10.833333i,0]
y1 =
        0 -14.5000i        0 + 8.0000i        0 + 4.0000i        0 + 2.5000i        0
        0 + 8.0000i        0 -17.0000i        0 + 4.0000i        0 + 5.0000i   1.0000
        0 + 4.0000i        0 + 4.0000i        0 -11.3333i        0                  0
        0 + 2.5000i        0 + 5.0000i        0                  0 -10.8333i        0
>> y2=[y1(1,:)/y1(1,1);y1(2,:);y1(3,:);y1(4,:)]
```


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1. Ejemplo

```
y2 =
   1.0000            -0.5517            -0.2759            -0.1724                  0
        0 + 8.0000i        0 -17.0000i        0 + 4.0000i        0 + 5.0000i   1.0000
        0 + 4.0000i        0 + 4.0000i        0 -11.3333i        0                  0
        0 + 2.5000i        0 + 5.0000i        0                  0 -10.8333i        0
>> y3=[y2(1,:);y2(1,:)*-y1(2,2)+y2(2,:);y2(1,:)*-y1(3,3)+y2(3,:);y2(1,:)*-y1(4,4)+y2(4,:)]
y3 =
   1.0000            -0.5517            -0.2759            -0.1724                  0
        0 +25.0000i        0 -26.3793i        0 - 0.6897i        0 + 2.0690i   1.0000
        0 +15.3333i        0 - 2.2529i        0 -14.4598i        0 - 1.9540i        0
        0 +13.3333i        0 - 0.9770i        0 - 2.9885i        0 -12.7011i        0
>> y3=[y2(1,:);y2(1,:)*-y1(2,1)+y2(2,:);y2(1,:)*-y1(3,1)+y2(3,:);y2(1,:)*-y1(4,1)+y2(4,:)]
y3 =
   1.0000            -0.5517            -0.2759            -0.1724                  0
        0                  0 -12.5862i        0 + 6.2069i        0 + 6.3793i   1.0000
        0                  0 + 6.2069i        0 -10.2299i        0 + 0.6897i        0
        0                  0 + 6.3793i        0 + 0.6897i        0 -10.4023i        0
>> y4=[y3(1,:);y3(2,:)/y3(2,2);y3(3,:);y3(4,:)]
y4 =
   1.0000            -0.5517            -0.2759            -0.1724                  0
        0             1.0000            -0.4932            -0.5068                  0 + 0.0795i
        0                  0 + 6.2069i        0 -10.2299i        0 + 0.6897i        0
        0                  0 + 6.3793i        0 + 0.6897i        0 -10.4023i        0
>> y5=[y4(1,:);y4(2,:);y4(2,:)*-y3(3,2)+y4(3,:);y4(2,:)*-y3(4,2)+y4(4,:)
y5 =
   1.0000            -0.5517            -0.2759            -0.1724                  0
        0             1.0000            -0.4932            -0.5068                  0 + 0.0795i
        0                  0                  0 - 7.1689i        0 + 3.8356i   0.4932
        0                  0                  0 + 3.8356i        0 - 7.1689i   0.5068
>> y6=[y5(1,:);y5(2,:);y5(3,:)/y5(3,3);y5(4,:)]
y6 =
   1.0000            -0.5517            -0.2759            -0.1724                  0
        0             1.0000            -0.4932            -0.5068                  0 + 0.0795i
        0                  0             1.0000            -0.5350                  0 + 0.0688i
        0                  0                  0 + 3.8356i        0 - 7.1689i   0.5068
```


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1. Ejemplo

```
>> y7=[y6(1,:);y6(2,:);y6(3,:);y6(3,:)*-y5(4,3)+y6(4,:)]
y7 =
   1.0000            -0.5517            -0.2759            -0.1724                  0
        0             1.0000            -0.4932            -0.5068                  0 + 0.0795i
        0                  0             1.0000            -0.5350                  0 + 0.0688i
        0                  0                  0                  0 - 5.1168i   0.7707
>> y8=[y7(1,:);y7(2,:);y7(3,:);y7(4,:)/y7(4,4)]
y8 =
   1.0000            -0.5517            -0.2759            -0.1724                  0
        0             1.0000            -0.4932            -0.5068                  0 + 0.0795i
        0                  0             1.0000            -0.5350                  0 + 0.0688i
        0                  0                  0             1.0000                  0 + 0.1506i
>> z4=y8(4,5)
z4 =
        0 + 0.1506i
>> z3=y8(3,5)-y8(3,4)*z4
z3 =
        0 + 0.1494i
>> z2=y8(2,5)-y8(2,4)*z4-y8(2,3)
z2 =
   0.4932 + 0.1558i
>> z2=y8(2,5)-y8(2,4)*z4-y8(2,3)*z3
z2 =
        0 + 0.2295i
>> z1=y8(1,5)-y8(1,4)*z4-y8(1,3)*z3-y8(1,2)*z2
z1 =
        0 + 0.1938i
>>
>> Z2=[z1;z2;z3;z4]
Z2 =
        0 + 0.1938i
        0 + 0.2295i
        0 + 0.1494i
        0 + 0.1506i
```


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1. Ejemplo

- Calcular la corriente subtransitoria de falla.
- Se conoce:

```
>> Z2=[z1;z2;z3;z4]
Z2 =
        0 + 0.1938i
        0 + 0.2295i
        0 + 0.1494i
        0 + 0.1506i
```

$$I''_f = \frac{V_f}{Z_{22}} = \frac{1}{j.2295} = -j4.3573\,pu\_or\_4.3573\angle -90°\,pu$$

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1. Ejemplo

- Determine los voltajes durante la falla:

$$V_{if} = V_j - \frac{Z_{jk}}{Z_{kk}} V_f$$

$$V_{1f} = V_1 - \frac{Z_{12}}{Z_{22}} V_f = 1 - \frac{j.1938}{j.2295} 1 = .15556\,pu$$

$$V_{2f} = 0$$

$$V_{3f} = V_3 - \frac{Z_{32}}{Z_{22}} V_f = .34902\,pu$$

$$V_{4f} = V_4 - \frac{Z_{42}}{Z_{22}} V_f = .343791 pu$$

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1. Ejemplo

- Determine las corrientes por las lineas 3-2, 1-2, y 4-2.

$$I''_{ij} = -V_f \frac{Z_{ik} - Z_{jk}}{Z_b Z_{kk}}$$

$$I''_{32} = -V_f \frac{Z_{32} - Z_{22}}{Z_b Z_{22}} = -1 \frac{j.1494 - j.2295}{(j.25)(j.2295)} = -j1.39608\,pu$$

$$I''_{12} = -V_f \frac{Z_{12} - Z_{22}}{Z_b Z_{22}} == -j1.244\,pu$$

$$I''_{42} = -V_f \frac{Z_{42} - Z_{22}}{Z_b Z_{22}} == -j1.71895\,pu$$

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