



4 Downloading and installing the program:

Click on the following link, you will be redirected to the page shown below where you can

download the program and sample cases:

https://www.powerworld.com/download-purchase/demo-software/simulator-20-glover-overbye-

sarma-edition-download

Home Products Services Solutions Download & Purchase Online Sup	ator for Free Google Custom See Q port Training & Events Company
Simulator 20 Glover, Overbye & Sa Download	arma Edition
program. Follow the directions and the program v 4. After the install program has finished, launch the Click on the file name to download:	the file on your hard drive. It will begin an installation vill automatically install itself. PowerWorld product!

Note: you might need to zoom in so you can see some of the figures in this document clearly

Installing the program is simple! Just keep clicking Next! you do not need to do crack or any other thing, this is a free demo software.



4 Opening the program, and starting a new case:

Once you have installed the program, open the start menu and search for "simulator GOS education 20" then open the program and you will see the following window:

O 10 -	👺 🖪 🖽 🧾						Simulator	20 (64 bit) GSO							-	٥	×
File	Case Informat	tion Draw	Onelines	Tools Options	Add Ons	Window	ı.										۲
Edit Mode Run Mode Mode	Model Explorer		Limit Information	Network ~ Aggregation ~ Solution Details ~	I ∆X Difference Case +	Simulator Options	Case Description Case Summary Custom Case Info Case Data	Power Flow List Quick Power Flow L AUX Export Format	Elstin	B + + Bus iew	Substation View	Oneline Viewer Views	Data View	Open Windows			~
	Cl choose or New	come to the lick on File Open Case (Case to C Upgra http://powery Glover, Sa Copyright © 19 Copyright © 19	orp he Power e in the u se to ope create a o vorde.com/alo arma, and Ove 206-2017 Powe	overoverbyesarma erbye Textbook erWorld Corporation nomas J. Overbye	on tor case,	OPF Avail PV a Trans	Add-Ons ational nal Power Flow (C Reserves able Transfer Cap ad QV Curves (PV curves (PV curves (PV sent Stability magnetically Induc	DPF) DPF (SCOPF) ability (ATC) QV)									
Edit Mode																	

To start a new case, click on file then new case as shown below:

C) 🗈 - 🎇 🖪 🖽 🦉 - 🕼 🤇	× 📰	Simulator 20 GSO —	o ×
	File		dow	Ø
a de la comencia de l		Recent Cases e (Ctrl+N) 6_9.pwb	Case Description Power Flow List Case Summary Quick Power Flow List Pr	
	Save Case		Custom Case Info AUX Export Format Desc View Viewer View Windows* Case Data Views	^
00 000	Open Oneline Saye Oneline Save Oneline As Export Oneline Glose Oneline Load Transient Stability Data Save Transient Stability Data Load Auxiliary		Add-Ons: fucational ptimal Power Flow (OPF) scurity Constrained OPF (SCOPF) PF Reserves valiable Transfer Capability (ATC) V and QV Curves (PVQV) ansient Stability eomagnetically Induced Current	
4	Print Oneline Prin <u>t</u> er Setup	Exit Program		
		Lgit rtugian		
Ma	ke a new case			



Once you have opened a new case you will see the following window, Maximize the case window:

) 🚡 - I	😤 🚯 🖽 🛄 🎆 🗐 😣 🎆 🔹 🕫		Simulator	20 (64 bit) GSO			- 6	
File	Case Information Draw Onelines							C
dit Mode Run Mode Mode	Model Explorer Area/Zone Filters Monitoring Case Information	Aggregation - Solution Details - Difference Case -	Case Description Case Summary Case Summary Case Summary Case Summary Case Description	Power Flow List <pre></pre>	Substation Oneline Data	Open Windows *		~
								1
	💽 NewOne1.pwd					-		

Lets add a grid to the background, click on options then draw grid as shown below, note that you can modify grid spacing e.g. I have selected 2x2 grid:

🌔 뿹 -	👺 🗈 🖽 🔲 🏭 🗐 😣 🎆	Example7_5 - Case: Example7_5.pwb Status: Paused Simulator 20 GSO	– 0 ×
Elit Mode	Case Information Draw Onelines Too	Options Add Ons Window Animation - Pie Chart + Dynamic Formatting + Toggle Eull Screen	- 0 × @ - 5 ×
Draw Grid Lin	es		



4 Building a system: inserting components

We will build the system shown below which is taken from example 6.9 in course book, data

tables of the system are given below.

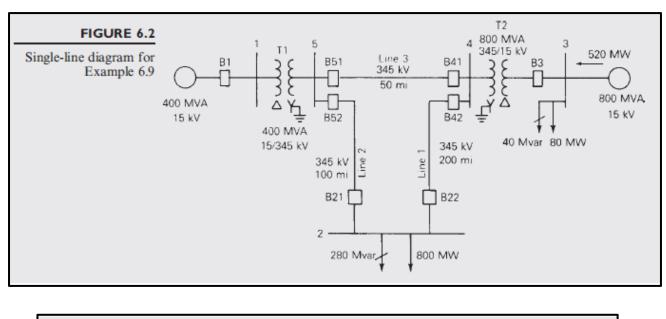


TABLE 6.1			V		P _G	Q _G	PL	QL	Q _{Gmax}	Q _{Gmin}
Bus input data for Example 6.9*	Bus	Туре	per unit	δ degrees	per unit	per unit	per unit	per unit	per unit	per unit
	1	Swing	1.0	0	_	_	0	0	_	_
	2	Load		_	0	0	8.0	2.8	_	_
	3	Constant voltage	1.05	_	5.2	_	0.8	0.4	4.0	-2.8
	4	Load	_	_	0	0	0	0	_	_
	5	Load	_	_	0	0	0	0	_	_

* $S_{\text{base}} = 100 \text{ MVA}$, $V_{\text{base}} = 15 \text{ kV}$ 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 u		G' per unit	B' per unit	Maximur MVA per unit
	2-4 2-5 4-5	0.0090 0.0045 0.00225	0.10 0.05 0.02	50	0 0 0	1.72 0.88 0.44	12.0 12.0 12.0
TABLE 6.3 sformer input data		R	x	G,	Bm	Maximum	TAP
TABLE 6.3 sformer 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	TAP Setting
sformer input data	Bus-to-Bus	per	per	per	per	MVA	Maximu TAP Setting per uni



Bus	Input Data	Unknowns
1	$V_1 = 1.0, \delta_1 = 0$	P1, Q1
2	$P_2 = P_{G2} - P_{12} = -8$	V_2, δ_2
	$Q_2 = Q_{G2} - Q_{L2} = -2.8$	
3	$V_3 = 1.05$	Q_3, δ_3
4	$P_3 = P_{G3} - P_{L3} = 4.4$ $P_4 = 0, Q_4 = 0$	V_4, δ_4
5	$P_4 = 0, Q_4 = 0$ $P_5 = 0, Q_5 = 0$	V_5, δ_5

> First: inserting buses

- 1. To be able to add components you must be in the "Edit mode" selected at the left top corner of the program window.
- 2. The simulator has two distinct modes: "Edit Mode" and "Run Mode". The Edit Mode is used to construct new simulation cases or to modify existing cases, while the Run Mode is used to perform the actual power system simulation. You can easily switch between the modes using the Edit Mode and Run Mode buttons
- 3. Always start by adding system buses, as other components (loads, generators, transformers ... etc.) are attached to buses.
- 4. To add a bus, click on "draw" tab, "network" list then select "bus" as shown below:

"ii - i <u>i</u>	🎗 🖪 🗄	5 🖩 🗐 😣) 🎬 - =											New0	ne1.pwd	- Simula	tor 20 (6	i4 bit) Eva	uation													-	٥	>
Mode Mode	2	mation Dra Auto Insert + Default Drawin	ıg) J	£	‡ ⇒0		ABCD			uges +	۲. Sala	J.	C) Se	lect Regi ctangle side	on	j,	Anchor		uning	(A)	Darte	Darte S	pecial	(A)	a: # Q. ##						۲	0 -	8
Mode	for *	Objects Not on	Oneline			Aggregatio	011 0	-	and	Indicati	on -	Crit	eria	💕 In	side			22	AVER	Layers 🔻		👌 Сору	X Cut	Delete	1009	6 V								
lode		Quick Insert		ا محر	Bus								S	elect		Fi I		Formattir	g		Fi I	C	ipboard		Zoo	om 🕞								
				ě	<u>G</u> enerat Lo <u>a</u> d	tor																												
					Switche	d Shunt																												
						ssion <u>L</u> ine	2																											
				*	Transfo	rmer																												
						apacito <u>r</u> smission L																									-		-	
						vinding Tri		mer																										
		_				5 Device			-			_				_					_	_	_		_			_		\vdash			_	
				-								_	_			_					_					_								
							-	_					-			_					-							_						
	_											_																_	_	\vdash			_	
					-																													
																						-												
					-		_		-			_	-			_						_								\vdash				
					-				-												-	-					+			\vdash				
					-		_	_	-			_	-			_				_	_	_			_					\vdash			_	



5. When you select "bus" a "cross cursor (+)" will show up inside the work window, just click once and the following window will show up:

Bus Options ×	
Bus Number Find By Number Find	
Bus Name One Find By Name	
Nominal Voltage 15.0000 kV	
Labels no labels	
Number Name Area Change 1 Balancing Authority Change 1 Cone Change 1 I I 1	
Owner Change 1 1	
Substation Change	
Bus Information Display Attached Devices Geography Custom	
Bus Voltage Voltage (p.u.) 1.0000 Angle (degrees) 0.000 Bus Voltage Regulator Devices	
System Slack Bus	
OK Save Save to Aux Cancel	

- 6. The data you have to insert is the bus "base voltage or nominal voltage", and you can add a bus name
- 7. You may need to insert other data depending on the type of the bus:
 - If the bus is a slack bus, then you have to tick the "system slack bus box" and by default the voltage is 1_{PU} and the angle is zero.
 - If the bus is a voltage controlled bus (a bus to which a generator is connected), then you have to insert the bus voltage by clicking the button then the window on the next page will show up:

		E	BIRZEIT UN	ب جَامَعَةُرُ IVERSITY				
🔘 Bus Voltage	Regulating D	Devices Dialog					- 🗆	x
	Number	Name	2					
Bus	3	Thre	e]			
Area	1	1]			
Zone	1	1]			
Owner	1	1]			
Substation	not assigned t	o substai	assigned to subs	tation]			
Voltage (p.u.)	1.0000	Volta	ge (kV) 15.000	D]			
🏢 📄 🔛 👌	k *.0 .00 Å	Records	▼ Geo ▼ Set	▼ Columns ▼		➡ SORT IZH ABED	f(x) 🕶 🏢	~
ſ	Device	Device Type	Reg Voltage Max	Reg Voltage Min	Device Voltage Target	Transformer Regulation Target Type	Device Voltag Target High	e
1 3 (Three	15.0) #1	Generator			1.0500			
						Close	? Help	

- The bus voltage is inserted in the indicated field shown on the figure.
- For other buses, the bus voltage is left as default and when you run the program it will calculate the bus voltage.
- 8. If you select "display" tab in the bus options window, you can modify bus size and orientation.



9. to show the bus voltage in the work window, right click on the bus and select "add new

field around bus", the following window will show up:

O 🖥 - I	🁺 🚯 👯 🧾 I	s 🔝 🕺							NewOne	e1 - Simul	ator 20 (SSO							- 0) ×
File Edit Mode	Case Informatio	on Draw		Tools Network -	Options	Add (Descriptio	n Po	wer Flow	v List		-	1		同田		0	- 8
Run Mode Mode	Model / Explorer		Limit Monitoring	Aggregatior Solution De		∆X Differen Case ▼	ce Simulator	Cust	Summary om Case In Case Data	fo AL		er Flow List t Format Desc	LI Bus View	Substation View	Oneline Viewer Views	Data View	Open Windows	Ŧ		,
							1 Bus Informati Bus View Quick Power Bus Palette Insert Connee Move Equipm Split Bus Format Bus Format Bus Add New Fiel Apply Default Copy Format Paste Format	Flow List ted Buse ent ds Arour Draw Va From Bu	ud Bus Iues To Bu	15										
						_	Snap Bus To (Create a Case		tion from	Selection.										

10. Select the position where you want the bus voltage to be placed by clicking on it.

Insert New Fie	lds arou	ind sele	ected o	bjects	×	
Bus Fields						
		Pos1	Pos5			
		POST	POSS			
		Pos2	Pos6			
		Pos3	Pos7			
		Pos4	Pos8			
	Pos1			Pos5		
	Pos2			Pos6		
	Pos3			Pos7		
	Pos4			Pos8		
🗸 ок		>	Cancel		? Help	



11. Select the data that you want to be displayed.

Bus Field Options			×
Total Digits in Field Digits to Right of Decimal	6	Delta per Mouse Click	0.0
	L1	Include Suffix	
Field Prefix			
Type of Field			
O Bus Name		O MW Marginal Cost	
O Bus Number		O Mvar Marginal Cost	
Bus Voltage (p.u.)		O MW Loss Sensitivity	
O Bus Voltage (kV)		○ Select a Field:	Find Field
O Bus Angle (degrees)			~
🗸 ок	S <u>R</u> emove Field	X Cancel	? Help



Second: inserting generators

 To insert a generator, go to draw tab (the same tab from where you have inserted bus) and select generator, then click on the bus you want to add a generator to, the following window will show up:

Bus Number Image: Status Open Generator MVA Base ID Image: Status Image: Status Open Area Name Image: Status Image: Status Image: Status Image: Status Area Name Image: Status Image: Status Image: Status Image: Status Image: Status Image: Display Information Power and Voltage Control Costs Fault Parameters Owners, Area, etc. Custom Stability Power Control MW Output 0.000 Part. Factor 10.00 Min. MW Output 0.000 Available for AGC Max. MW Output Image: Status Image: Status Voltage Control Min Mvars 9900.000 Iwa Capability Curve Remote Reg % 100.0 Wind Control Mode Power Factor Image: Status Image: Status Image: Status Image: Status Min Mvar	Generator C	Options										x
Bus Name One Find By Name Closed Generator MVA Base ID 1 Find ID	Bus Number	1			Find B	y Number						
ID 1 Area Name 1 Fuel Type Unknown Labels no labels Unit Type UN (Unknown) Display Information Power and Voltage Control Costs Fault Parameters Owners, Area, etc Custom Stability Power Control MW Setpoint 0.000 MW Output 0.000 Part. Factor 10.00 Min. MW Output 0.000 Available for AGC Max. MW Output 1000.000 Enforce MW Limits during automatic control Voltage Control Mvar Output 0.000 Available for AVR SetPoint Voltage 1.000000 Max Mvars 9900.000 Available for AVR SetPoint Voltage 1.000000 Min Mvars 9900.000 Use Capability Curve Remote Reg % 100.0 Wind Control Mode Power Factor Mode None MW Min Mvar Max Mvar	Bus Name	One			Find	By Name	-		Gene	rator MVA	Base	
Labels no labels Unit Type UN (Unknown) Display Information Power and Voltage Control Costs Fault Parameters Owners, Area, etc Custom Stability Power Control MW Output 0.000 Part. Factor 10.00 Min. MW Output 0.000 Available for AGC Max. MW Output 1000.000 Image: Control Voltage Control Mvar Output 0.000 Regulated Bus Number 1 Min Mvars -9900.000 Available for AVR SetPoint Voltage 1.000000 Max Mvars 9900.000 Use Capability Curve Remote Reg % 100.0 Wind Control Mode Power Factor 1.0000 Image: Power Factor Mode None 1.0000 Image: Power Factor Max Mvar Image: Power Factor Image: Power Factor Image: Power	ID	1			Fi	ind	۲	Closed	100	0.00		
Display Information Power and Voltage Control Costs Fault Parameters Owners, Area, etc Custom Stability Power Control MW Output 0.000 Part. Factor 10.00 Min. MW Output 0.000 Available for AGC Max. MW Output 1000.000 Max. MW Output 1000.000 ✓ Enforce MW Limits during automatic control Voltage Control Mvar Output 0.000 ✓ Regulated Bus Number 1 Min Mvars 9900.000 ✓ Available for AVR SetPoint Voltage 1.000000 Max Mvars 9900.000 Use Capability Curve Remote Reg % 100.0 Wind Control Mode Power Factor 1.0000 🖤 1.0000 🖤 Mw Index of a set of a s	Area Name	1]		Fuel Type	Unkr	nown			~	
Power Control MW Output 0.000 Part. Factor 10.00 Min. MW Output 0.000 Available for AGC Max. MW Output 1000.000 Image: Enforce MW Limits during automatic control Voltage Control Mvar Output 0.000 Regulated Bus Number Min Mvars -9900.000 Available for AVR SetPoint Voltage Min Mvars 9900.000 Use Capability Curve Remote Reg % 100.0 Wind Control Mode Power Factor 1.0000 Image: None MW Min Mvar 1.0000 Image: None	Labels	no labels				Unit Type	UN ((Unknown)			\sim	
MW Setpoint 0.000 MW Output 0.000 Part. Factor 10.00 Min. MW Output 0.000 Available for AGC Max. MW Output 1000.000 Enforce MW Limits during automatic control Voltage Control Mvar Output 0.000 Regulated Bus Number 1 Min Mvars -9900.000 Available for AVR SetPoint Voltage 1.000000 Max Mvars 9900.000 Use Capability Curve Remote Reg % 100.0 Wind Control Mode Power Factor 1.0000 (*) MW Mode 1.0000 (*) 1.0000 (*)	Display Inform	nation Po	ower and V	oltage Control	Costs	Fault Parame	ters	Owners, Area	a, etc	Custom	Stability	
Min Octput 0.000 Available for AGC Max. MW Output 1000.000 Enforce MW Limits during automatic control Voltage Control Mvar Output 0.000 Min Mvars -9900.000 Available for AVR SetPoint Voltage 1.000000 Max Mvars 9900.000 Use Capability Curve Wind Control Mode Power Factor Mode None 1.0000 MW Min Mvar Intervention	Power Contro	ol				_						
Max. MW Output 1000.000 Image: Finite control Voltage Control Regulated Bus Number 1 Mvar Output 0.000 Image: Regulated Bus Number 1 Min Mvars -9900.000 Image: Available for AVR SetPoint Voltage 1.000000 Max Mvars 9900.000 Image: Use Capability Curve Remote Reg % 100.0 Wind Control Mode Power Factor 1.0000 Image: Power Factor Mode None 1.0000 Image: Power Factor Mw Image: Power Factor Image: Power Factor Image: Power Factor Max Mvar Image: Power Factor Image: Power Factor Image: Power Factor Max Mvar Image: Power Factor Image: Power Factor Image: Power Factor Max Mvar Image: Power Factor Image: Power Factor Image: Power Factor Max Mvar Image: Power Factor Image: Power Factor Image: Power Factor Max Mvar Image: Power Factor Image: Power Factor Image: Power Factor Image: Power Factor Max Mvar Image: Power Factor Image: Power Factor Image: Power Factor Image: Power Factor Image: Power Fac	MW Set	point 0.0	000	MW Output 0	.000	Part. F	actor	10.00				
Voltage Control Regulated Bus Number 1 Mvar Output 0.000 Available for AVR SetPoint Voltage 1.000000 Max Mvars 9900.000 Use Capability Curve Remote Reg % 100.0 Wind Control Mode Power Factor 1.0000 1.0000 Mode None 1.0000 I MW Indicate the set of t	Min. MW Out	put 0.0	000	Available fo	r AGC							
Mvar Output 0.000 Regulated Bus Number 1 Min Mvars -9900.000 Available for AVR SetPoint Voltage 1.000000 Max Mvars 9900.000 Use Capability Curve Remote Reg % 100.0	Max. MW Out	put 100	0.000	Enforce MW	Limits d	uring automati	c cont	trol				
Mvar Output 0.000 Regulated Bus Number 1 Min Mvars -9900.000 Available for AVR SetPoint Voltage 1.000000 Max Mvars 9900.000 Use Capability Curve Remote Reg % 100.0	Voltage Cont	rol										
Max Mvars 9900.000 Use Capability Curve Remote Reg % Wind Control Mode Power Factor Mode None 1.0000 MW MW Min Mvar Max Mvar			000		Re	gulated Bus N	umber	r 1				
Wind Control Mode Mode None MW Min Mvar Max Mvar	Min Mva	ars -99	00.000	🗹 Available fo	r AVR	SetPoint V	oltage	1.000000				
Power Factor Mode None MW	Max Mv	ars 990	0.000	Use Capabil	ity Curve	e Remote R	eg %	100.0				
Mode None 1.0000 MW Imax Mvar Imax Mvar	-Wind Cor	ntrol Mode			Doworl	Easter						
MW Image: Second seco		-										
Min Mvar Max Mvar	Mode N	lone		~	1.000							
Max Mvar	MW											
	Min Mvar											
<	Max Mvar											
	<											>
OK Save Save to Aux Cancel Help	ОК	Sav	/e Sav	e to Aux				Cancel		Help		

- 2. The data you have to insert is generator MVA base only.
- 3. If the generator is connected to a voltage controlled bus, then you have to insert real power in the "MW set point" field.
- 4. If the generator is connected to a slack bus, then you do not have to insert the power values, leave them zero, and when you run the program it will calculate power values.



> Third: inserting transformers

- 1. To insert a transformer, go to draw tab (the same tab from where you have inserted bus) and select transformer:
- Single click on the first bus to which the transformer is connected.
- Drag the cursor to the second bus where the transformer is connected, then double click on it and the following window will show up:

🔘 Branch Opt			-		х						
Transformer Number Name Area Name Nominal kV Labels	Fro 1 0ne 1 (1) 15.00 no lab		To Bu 5 Five 1 (1) 345.0	ZL	Circuit 1		Find By Numb Find By Nam Find From End Me Owner (Same	es tered	3us)		
Display Parame	eters	Transformer Control	Fault In	ifo Own	er, Area,	Zone, Sub	Custom S	tability			
Status		Per Unit Impedance	e Parame	ters		MVA Lir	nits	_			
Open		Series Resistance ((R)	0.00150	D	Limit A	600.00	• •			
Closed		Series Reactance (X)	0.02000	D	Limit B	600.00	0			
Branch Device Ty	ype	Shunt Charging (B)		0.00000	0	Limit C	600.00	0			
Transformer		Shunt Conductance	ce (G) 0.000000			Limit D	0.00	0			
Allow Consoli	dation	Magnetizing Condu	uctance 0.000000			Limit E	0.00	0			
Length 0.0	00	Magnetizing Susce	otance	0.00000	0	Limit F	0.00	0			
	- ⁻	Note: All Impedance	es above	are in per	r unit on	Limit G	0.00	0			
Calculate Impedances	>	the system MVA an following button to	d Voltage	bases. C	lick	Limit H	0.00	0			
Name Chature						Limit I	0.00	0			
Normal Status		Specify Transforme				Limit J	0.00	0			
Closed		Has Line Shunts	3	Line Sł	nunts	Limit K	0.00	• •			
Convert Tr		on the Line	Has D-F	ACTS			,			1	
ОК	Sa	Save to Aux				Ca	ancel	He	lp		

- 2. The data you have to insert is shown in the indicated boxes in r=the figure above, this data is taken from tables of example 6.9.
- 3. Note that the number and voltages of buses to which the transformer is connected are loaded automatically.
- 4. Other transformers are inserted similarly.

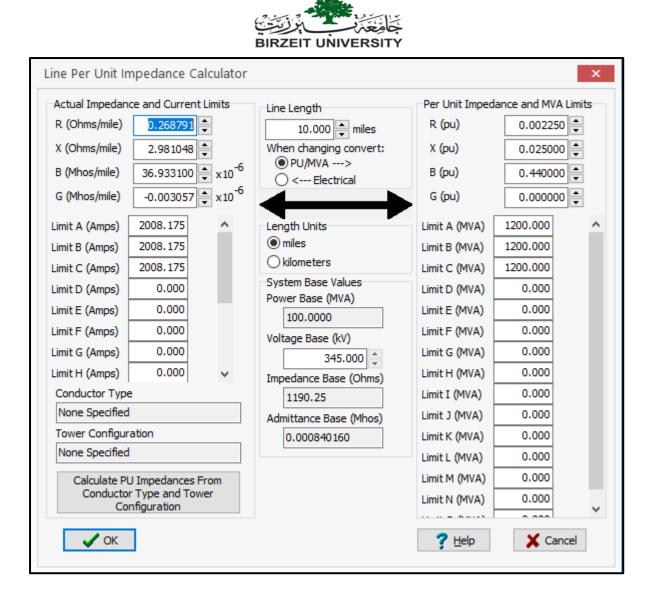


> Fourth: inserting transmission line

- 1. To insert transmission line, follow the same steps of inserting transformer after selecting transmission line from draw tab.
- 2. When you finish drawing the transmission line, the following window will show up:

Branch Opt	tions										-		x
Line Number Name Area Name Nominal kV Labels Display Param	From 5 Five 1 (1) 345.0 no labe	ls Fault Info	Owner, Ar	-	1	Defau tability	Fir Fin Fro It Owr	d By Numbers nd By Names nd om End Meter ner (Same as l	ed	Bus)			
Status Open Open Closed Branch Device Tr Line Allow Consoli Length 0.0 Calculate Impedances Normal Status Open Open Open	dation 00 ♠ ▼	Series R Series R Shunt C Shunt C	Impedance (R eactance (X harging (B) onductance .ine Shunts	l)	0.0022	000	MVA Limit Limit Limit Limit Limit Limit Limit Limit Limit	B C D F G H I J	1200.000 1200.000 1200.000 0.000 0.000 0.000 0.000 0.000 0.000	~			
Convert Lir D-FACTS D OK		n the Line	ve to Aux	Has D-F	ACTS			Canc	el	Не	lp]	

- 3. The data you have to insert is shown in the indicated boxes in the figure above, this data is taken from tables of example 6.9.
- 4. If transmission line per unit impedances are not give, you can calculate them using the program by clicking on "calculate impedances>" which will open the following window:



5. Other transmission lines are inserted similarly.



> Fifth: inserting loads

1. To insert a load, go to draw tab (the same tab from where you have inserted bus) and select load, then click on the bus you want to add a load to, the following window will show up:

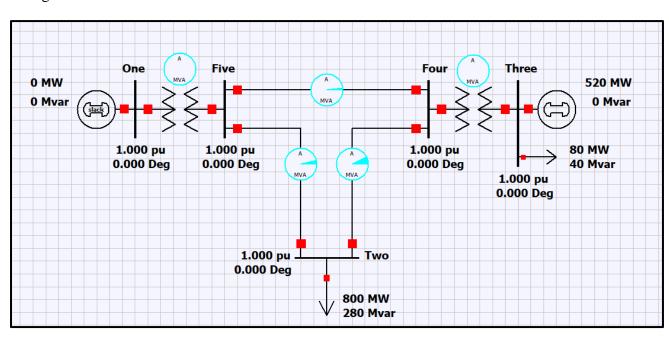
C Load Op	tions	_ 🗆 🗙
Bus Number	3	Find By Number Status
Bus Name	Three	Find By Name Closed
ID	1	Find
Labels	no labels	
	Number	Name
Area Cha	nge 1	1
Zone Cha	nge 1	1
Substation		
Owner Cha	nge 1	1
	Same O	wner as Terminal Bus
Load Informat	tion OPF Load D	ispatch Custom Stability
	Constant C	Constant Constant Distributed Generation
		Current Impedance Open OClosed
MW Value	80.000	0.000 0.000 MW 0.000
Mvar Value	40.000	0.000 0.000 Mvar 0.000
Display Infor	mation	
Display S	ize 6.00 🌲	Orientation
	/idth with Size	
I Scale V		O Up O Down
Display Wie	dth 2.25 💂	Anchored
Pixel Thickne	ss 2	Link To New Load
ОК	Save Sav	ve to Aux Cancel Help

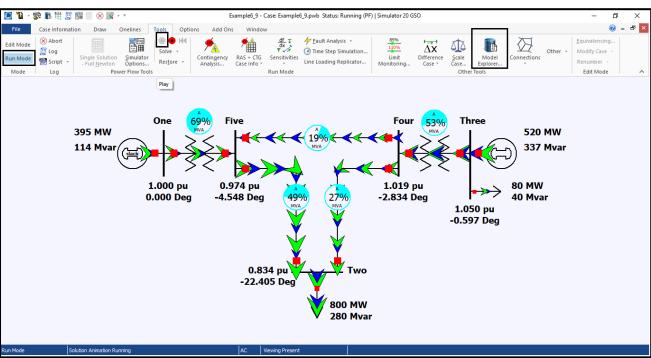
- 2. The data you have to insert is shown in the indicated boxes in the figure above, this data is taken from tables of example 6.9.
- 3. Other loads are inserted similarly.



4 Running the program and solving the case:

After you have finished building the system, your window should be similar to the following figure.





To solve the case, first select "Run mode", then go to "Tools" tab and select the green play button as shown below:

Electrical and Computer Engineering Department – Birzeit University

. . . .



To show the percentage of loading on pie charts above transmission line and transformers as in the figure in the previous page right click on the pie chart and the following window will show up: tick the box show in the figure below.

Line/Transfo	rmer Flow Pie Cha	art	×
	Near Bus	Far Bus	Circuit
Number	5	4	1 Find
Name	Five	Four	Switch Near/Far
Nom kV	345.0000	345.0000	
Substation			
Labels			
MVA Rating Size	1200.000	▲ Percent	18.8
Ignore D	10.0 💌 Iynamic Sizing Iynamic Open Sizing	Always Sh	ow Value (Percent)
O Total p	Oneline Options (ower (MVA) (ower (MW) (ve power (Mvar)) Line Amp, Transf. M) Max % Load Cont.) PTDF	IVA
* recomme	nded setting		
	View Pie Cha	art Display Options	
🗸 ОК	X c	ancel	? Help



This figure just shows the direction of power flow, the solution details can be reached by clicking on the "model explorer" button shown above, which will show the following window:

P2 Case information Daw Orelins Tools Options Add Ons Window Image: Control options Image: Control optioptions Image: Control optioptions Im																-
With American Control Marken Marken Note Single Solution Single Solution Single Solution Prever Flow Note Single Solution Basingle Solution Single Solution Basingle Solution Single Solution Basingle	O 🔁 - 😵 📭 🖽 🖉	× 11			Model Explor	er: Buses - Cas	e: Exampleb_9	.pwb Status: P	'aused Simul	ator 20 GSO						
Run Model Biggle Solution Single Solution Residuet Contingency RAS - CIG Sentitivities Line Model Connections Renumber - Mode Log Single Solution Single Solution Residuet Renumber - Renumber - Eat Mode Connections Browner Flow Tools Bewer Tools Bewer Tools Bewer Tools Bewer Tools Renumber - Eat Mode Connections Browner Flow Bewer Tools Bewer Tools Bewer Tools Bewer Tools Bewer Tools Bewer Tools Renumber - Browner State Banches By Tope Bewer Tools Bewer Tools Bewer Tools Bewer Tools Res None Browner State Benches State Node Node Connections Act C State Act C State Act C State Browner State Benches State Node Node Node Node Node Node Browner State Benches State Node Node Node Node Node Browner State Benches State Node Node Node Node Node Browner State Benches State Node Node Node Node Node Benches State Benches State Node Node Node Node Node Benches State Benches State Node Node Node Node Node Benches State Benches State Node Node Node Node Node Benches State Be	File Case Information	Draw	Onelines Tools	Options Add	Ons Win	dow									(🕖 – 🗗 🗡
Recent I find Remove Quick Filter * Franches By Uppe Eranches State Data Disci Chansmission Lin Stretches State Disci Chansmission Lin Stretches State Disci Stretches State Stretches	Run Mode Script - Sing Mode Log	ile Solutio III <u>N</u> ewtor P	n <u>S</u> imulator Options	Continger	ncy RAS + C	IG Sensitivit	Line Load	tep Simulation	Lim	it Differ	rence <u>S</u> cale e + Case	Model Explorer			Modify Case Renumber 👻	
Network Image: Control in the state Image: Control in						t - Columns				Option	ns ▼					
 	✓ ► Network	Fitter				0111/-18				Lond Marco	C	Continue	Culture	Land Comment	Art D Church	A
Branches State 1 10 /m e 1 15:00 10:00 /m 0:00 394.83 114.24 0.00 0.00 1 B Border State 2 2 /m o 1 345.00 0.03330 227.661 -224.00 230.00 337.43 0.00 0.00 1 B Borderators 4 4 rour 1 15:00 1.0360 15:750 -0.66 60:00 40:00 520:00 337.43 0.00 0.00 1 B Impedance Corrective 5 Free 1 545:00 0.074.80 336.132 -4.35 -4.35 0.00 0.00 1 0.00 0.00 1 1 0.00 0.00 1 1.00 0.00 0.00 1 1.00 0.00 1.00 0.00 1.00 0.00 1.00 0.00 1 0.00 0.00 1 1.00 1.00 0.00 1.00 0.00 1.00 1.00 0.00 1.00 1.00 1.00 0.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 </td <td></td> <td></td> <td></td> <td>Area Name</td> <td></td> <td></td> <td></td> <td></td> <td>Load MVV</td> <td>Load Mvar</td> <td></td> <td></td> <td></td> <td>MW</td> <td>Mvar</td> <td>Area Num</td>				Area Name					Load MVV	Load Mvar				MW	Mvar	Area Num
Bucc 3 Three 1 15.00 1.05000 15.750 -0.60 80.00 40.00 520.00 337.43 0.00 0.00 1 S Generators Generators 0.00 0.011931 351.66 -2.83 0.00 0.00 0.00 1 S File 1 345.00 0.97430 336.132 -4.55 0.00 0.00 0.00 1 S File 1 345.00 0.97430 336.132 -4.55 0.00 0.00 1 S Muth-Terminal DC Minmatches 0.00 0.00 1 0.00 0.00 1 Withed Shunts Timere-Winding Tan VSC DC Tansmission		1		1					800.00	280.00		114.24				1
 Generators Importance Correction Interfaces S Five S Five<td></td><td>- 2</td><td></td><td>1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>337.43</td><td></td><td></td><td></td><td>1</td>		- 2		1								337.43				1
Impedance Correction > Impedance Correction > Impedance Correction > Mismatches > Interfaces Impedianes Mismatches > Nomograms	DC Transmission Lin	4		1												1
Line D-FACTS Device Hu is Shunts Humatches Mumatches Multi-Reminal DC Humatches Multi-Reminal DC Hongradions Worked Shunts Hore-Winding Tan Hore-Winding Tan		5	5 Five	1	345.00	0.97430	336.132	-4.55						0.00	0.00	1
	Hine Shunts Hods Hods Hods Holds Holds	<														>
dit Mode	Open New Explorer		1		:	Search Now 0	Options -									
	Edit Mode															

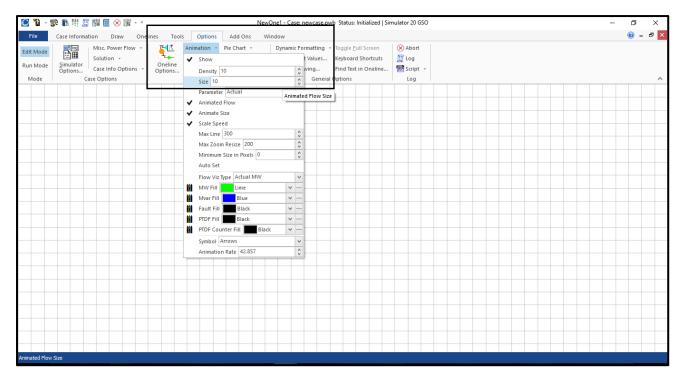
You can find other information regarding the system e.g. to view the bus admittance matrix Y matrix by scrolling down to "solution details" and selecting Ybus.

to return to the one-line diagram go to case information tab and click on "open windows" then select the name of your project from the list.

🔘 🛅 -	🌚 🗄 🖽 🧝						Mo	del Explore	r: Buses - (Case: Exampl	e6 9.pv	/b. Status: Pau	used 1.9	Simulator 20 GS	0			_	ć	1	×
File	Case Informatio		Draw	Onelines	Tools	Options	Add Ons			cuse examp	co_5.p+	ib status i at	isea [.		Ŭ				. @		
Edit Mode Run Mode Mode	Model A	Area/Zo Filters	one Mo	Limit formation	Network + Aggregation Solution Deta		Difference Case *	Simulato Options.	Case Case r Custo	Description Summary om Case Info Case Data	Qui	ver Flow List ck Power Flov (Export Forma	/ List	Bus View	Substation View	Oneline Viewer Views	Data View	Open Windows *			^
Explore		4	× YBus	× Buses	× Branches	State	× Loads >	Generato	rs									2 Model Explorer: YBus			
Explore	Fields			. ∰ ∦ 5	8 ; % 🐴 🕯	NA 🕂	Records *	Geo 👻 Set	• Colum	ns 🕶 🔤 🕶	1080 - 8 1080 - 8	四• 🌱 🚊	SORT 124 ABED	f(x) ▼ Ⅲ Op	tions 🔻						
	Islands	^	Filter	Advanced V	Bus		~			~	Find.	Remove Q	uick Fi	lter 🕶							
	Multi-Section Line MW Transactions	25		Number	Name		Bus 1	Bu	s 2	Bus	3	Bus 4	+	Bus 5							
	Nomograms Owners		1		1 One	3.7	73 - j49.72							-3.73 + j49.7	2						
H :	Substations		2		2 Two			2.68 -	j28.46			-0.89 + j9.	92	-1.79 + j19.8	4						
	Super Areas Tielines between a	Ar	3		3 Three					7.46 - j99		-7.46 + j99									
III 1	Tielines between I	Ba	4		4 Four				-	-		-		-3.57 + j39.6							
	Tielines between Transfer Direction		5		5 Five	-3.	.73 + j49.7	2 -1.79	+ j19.84			-3.57 + j39	.68	9.09 - j108.5	8						
Solution	ution Details Bus Zero-Impedar Fast Decoupled B Mismatches Outages Post Power Flow 1 Power Flow Jacob Remotely Regulat Time Step Actions You e Information and e Information and infingency Analysis timal Power Flow Is and Add Ons sient Stability r-Defined	PI PF So iia ec																			
Oper	n New Explorer		Search	n				S	earch Now	Options -											
Run Mode	Sol	lution A	inimation S	Stopped				AC	Viewing P	resent											



You might face the problem that you run the program, but you do not see power flow arrows to solve this go to options tab and increase the animation size as shown below:





4 Fault analysis:

- > Three phase symmetrical fault:
 - 1. Fault analysis can only be performed when Simulator is in Run Mode.
 - 2. To perform a 3-phase symmetrical fault you need to insert the sequence specific data for generators, transformers, and transmission lines.
 - 3. This data is loaded by double clicking on each component e.g. double click on a transmission line to open the "branch options" window, then select "fault info" tab as shown in the figure below:

🔘 Branch Opti	ions						-		x
Name (From Bus 5 Five 1 (1) 345.0	To 4 Fou 1 (1 345)		Fin Fin Fin	d By Numbers d By Names d om End Metered			
Display Parame	no labels eters Fault Info n circuit in zero se		Zone, Sub Custom			ier (Same as Fro	m Bus)		
Zero Sequence I R: 0.0 X: 0.0 C: 0.4 Secondary Zero R2: 0.0	Impedance 005625 062500 140000	-	0.000000	nce	Ground R: X: R2: X2:	d Impedance 0.000000 0.000000 0.000000 0.000000			
	Phase shift	ers must be enter	es the grounding of red as part of the Tr		er Contr	rol data.		1	
ОК	Save Sa	ve to Aux			Cance		Help		



- 4. Note that we have not inserted any data in this tab previously, typically simulator assumes that if no zero-sequence data is given for a branch that the zero-sequence impedance is defaulted to 2.5 times the positive sequence impedance, this is where this data came from.
- 5. An example of sequence data is given in tables below which was taken from example 7.5 in the course book.

TABLE 7.3 Synchronous machine	Bus	Machine Subtransient Reactance— X''_d (per unit)	
data for SYMMETRICAL SHORT CIRCUITS	1 3	0.045 0.0225	
program*	$\label{eq:base} \begin{split} ^*S_{\text{base}} &= 100 \text{ MVA} \\ V_{\text{base}} &= 15 \text{ kV at b} \\ &= 345 \text{ kV at} \end{split}$		
TABLE 7.4 Line data for	Bus-to-Bus	Equivalent Positive-Sequence Series Rea (per unit)	ctance
SYMMETRICAL SHORT CIRCUITS program	2-4 2-5 4-5	0.1 0.05 0.025	
TABLE 7.5		Leakage Reactance—X	
Transformer data for SYMMETRICAL	Bus-to-Bus	(per unit) 0.02	



6. To insert this data, you have to double click on each component, and go to the "fault info" tab, then inset the data there. For example, the data for the generator is shown below

Generator	Options							×
Bus Number Bus Name ID Area Name Labels Display Inform Generator In		and Voltage Control	Find F Costs Genera	By Number By Name ind Fuel Type Unit Type Fault Parame tor Step Trans		10	erator MVA B 0.00	
	ral Grounded quence Impedan		R: X: Tap	0.0000	00			
Positive Negative Zero	R: 0.00000 0.00000 0.00000	X : 0.04500 0.00	Neutral R X :		00			
ОК	Save	Save to Aux			C	Cancel	Help	



7. The sequence data for a transformer is shown below:

C Branch Op	otions								-		x
Transformer	From Bus]	To Bus	Circuit		Fin	Find By Numbers				
Number						Find By Names					
Name	Three		Four			Fi	nd]			
Area Name	1 (1)		1 (1)				rom End N	Metered			
Nominal kV	15.00		345.0)efault Owner (Same as From Bus)					
Labels	no labels								-		
Display Param	neters Transform	er Control	Fault Info	Owner, Area,	Zone, S	Sub	Custom	Stability			
Zero Sequence		Zero Sequ		hunt Admittanc	e		nd Imped				
R : 0.	.000000	From	From G: 0.0			R: 0.000000					
X: 0.	.010000	Fron	n B: 0.0	00000		Х:	0.000	000			
C: 0.	.000000	To G	G: 0.0	00000		R2:	0.000	000			
Secondary Zer	o Sequence Imp	To B	: 0.0	00000		X2:	0.000	000			
R2: 0.	.000000	Neutral Im	pedance								
X2: 0.	.000000	Neutr	al R: 0.0	00000							
		Neutr	al X : 0.0	00000							
Configuration	Note: Configurat			yrounding of the part of the Tra			-				
ОК	Save Sa	ave to Aux				Can	cel	ŀ	lelp		



8. To start fault analysis, make sure that you select the run mode, then go to tools tab and select "fault analysis", then the following window will show up:

💽 🖺 - 👺	R 👯 🖫	iii 🔟 😣 🗱				Fault Analys	is - Case:	Example	_5.pwb Status	: Paused Sim	ulator 20 GSO					-	- 0	×
	ase Informat			Tools Optio	ns Add Ons	Windo	w		- •								🥝 –	æ ×
	Abort Log Script + Log	Single Solutio - Full <u>N</u> ewtor P	on Simulator Options Power Flow Tools	Solve + Res <u>t</u> ore +	Contingency Analysis	RAS + CTG Case Info *	df dx ₹ ✓ Sensiti Run Mo	vities Lin	[•] <u>F</u> ault Analysis Time Step Simi te Loading Repl	ulation	Limit Aonitoring	Difference	Scale M	lorer	Othe T	r • Modify Renum		^
	Run Faults Abort Units Inserts a temporary bus to represent til Fault Analysis ha Branch, WARNUNG: Will make solution slower Note - If Unchecked: if Fault Location = Tobus, else Fault Location = Tobus, else Fault Location = TonBus																	
Fault Definitio > - Single Fault	ons	Fault Definitions																
Options Sequence Dat	ata	📰 🔝 🖽	** *** ***		s ▼ Set ▼ Colu				$ \begin{array}{c} & & \\ & & \\ & & \\ & & \\ & \\ & \\ & \\ & $	• 🌐 Optio								
			Fault Name	Skip Sol	ved Fault Objec (File Forma	t Fault Location	Type for Fault 1	Type for Fault 2	Fault Resistance	Fault Reactance	Fault 1 Current Mag	Fault 1 Current Ang	Fault 1 Subtrans Mag A (pu)	Fault 1 Subtrans Ma B (pu)	Fault 1 g Subtrans Mag C (pu)	Fault 1 Thev R	Fault 1 Thev X	Curre
		None		Defined													í	
		<																>
			Auto Insert	Load Data	Save Data											Close	7 Hel	p
Run Mode	S	olution Animation S	Stopped			AC	Viewing Pr	esent										

9. Click on single fault then select "bus records", and you will see the following window:

🧕 뿹 - р 🖪 🗄 💭 📰 🗐 😣 🗱	φ.	Fault Analysis - Case: Evample7 5 n	wb Status: Paused Simulator 20 GSO		– 0 ×
		,	ing pratas radica lonnation to 000		
Edit Mode & Abort Run Mode & Log Script - Mode Log Powe	Solve - Contingency Analysis	RAS + CIG Sensitivities	t Analysis - Step Simulation ding Replicator Himit Difference Monitoring Case -	Scale Case Under Other Tools	Equivalencing
Fault Definitions Single Fault Generators Loads Witched Shunt Buses > V + Bus Matrices Options > Sequence Data Sequence Data Generators Sequence Data Sequence Data Generators Sequence Data Sequence Data Sequence Data	2 ● Number {/] {/] k/] k/]		Fault Location % Bas Fault O In-Line F Location % Fault Imped R : 0.00000 X : 0.00000	It Single Line-to-Ground Image: Comparison of the comparison of) 3 Phase Balanced) Double Line-to-Ground Subtransient Phase Current p.u. deg. A (0.000 (0.00 B (0.000 (0.00) C (0.000 (0.00)
Bus Records Lines					
2 3 4 5		t * Columns * [점 *] 많은 * 많은 * se Volt B Phase Volt C Phase A			
< >					
	Auto Insert Load Data Save Data				Close ? Help
Run Mode Solution Animation Stopp	ped	AC Viewing Present			



10. Note the indicated fields in the previous figure, you can select the fault type, and the faulted bus, after that click calculate, and note the results as shown in the next figure

💽 🏪 - 🎇 👪 🛄	i 🏭 📃 🛞 🎇 🔹 🔹 👘 🔤 Fault Analysis - Case: Example7_5.pwb Status: Paused Simulator 20 GSO	– 0 ×			
File Case Informat	tion Draw Onelines Tools Options Add Ons Window	() – B ×			
Edit Mode Run Mode Mode Korpt + Log	Single Solution Single Solution Solve + Restore + Analysis Image: Solution - Contingency Analysis Image: Solution - Rase + CTG Solve + Restore + Image: Solution - Contingency Analysis Image: Solution - Contingency Rase + CTG Solution - Contingency Rase + CTG Solution - Rase + CTG Solution - Connections - Connect	Equivalencing Modify Case - Renumber - Edit Mode			
	Run Faults Abort				
 ✓ Fault Definitions ✓ Single Fault Bus Records Lines Generators 	Single Fault Calculate Clear C				
Loads	© Sort by O Name @ Number O Single Line-to-Ground @) 3 Phase Balanced			
 Switched Shunt Buses Y-Bus Matrices 	Officient Contraction Contraction	O Double Line-to-Ground			
- Options > - Sequence Data	I (One) (15:00 k/) Location % 0 0 Fault Current Scale Current By: L00000 3 (Three) (15:00 k/) (Fault Impedance Fault Impedance If Magnitude: 37:536 p.u. 4 (Four) [345.0 k/] S (Five) [345.0 k/] Fault Impedance If Scaled Mag: 37:536 p.u. 1 (Fault Impedance R : 0.00000 If Scaled Mag: 37:536 p.u. If Angle: 90.00 deg. Units Units Units Units Units	Subtransient Phase Current deg. p.u. deg. A 37.536 -90.00 B 37.535 150.00 C 37.535 30.00			
	Bus Records Lines Generators Loads Switched Shunt Buses Y-Bus Matrices				
	🔝 🗋 非 🕼 🕫 🌺 🤮 Records - Geo - Set - Columns - 🖼 - 🐩 🐨 - 🎔 腆 - 蹴 fb) - 囲 Options -				
	Number Name Phase Volt A Phase Volt B Phase Volt C Phase Ang A Phase Ang B Phase Ang C 1 1 0ne 0.00000 0.00000 -0.00 -120.00 120.00				
	2 2. Two 0.38551 0.38551 -0.00 -120.00 120.00 3 3. Three 0.73043 0.73043 -0.00 -120.00 120.00				
	4 4 Four 0.58841 0.58841 0.58941 -0.00 -120.00 120.00 5 Five 0.28406 0.28406 -0.28406 -0.00 -120.00 120.00				
< >>		-			
p	Auto Insert Load Data Save Data	👖 Close 💙 Help			
Run Mode S	AC Viewing Present				

Note: in the following link you can find a useful video tutorial as an additional help: <u>https://www.youtube.com/watch?v=q4Deo2324Ck</u>

References:

- Glover, J. and Sarma, M. (2012). Power System Analysis and Design, 5th Edition. Brooks/Cole. Pacific Grove, California.
- 2. https://www.powerworld.com/files/Simulator16_Help_Printed.pdf

