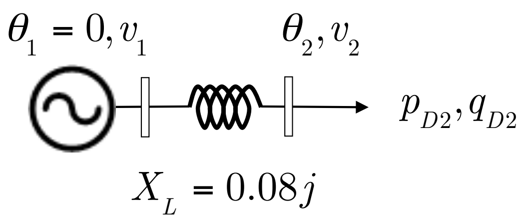
Solución
Prueba escrita

En el siguiente circuito se dispone de 4 mediciones (z), todas con la misma precisión. Estime el valor de la demanda reactiva:



$$\mathbf{z} = \begin{bmatrix} \theta_2^m \\ v_1^m \\ v_2^m \\ p_2^m = -p_{D2}^m \end{bmatrix} = \begin{bmatrix} 0.0324 \\ 1.0000 \\ 0.9481 \\ -0.820 \end{bmatrix}$$

Injection

$\frac{\partial P_i}{\partial V_i}$	$\sum_{j=1}^{N} V_j(G_{ij}\cos\theta_{ij} + B_{ij}\sin\theta_{ij}) + V_i G_{ii}$
$\frac{\partial P_i}{\partial V_j}$	$V_i(G_{ij}\cos\theta_{ij} + B_{ij}\sin\theta_{ij})$
$\frac{\partial Q_i}{\partial V_i}$	$\sum_{j=1}^{N} V_j(G_{ij}\sin\theta_{ij} - B_{ij}\cos\theta_{ij}) - V_i B_{ii}$
$\frac{\partial Q_i}{\partial V_j}$	$V_i(G_{ij}\sin\theta_{ij} - B_{ij}\cos\theta_{ij})$
$\frac{\partial P_i}{\partial \theta_i}$	$\sum_{j=1}^{N} V_i V_j(-G_{ij}\sin\theta_{ij} + B_{ij}\cos\theta_{ij}) - V_i^2 B_{ii}$
$\frac{\partial P_i}{\partial \theta_j}$	$V_i V_j(G_{ij}\sin\theta_{ij} - B_{ij}\cos\theta_{ij})$
$\frac{\partial Q_i}{\partial \theta_i}$	$\sum_{j=1}^{N} V_i V_j(G_{ij}\cos\theta_{ij} + B_{ij}\sin\theta_{ij}) - V_i^2 G_{ii}$
$\frac{\partial Q_i}{\partial \theta_j}$	$-V_i V_j(G_{ij}\cos\theta_{ij} + B_{ij}\sin\theta_{ij})$

Maestría
Análisis de Sistemas Eléctricos de Potencia

Universidad de los Andes
de Ingeniería

SGEE   PRUEBA ESCRITA — SOLUCIÓN

SISTEMA

$\bar{P}_2 = -P_{D2} - jQ_{D2}$

$\bar{V}_1 = V_1 e^{j\theta_1}$ $\bar{V}_2 = V_2 e^{j\theta_2}$

DATA

$\theta_1 = 0°$ REFERENCIA

$X_L = 0.08$ pu

$$Z = \begin{bmatrix} \theta_2^m \\ V_1^m \\ V_2^m \\ P_2^m \end{bmatrix} = \begin{bmatrix} 0.0324 \\ 1.0000 \\ 0.9481 \\ -0.8200 \end{bmatrix}$$

MATRIZ DE ADMITANCIA:

$$Y = G + jB = \begin{bmatrix} B_{11} & B_{12} \\ B_{21} & B_{22} \end{bmatrix} = \begin{bmatrix} -12.5 & 12.5 \\ 12.5 & -12.5 \end{bmatrix} \text{ pu}$$

JACOBIANO

$$\begin{array}{cc} & \begin{array}{ccc} \theta_2 & V_1 & V_2 \end{array} \\ H = & \begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ \frac{\partial P_2}{\partial \theta_2} & \frac{\partial P_2}{\partial V_1} & \frac{\partial P_2}{\partial V_2} \end{bmatrix} \begin{array}{c} \theta_2 \\ V_1 \\ V_2 \\ P_2 \end{array} \end{array}$$

donde $\frac{\partial P_2}{\partial \theta_2} = V_2 V_1 B_{21} \cos\theta_2$

$\frac{\partial P_2}{\partial V_1} = V_2 B_{21} \operatorname{Sen}\theta_2$

$\frac{\partial P_2}{\partial V_2} = V_1 B_{12} \operatorname{Sen}\theta_2$

Comenzamos con $x^0 = [\theta_2^0 \; V_1^0 \; V_2^0]^T = [0\,1\,1]^T$

$h^0_{(x)} = [\theta_2^0 \; V_1^0 \; V_2^0 \;\; V_1^0 V_2^0 B_{12} \sin\theta_2^0]^T = [0\;1\;1\;0]^T$

$\theta_2 \; V_1 \; V_2$ $P_2(x)$

$$H^0 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ B_{21} & 0 & 0 \end{bmatrix} \Rightarrow x^1 = x^0 + [H^T \cdot W \cdot H]^{-1} H \cdot W \cdot [z - h]$$

$x^1 = x^0 + \Delta x^0$

$\max(\|\Delta x^0\|)$

$$H^0 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ B_{21} & 0 & 0 \end{bmatrix} \Rightarrow x^1 = x^0 + [H^T \cdot W \cdot H]^{-1} H \cdot W \cdot [z - h]$$

$x^1 = x^0 + \Delta x^0$

$\max(\|\Delta x^0\|) = 0.06 > 1\%$

$$\begin{bmatrix} \theta_2^1 \\ V_1^1 \\ V_2^1 \end{bmatrix} = \begin{bmatrix} -0.0650 \\ 1.0000 \\ 0.9481 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} + \begin{bmatrix} -0.065 \\ 0 \\ -0.0519 \end{bmatrix}$$

NO Converge!

$h^1_{(x)} = [\theta_2^1 \; V_1^1 \; V_2^1 \; P_2^1]^T = [-0.065 \;\; 1.000 \;\; 0.9481 \;\; -0.7695]^T$

$$H^1_{(x)} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 11.82 & -0.76 & -0.81 \end{bmatrix} \Rightarrow x^2 = x^1 + \Delta x^1$$

$$\begin{bmatrix} \theta_2^2 \\ V_1^2 \\ V_2^2 \end{bmatrix} = \begin{bmatrix} -0.065 \\ +1.000 \\ +0.9481 \end{bmatrix} + \begin{bmatrix} -0.0027 \\ 0.0065 \\ 0.0069 \end{bmatrix} = \begin{bmatrix} -0.0676 \\ 1.0065 \\ 0.9549 \end{bmatrix}$$

$\max(|\Delta x^1|) = 0.0069 < 1\%$

Converge!

$h_{(x)} = [-0.0676 \;\; 1.0065 \;\; 0.9549 \;\; -0.8120]^T$

$J_{(x)} = \sum_{i=1}^{4} w_{ii} (z_i - h_i)^2 = 0.0102$

$P_{d2} = -h(4) = 0.8120$

La demanda de Potencia Reactiva ESTIMADA ES:

$Q_{D2} = V_2 V_1 B_{21} \cos\theta_2 + V_2^2 B_{22} = 0.588$

Sistemas de Gestión de Energía Eléctrica

Solución
Prueba escrita

```
% Prueba escrita — Estimación de Estado
clc
clear all
t1=0;
XL=.08;
S=-complex(.8,.6);
v1=1;v2=1;
for k=1:3
v2=v1+complex(0,XL)*conj(S/v2);
end
z=[angle(v2)+.1; 1; abs(v2)+.001; real(S)-.02];
W=eye(4,4);
B11=-inv(XL);B21=inv(XL);B22=-inv(XL);
%flat begin
t2=0;v1=1;v2=1;
e=1;
dP2dt2=v2*v1*B21*cos(t2-t1);
dP2dv1=v2*B21*sin(t2-t1);
dP2dv2=v1*B21*sin(t2-t1);
H=[1 0 0; 0 1 0; 0 0 1; dP2dt2 dP2dv1 dP2dv2]
P2=v2*v1*B21*sin(t2-t1);
h=[t2; v1; v2; P2]
x=[t2; v1; v2];
dx=inv(H'*W*H)*H'*W*(z-h)
e=max(abs(dx))
disp('NO Converge!')
x=x+dx
t2=x(1);v1=x(2);v2=x(3);
P2=v2*v1*B21*sin(t2-t1);
h=[t2; v1; v2; P2]
dP2dt2=v2*v1*B21*cos(t2-t1);
dP2dv1=v2*B21*sin(t2-t1);
dP2dv2=v1*B21*sin(t2-t1);
H=[1 0 0; 0 1 0; 0 0 1; dP2dt2 dP2dv1 dP2dv2]
dx=inv(H'*W*H)*H'*W*(z-h)
x=x+dx
t2=x(1);v1=x(2);v2=x(3);
e=max(abs(dx))
disp('Converge!')
P2=v2*v1*B21*sin(t2-t1);
h=[t2; v1; v2; P2]
J=sum((z-h).^2)
pd2=-h(4)
qd2=+v2*v1*B21*cos(t2-t1)+v2^2*B22
```