ASPEN Tutorial

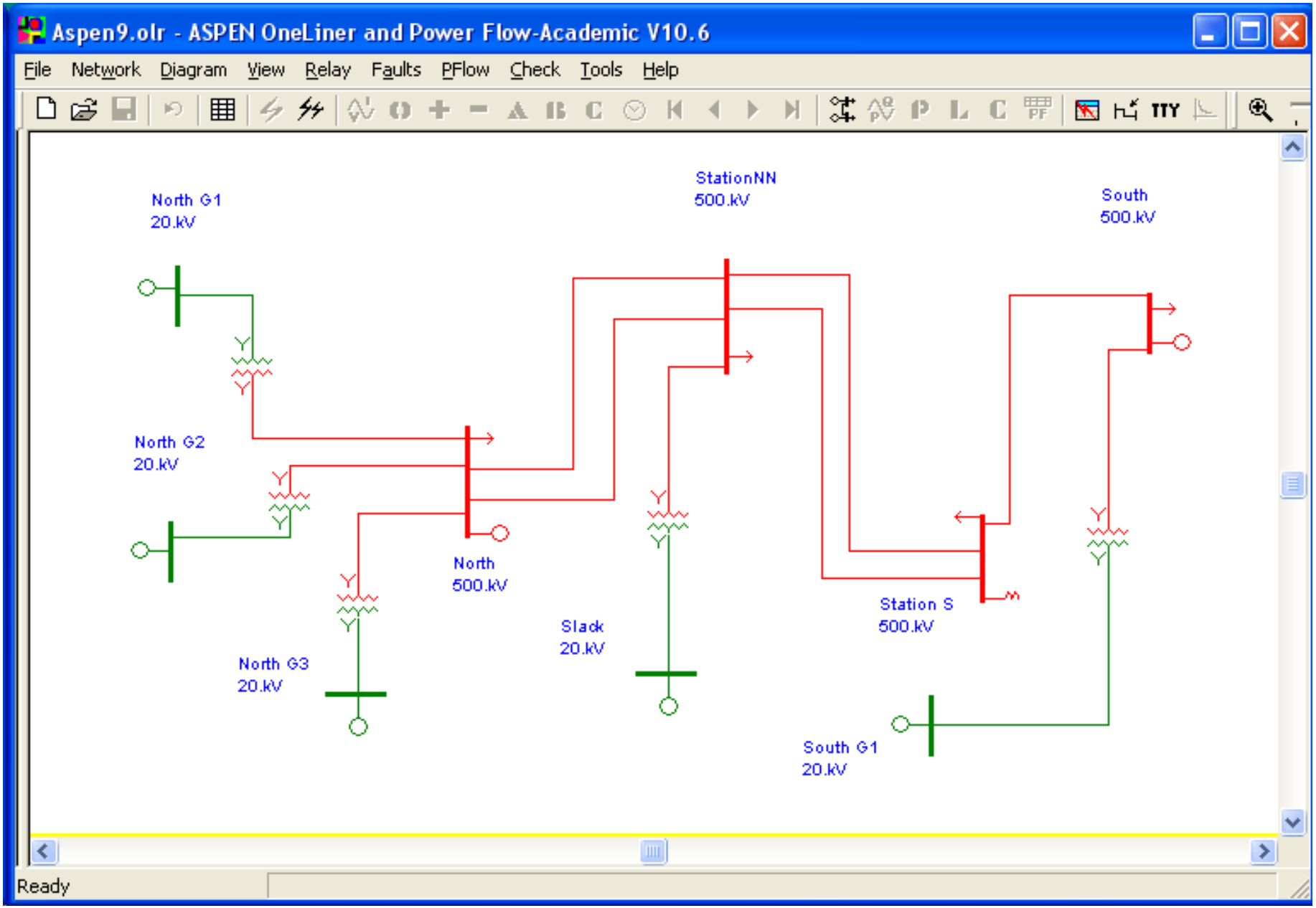
Intro to Software Capabilities

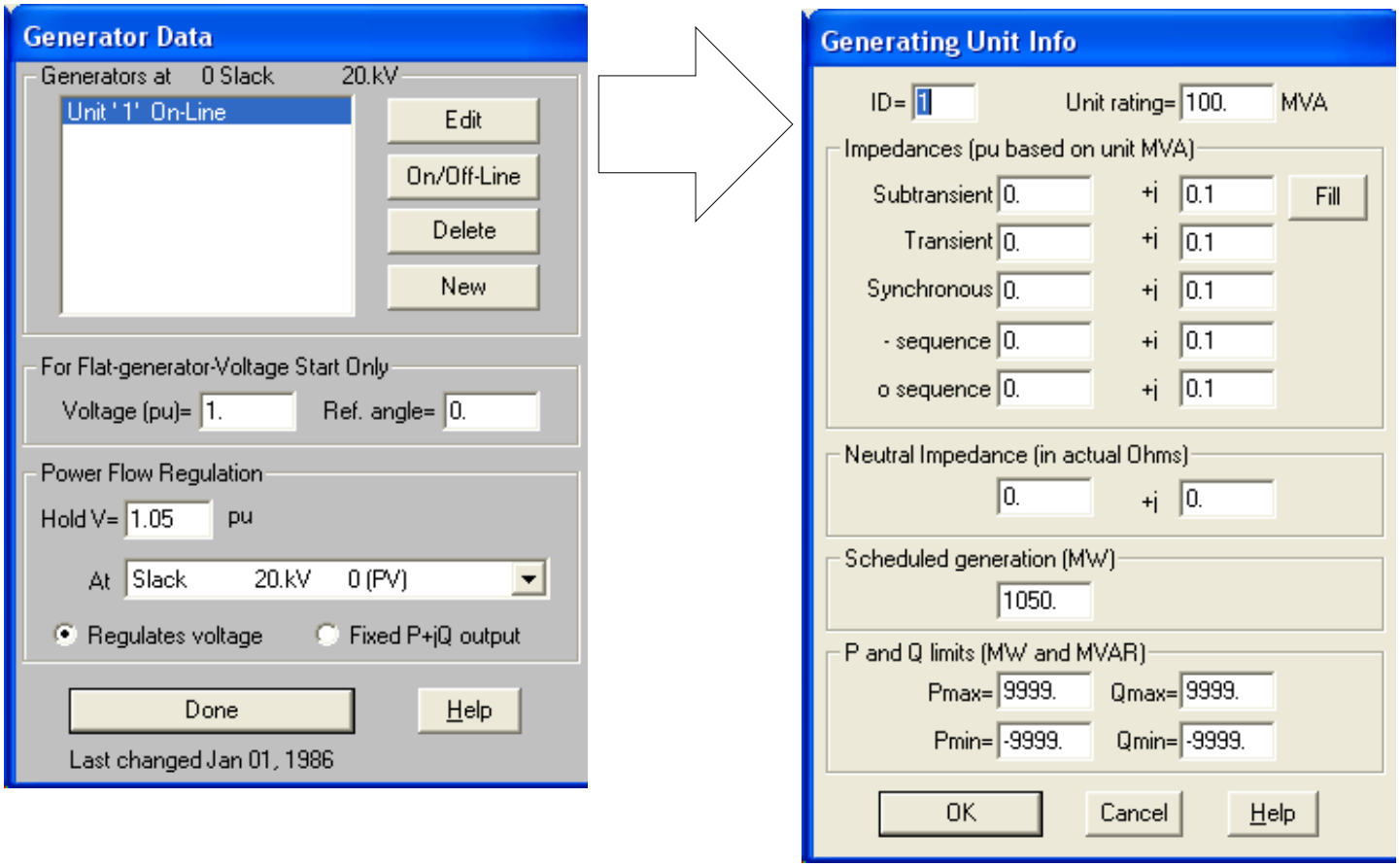
a. Loadflow
b. Short circuit, arc flash
c. Relay application, coordination

Basics of setting up a loadflow

d. Get the system data, parameters
e. Basics of program
f. Draw system configuration
g. Parameters
    i. Buses
    ii. Lines
    iii. Transformers
    iv. Generators
    v. Loadflow configuration
h. Output
i. Remedial actions

First - Start program: “Aspen Oneliner”


Aspen9.olr - ASPEN OneLiner and Power Flow-Academic V10.6
File Network Diagram View Relay Faults PFlow Check Tools Help
North G1
20.kV
StationNN
500.kV
South
500.kV
North G2
20.kV
North
500.kV
Slack
20.kV
Station S
500.kV
North G3
20.kV
South G1
20.kV
Ready


Generator Data
Generators at 0 Slack 20.kV
Unit '1' On-Line
Edit
On/Off-Line
Delete
New
For Flat-generator-Voltage Start Only
Voltage (pu)= 1.
Ref. angle= 0.
Power Flow Regulation
Hold V= 1.05 pu
At Slack 20.kV 0 (PV)
Regulates voltage
Fixed P+jQ output
Done
Help
Last changed Jan 01, 1986
Generating Unit Info
ID= 1
Unit rating= 100. MVA
Impedances (pu based on unit MVA)
Subtransient 0. +j 0.1
Transient 0. +j 0.1
Synchronous 0. +j 0.1
- sequence 0. +j 0.1
o sequence 0. +j 0.1
Fill
Neutral Impedance (in actual Ohms)
0. +j 0.
Scheduled generation (MW)
1050.
P and Q limits (MW and MVAR)
Pmax= 9999. Qmax= 9999.
Pmin= -9999. Qmin= -9999.
OK
Cancel
Help

Transmission Line Data

0 Station S 500.kV - 0 South 500.kV

Name= Ckt ID=

Length= 0. ft Type

Branch Parameters

Recompute from table

R= 0.003 X= 0.02

R0= 0.003 X0= 0.02

G1= 0. B1= 1. G2= 0. B2= 1.

G10= 0. B10= 0. G20= 0. B20= 0.

Current Ratings (A)

A: 0. B: 0. C: 0. D: 0.

Metered at: Station S 500. kV

Mutuals... OK Cancel Help

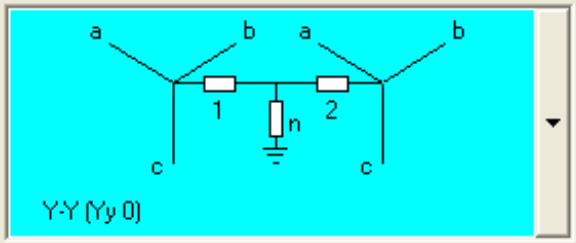
Last changed Jan 01, 1986

2-Winding Transformer Data

0 South G1 20.kV - 0 South 500.kV

Name= Ckt ID= MVA1= 0. MVA2= 0. MVA3= 0.

MVA base for per-unit quantities= 100. Change



R= 0. X= 0.004

B= 0.

Ro= 0. Xo= 0.004

Bo= 0.

South G1 20. kV

Tap kV= 20.

G1*= 0.

B1*= 0.

G10*= 0.

B10*= 0.

South 500. kV

Tap kV= 500.

G2*= 0.

B2*= 0.

G20*= 0.

B20*= 0.

Neutral grounding Z (ohms)

Zg1= 0. +j 0.

Zg2= 0. +j 0.

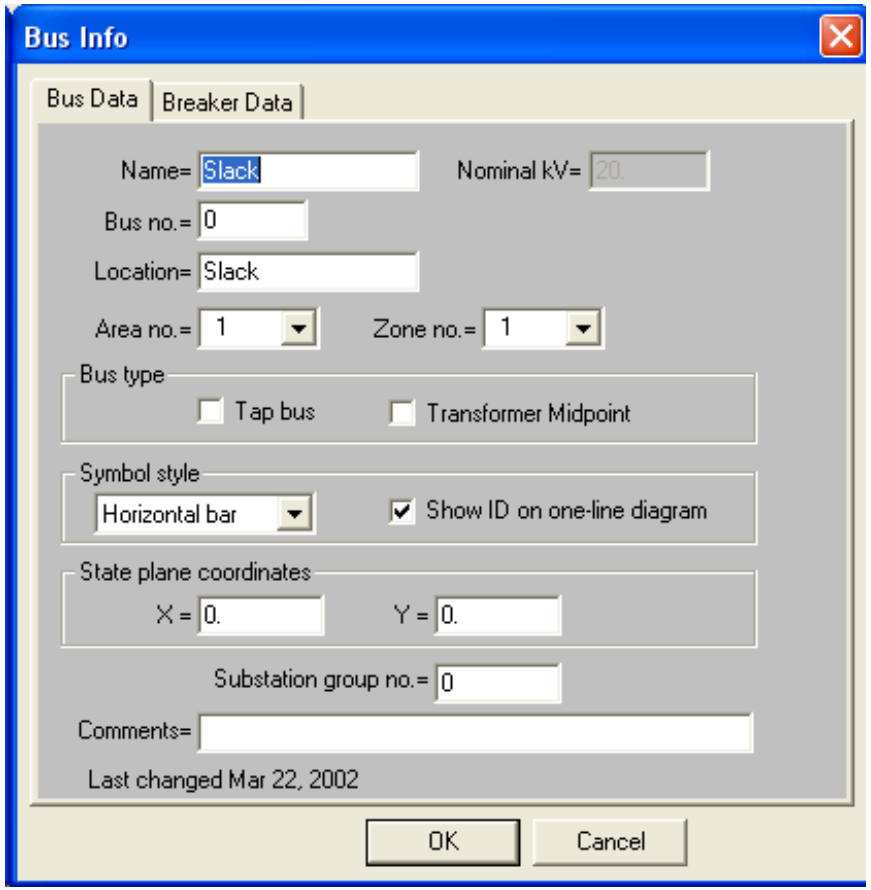
Zgn= 0. +j 0.

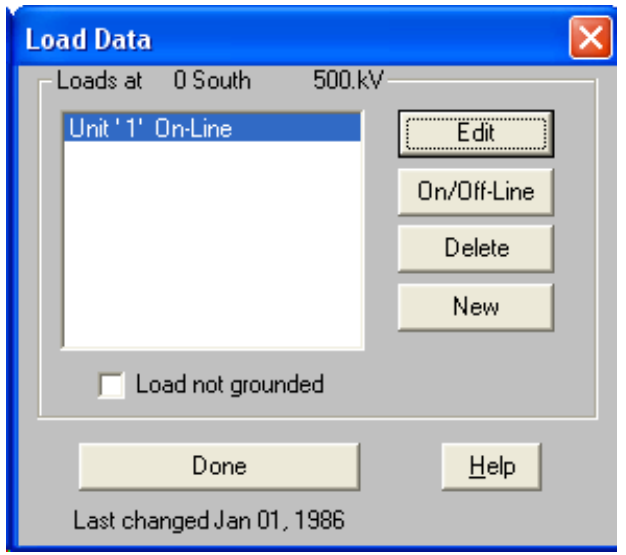
*Based on system MVA

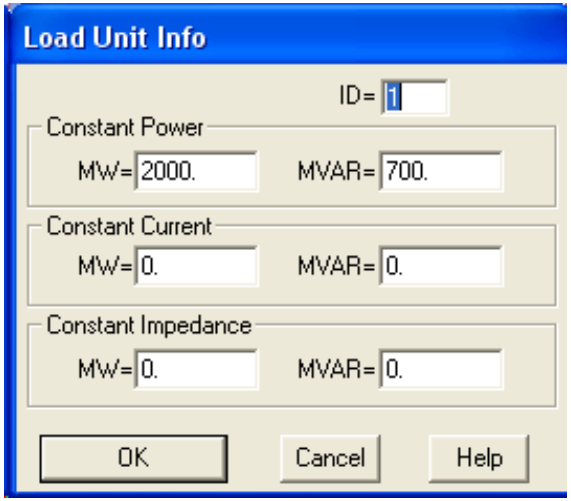
Metered at: South G1 20. kV

LTC... Swap sides OK Cancel Help

Last changed Jan 01, 1986


Bus Info
Bus Data
Breaker Data
Name= Slack
Nominal kV= 20.
Bus no.= 0
Location= Slack
Area no.= 1
Zone no.= 1
Bus type
Tap bus
Transformer Midpoint
Symbol style
Horizontal bar
Show ID on one-line diagram
State plane coordinates
X = 0.
Y = 0.
Substation group no.= 0
Comments=
Last changed Mar 22, 2002
OK
Cancel


Load Data
Loads at 0 South 500.kV
Unit '1' On-Line
Edit
On/Off-Line
Delete
New
Load not grounded
Done
Help
Last changed Jan 01, 1986


Load Unit Info
ID= 1
Constant Power
MW= 2000.
MVAR= 700.
Constant Current
MW= 0.
MVAR= 0.
Constant Impedance
MW= 0.
MVAR= 0.
OK
Cancel
Help

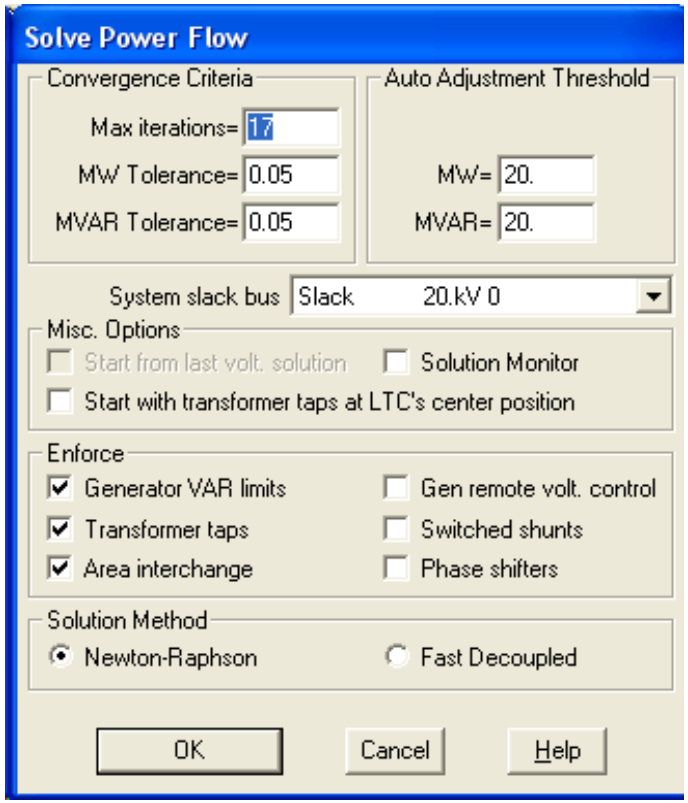

Solve Power Flow
Convergence Criteria
Max iterations= 17
MW Tolerance= 0.05
MVAR Tolerance= 0.05
Auto Adjustment Threshold
MW= 20.
MVAR= 20.
System slack bus Slack 20.kV 0
Misc. Options
Start from last volt. solution
Solution Monitor
Start with transformer taps at LTC's center position
Enforce
Generator VAR limits
Gen remote volt. control
Transformer taps
Switched shunts
Area interchange
Phase shifters
Solution Method
Newton-Raphson
Fast Decoupled
OK
Cancel
Help

Figure 6.2 shows a single-line diagram of a five-bus power system. Input data are given in Tables 6.1, 6.2, and 6.3. As shown in Table 6.1, bus 1, to which a generator is connected, is the swing bus. Bus 3, to which a generator and a load are connected, is a voltage-controlled bus. Buses 2, 4, and 5 are load buses. Note that the loads at buses 2 and 3 are inductive since $Q_2 = -Q_{L2} = -0.7$ and $-Q_{L3} = -0.1$ are negative.

For each bus k, determine which of the variables V_k, δ_k, P_k, and Q_k are input data and which are unknowns. Also, compute the elements of the second row of $\boldsymbol{Y}_{\text{bus}}$.

FIGURE 6.2

Single-line diagram for Example 6.9

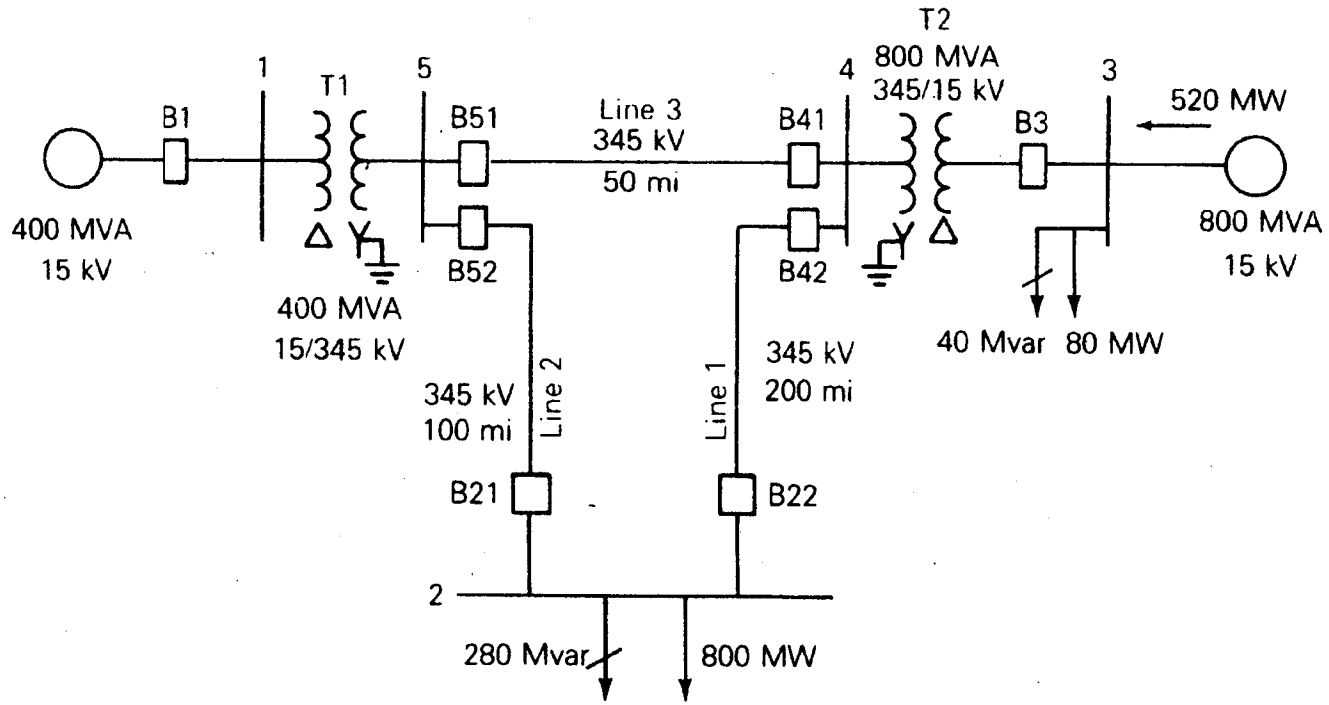


TABLE 6.1
Bus input data for Example 6.9*

Bus	Type	V per unit	δ degrees	P_G per unit	Q_G per unit	P_L per unit	Q_L per unit	Q_{Gmax} per unit	Q_{Gmin} per unit
1	Swing	1.0	0	—	—	0	0	—	—
2	Load	—	—	0	0	8.0	2.8	—	—
3	Constant voltage	1.05	—	5.2	—	0.8	0.4	4.0	−2.8
4	Load	—	—	0	0	0	0	—	—
5	Load	—	—	0	0	0	0	—	—

*S_{base} = 100 MVA, V_{base} = 15 kV at buses 1, 3, and 345 kV at buses 2, 4, 5

TABLE 6.2
Line input data for Example 6.9

Bus-to-Bus	R′ per unit	X′ per unit	G′ per unit	B′ per unit	Maximum MVA per unit
2–4	0.0090	0.100	0	1.72	12.0
2–5	0.0045	0.050	0	0.88	12.0
4–5	0.00225	0.025	0	0.44	12.0

TABLE 6.3
Transformer input data for Example 6.9

Bus-to-Bus	R per unit	X per unit	G_c per unit	B_m per unit	Maximum MVA per unit	Maximum TAP Setting per unit
1–5	0.00150	0.02	0	0	6.0	—
3–4	0.00075	0.01	0	0	10.0	—

SOLUTION The input data and unknowns are listed in Table 6.4. For bus 1, the swing bus, P_1 and Q_1 are unknowns. For bus 3, a voltage-controlled bus, Q_3 and δ_3 are unknowns. For buses 2, 4, and 5, load buses, V_2, V_4, V_5 and δ_2, δ_4, δ_5 are unknowns.

TABLE 6.4
Input data and unknowns for Example 6.9

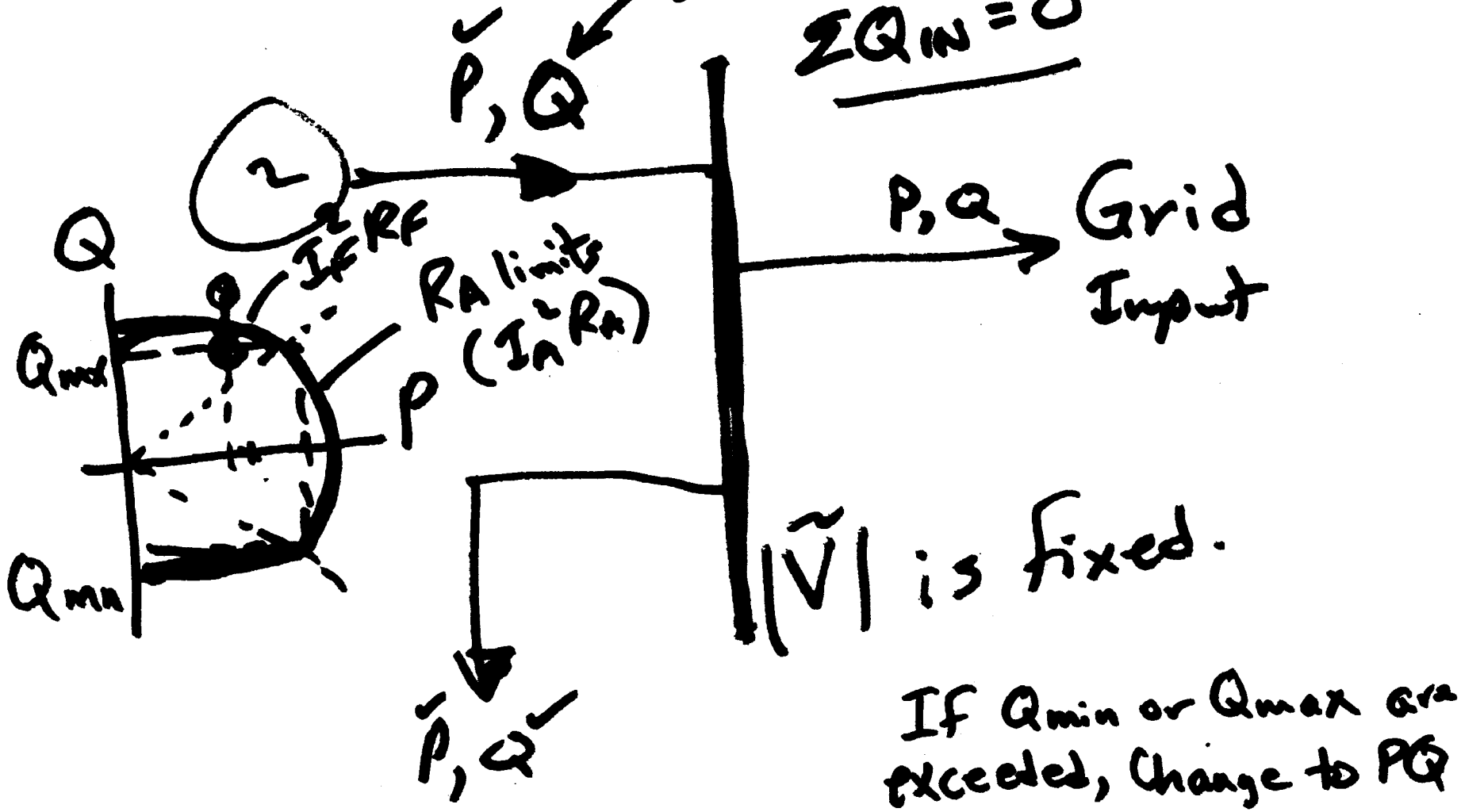
Bus	Input Data	Unknowns
1	$V_1 = 1.0, \delta_1 = 0$	P_1, Q_1
2	$P_2 = P_{G2} - P_{L2} = -8$ $Q_2 = Q_{G2} - Q_{L2} = -2.8$	V_2, δ_2
3	$V_3 = 1.05$ $P_3 = P_{G3} - P_{L3} = 4.4$	Q_3, δ_3
4	$P_4 = 0, Q_4 = 0$	V_4, δ_4
5	$P_5 = 0, Q_5 = 0$	V_5, δ_5

Gen Bus (P-V Bus)

Solve for 2 Q & δ.
↑ solved

"Slack Variable"

$\Sigma Q_{IN} = 0$



If Qmin or Qmax are exceeded, Change to PQ