E_E 491
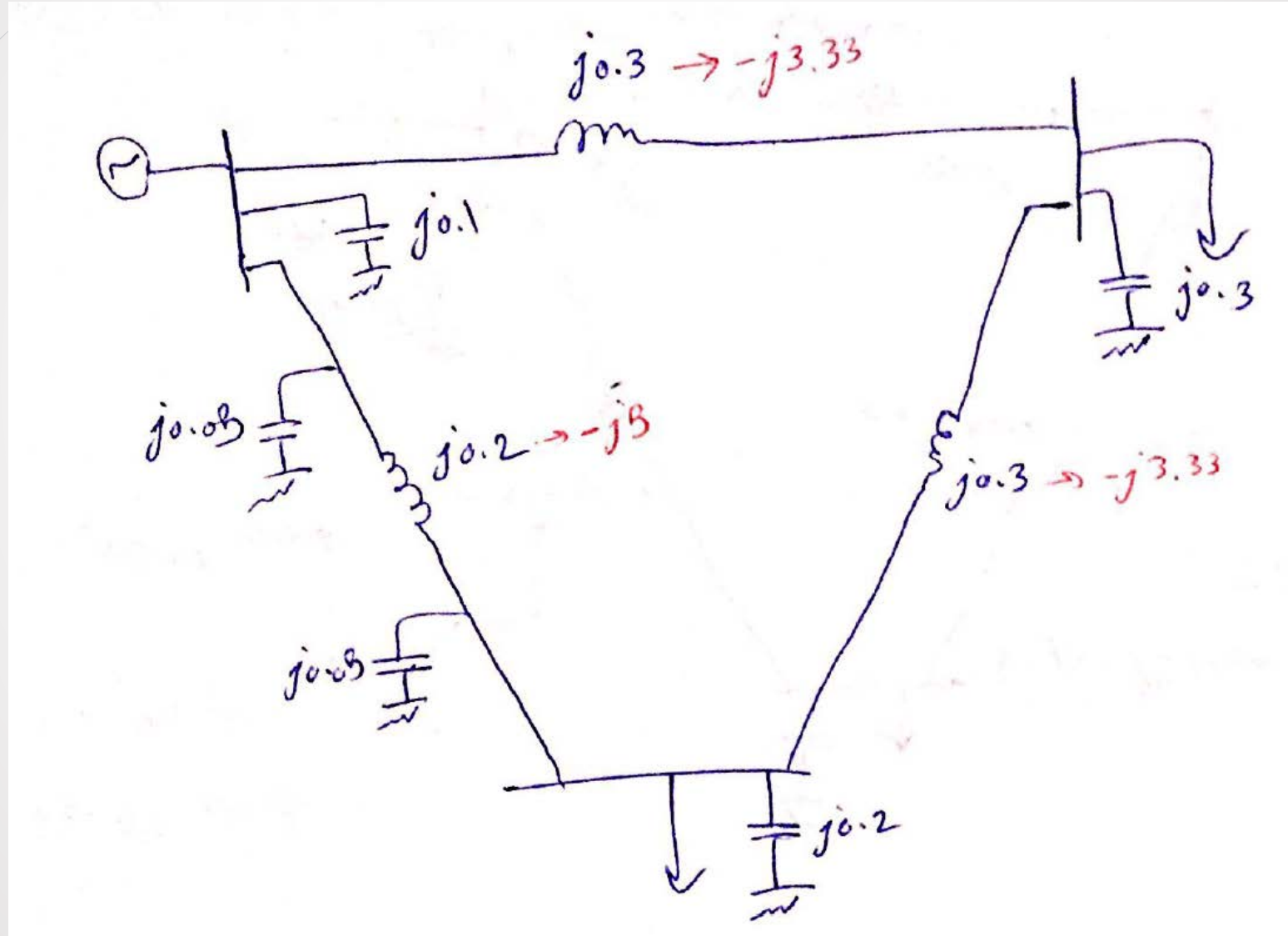# Review Session #3

Ali Shakeri Kahnamouei

Fall 2020
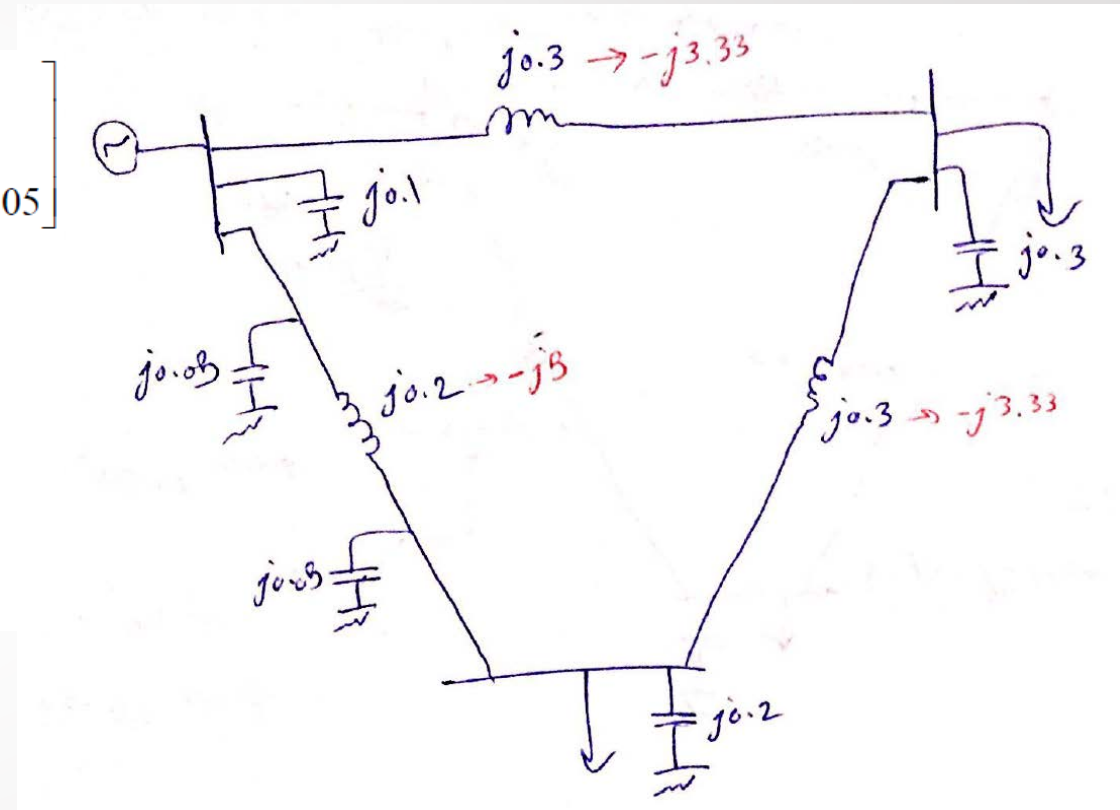
Determine Ybus Matrix (Ex. 1)

Determine Ybus Matrix (Ex. 1)

$$\overline{Y_{BUS}} = \begin{bmatrix} -j3.33 - j5 + j0.05 + j0.1 & j3.33 & j5 \\ j3.33 & -j3.33 - j3.33 + j0.3 & j3.33 \\ j5 & j3.33 & -j5 - j3.33 + j0.2 + j0.05 \end{bmatrix}$$

$$\Rightarrow \overline{Y_{BUS}} = \begin{bmatrix} -j8.18 & j3.33 & j5 \\ j3.33 & -j6.36 & j3.33 \\ j5 & j3.33 & -j8.08 \end{bmatrix}$$

$$\Rightarrow\Rightarrow \overline{Y_{BUS}} = \begin{bmatrix} 8.18\angle -90° & 3.33\angle 90° & 5\angle 90° \\ 3.33\angle 90° & 6.36\angle -90° & 3.33\angle 90° \\ 5\angle 90° & 3.33\angle 90° & 8.08\angle -90° \end{bmatrix}$$

Power Flow Equations

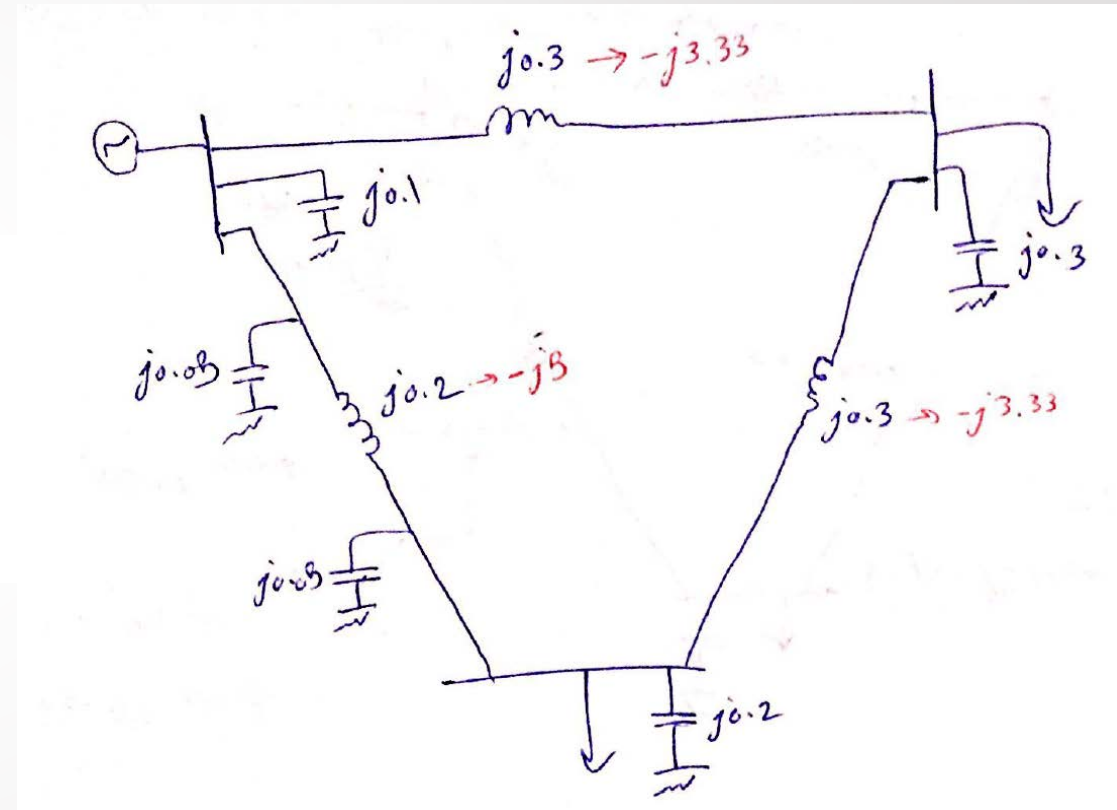| Bus Type	Given Parameters	Unknown Parameters
Slack Bus	V, δ	P, Q
Generator Bus	P, |V|	Q, δ
Load Bus	P, Q	V, δ

$$P_i = \sum_{j=1}^{n} \left| Y_{ij} V_i V_j \right| \cos(\delta_i - \delta_j - \theta_{ij})$$

$$Q_i = \sum_{j=1}^{n} \left| Y_{ij} V_i V_j \right| \sin(\delta_i - \delta_j - \theta_{ij})$$

Power Flow Equations (Ex. 1)

$V1 = 1, \delta1 = 0, \; PL2 = 0.2, QL2 = 0.1, PL3 = 0.5, QL3 = 0.3$

(1) Slack Bus: $V1 = 1, \delta1 = 0, P1 = ?, Q1 = ?$

(2) PQ Bus: $P2 = PG2 - Pl2 = 0 - 0.2 = -0.2, Q2 = -0.1, V2=?, \delta2 = ?$

(3) PQ Bus: $P3 = -0.5, Q3 = -0.3, V3 = ?, \delta3 = ?$

Power Flow Equations (Ex. 1)

$$\overline{Y_{BUS}} = \begin{bmatrix} 8.18\angle-90° & 3.33\angle90° & 5\angle90° \\ 3.33\angle90° & 6.36\angle-90° & 3.33\angle90° \\ 5\angle90° & 3.33\angle90° & 8.08\angle-90° \end{bmatrix}$$

P1 = 3.33*V1*V2*cos(-δ2−90) + 5*V1*V3*cos(-δ3−90)

Q1= 8.18*V1^2*sin(90) + 3.33*V1*V2*sin(δ1−δ2−90) + 5*V1*V3*sin(δ1−δ3−90)

Bus 2:

P2 = 3.33*V2*V1*cos(δ2−δ1−90) + 6.36*V2^2*cos(90) +3.33*V2*V3*cos(δ2−δ3−90)

Q2 = 3.33*V2*V1*sin(δ2−δ1−90) + 6.36*V2^2*sin(90) +3.33*V2*V3*sin(δ2−δ3−90)

Bus 3:

P3 = 5*V3*V1*cos(δ3−δ1−90) + 3.33*V3*V2*cos(δ3−δ2−90) +8.08*V3^2*cos(90)

Q3 = 5*V3*V1*sin(δ3−δ1−90) + 3.33*V3*V2*sin(δ3−δ2−90) +8.08*V3^2*sin(90)

Determine Ybus Matrix (Ex. 2)

$0.03 + j0.4 \rightarrow \dfrac{1}{0.03 + j0.4} = 0.3077 - j2.4615$

$j0.05$

$j0.05$

$j0.3$

$0.04 + j0.3$

$0.03 + j0.2$

$\dfrac{1}{0.04 + j0.3} = 0.4367 - j3.2751$

$= \dfrac{1}{0.03 + j0.2} = 0.7335 - j4.89$

Determine Ybus Matrix (Ex. 2)

$$\overline{Y}_{BUS} = \begin{bmatrix} 0.3077 - j2.4615 + 0.4367 \\ -j3.2751 + j0.05 & -0.3077 + j2.4615 & -0.4367 + j3.2751 \\ & 0.3077 - j2.4615 + 0.7335 \\ -0.3077 + j2.4615 & -j4.89 + j0.05 + j0.3 & -0.7335 + j4.89 \\ & & 0.4367 - j3.2751 + \\ -0.4367 + j3.2751 & -0.7335 + j4.89 & 0.7335 - j4.89 + j0.2 \end{bmatrix}$$

$$\Rightarrow \overline{Y}_{BUS} = \begin{bmatrix} 0.7444 - j5.6866 & -0.3077 + j2.4615 & -0.4367 + j3.2751 \\ -0.3077 + j2.4615 & 1.0412 - j7.0015 & -0.7335 + j4.89 \\ -0.4367 + j3.2751 & -0.7335 + j4.89 & 1.1702 - j7.9651 \end{bmatrix}$$

$$\Rightarrow \overline{Y}_{BUS} = \begin{bmatrix} 5.7351\angle -82.54° & 2.4842\angle 97.125° & 3.3041\angle 97.595° \\ 2.4842\angle 97.125° & 7.0785\angle -81.54° & 4.9447\angle 98.53° \\ 3.3041\angle 97.595° & 4.9447\angle 98.53° & 8.051\angle -81.64° \end{bmatrix}$$
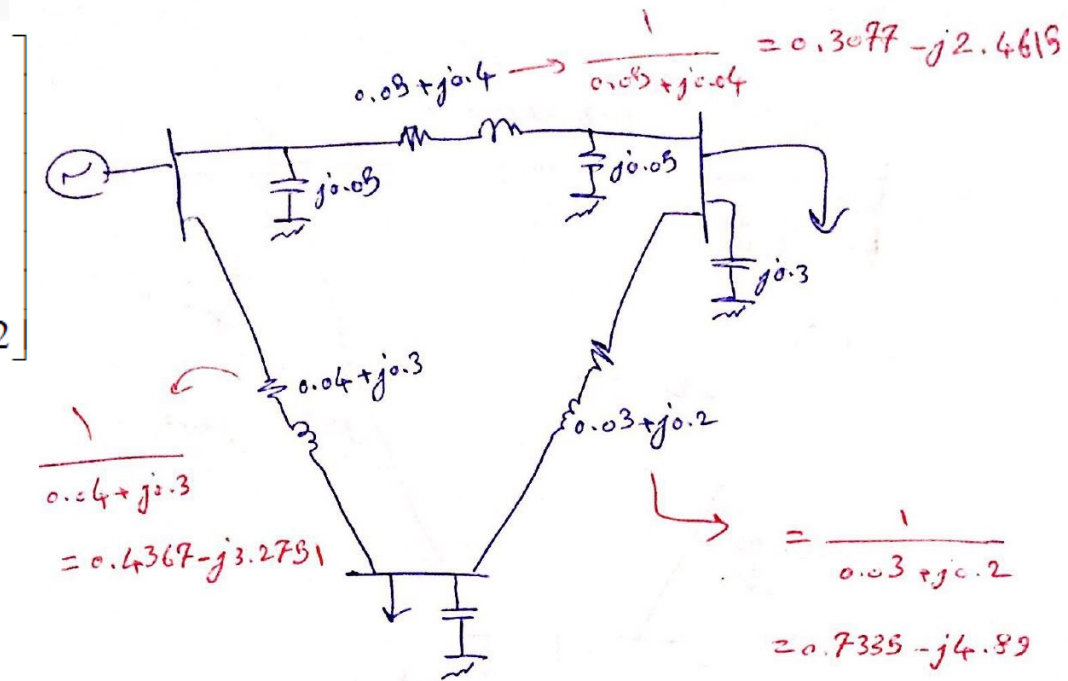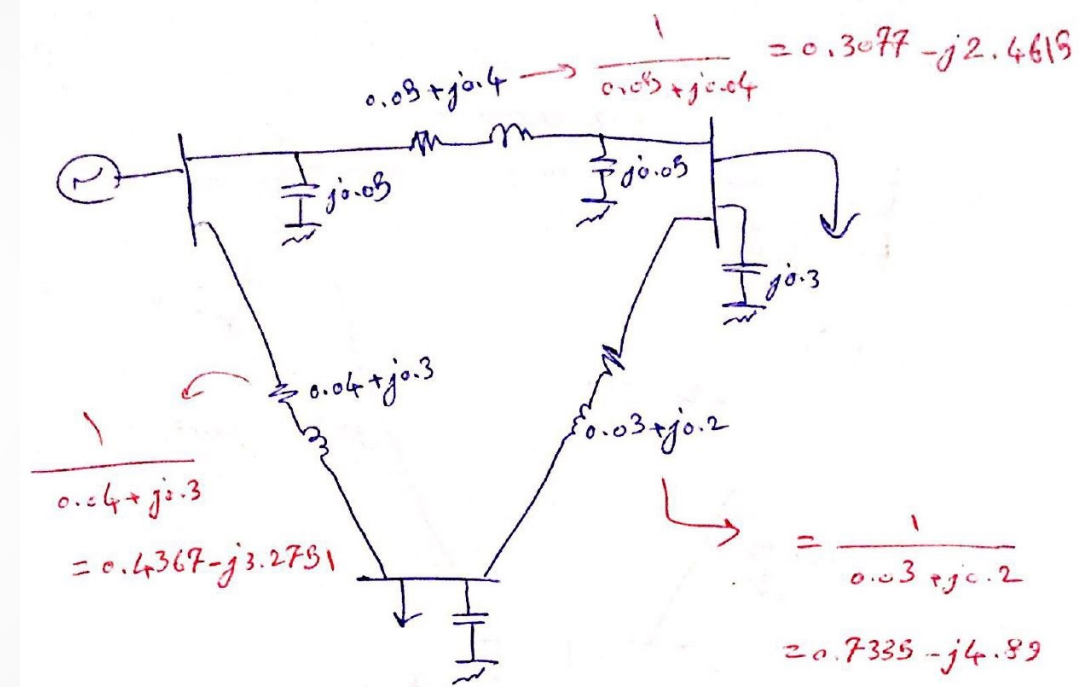
Power Flow Equations (Ex. 2)

$V1 = 1, \delta1 = 0, PL2 = 0.6, QL2 = 0.2, PL3 = 0.8, QL3 = 0.3$

(1) Slack Bus: $V1 = 1, \delta1 = 0, P1 = ?, Q1 = ?$
(2) PQ Bus: $P2 = -0.6, Q2 = -0.2, V2 = ?, \delta2 = ?$
(3) PQ Bus: $P3 = -0.8, Q3 = -0.3, V3 = ?, \delta3 = ?$

Power Flow Equations (Ex. 2)

P1 = 5.7351*V1^2*cos(82.54) + 2.4842*V1*V2*cos(-δ2−97.125) + 3.3041*V1*V3*cos(-δ3−97.595)

Q1= 5.7351*V1^2*sin(82.54) + 2.4842*V1*V2*sin(-δ2−97.125) + 3.3041*V1*V3*sin(-δ3−97.595)

$$\overline{Y_{BUS}} = \begin{bmatrix} 5.7351\angle{-82.54}° & 2.4842\angle{97.125}° & 3.3041\angle{97.595}° \\ 2.4842\angle{97.125}° & 7.0785\angle{-81.54}° & 4.9447\angle{98.53}° \\ 3.3041\angle{97.595}° & 4.9447\angle{98.53}° & 8.051\angle{-81.64}° \end{bmatrix}$$

Bus 2:

P2 = 2.4842*V2*V1*cos(δ2−δ1−97.125) + 7.0785*V2^2*cos(81.54)   + 4.9447*V2*V3*cos(δ2−δ3−98.53)

Q2 = .4842*V2*V1*sin(δ2−δ1−97.125) + 7.0785*V2^2*sin(81.54)   + 4.9447*V2*V3*sin(δ2−δ3−98.53)

Bus 3:

P3 = 3.3041*V3*V1*cos(δ3−δ1−97.595) + 4.9447*V3*V2*cos(δ3−δ2−98.53) +8.051*V3^2*cos(81.64)

Q3 = 3.3041*V3*V1*sin(δ3−δ1−97.595) + 4.9447*V3*V2*sin(δ3−δ2−98.53) +8.051*V3^2*sin(81.64)

Questions?