



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

CORPORATION Try Simulator for Free Google Custom See
Home Products Services Solutions Download & Purchase Online Support Training & Events Company
Simulator 20 Glover, Overbye & Sarma Edition Download
Instructions 1. Click on the filename below to begin the download. This file is a Microsoft Installer package. 2. When prompted, save the file to your hard drive. 3. Once the download is completed, double-click on the file on your hard drive. It will begin an installation program. Follow the directions and the program will automatically install itself. 4. After the install program has finished, launch the PowerWorld product! Click on the file name to download: pw20EduGloverOverbyeSarmaSetup.msi (60.3 MB) Click here to download the program GoSSampleCases6thEd.zp (2.3 MB) Click here to downaload sample cases (examples from course book) Last Updated: December 1, 2017

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:

0 10 - 1	影 🖪 🖽 📓	i 🖩 🗐 🛞 🖡					Simulator	20 (64 bit) GSO						-	٥	×
File	Case Informat	tion Draw		Tools Option	s Add Ons	Window										۲
Edit Mode Run Mode	Model Explorer	Area/Zone Filters N	Limit Monitoring	Network - Aggregation - Solution Details -	∐ ∆X Difference Case →	Simulator Options	Case Description Case Summary Custom Case Info	Power Flow List Quick Power Flow I AUX Export Format	Deer	Substation View	Oneline Viewer	Data View	Open Windows			
Mode		Case	Information				Case Data				Views					^
(Cl choose or New	come to the lick on File Open Case (Case to of Upgr. http://powery Glover, Sa Copyright © 199 Copyright © 199	orp he Power e in the u se to ope create a o world.com/glo arma, and Ove 96-2017 Powe	overoverbyesarma erbye Textbook erWorld Corporation iomas J. Overbye	on tor case,	Optin Secu OPF Avail PV a Trans	Add-Ons ational and Power Flow ((rity Constrained C Reserves able Transfer Cap ad QV Curves (PV eint Stability nagnetically Indu	DPF) DPF (SCOPF) ability (ATC) QV)								
Edit Mode																

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

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	File		dow	۲
5	New Case Open Case Save Case Save Case As	Recent Cases e (Ctrl+N) ^{6_9.pwb}	Case Description Case Summary Custom Case Data Custom Custom C	^
	Ngw Oneline Open Oneline		Add-Ons: Jucational ptimal Power Flow (OPF) pc reserves valiable Transfer Capability (ATC) V and OV Curves (PVQV) ansient Stability eomagnetically Induced Current	
Ме	Printer Setup	Egit Pro		



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

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File	Case Information Draw Onelines	Tools Options Add Ons	Window					0
Edit Mode Run Mode Mode	Model Area/Zone Limit Explorer Filters Monitoring Case Information	Network → Aggregation → Solution Details → Difference Case →	Case Description Case Summary Simulator Options Case Summary Custom Case Info Case Data	BI	us Substation Oneline Date w View Views	ta Open		^
	NewOne1.pwd					-		
L								
Edit Mode		X = 56.88 Y = 61.91	Viewing Present					

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:

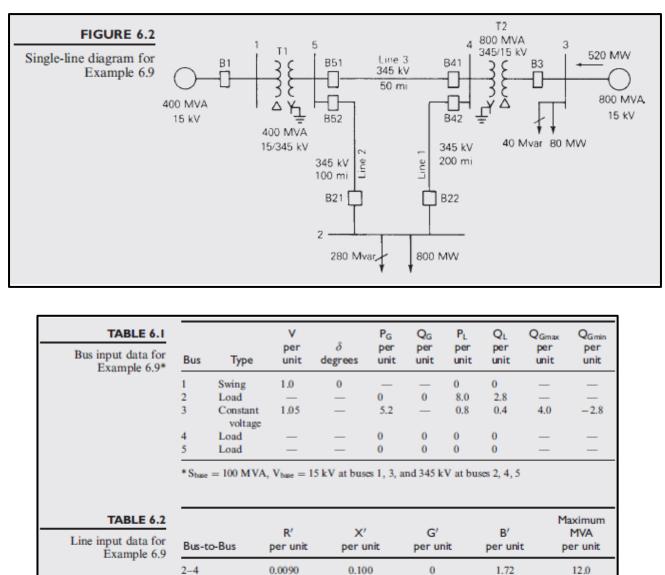
I III	ellin. 💼 214 🦛									
		i 🛤 🔲 😣 🎆					5.pwb Status: Paused S	imulator 20 GSO	}	- 0 ×
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Edit Mode		Misc. Power Flow +	F	Animation \cdot	Pie Chart 🛛	Dynamic Formatting	 Toggle <u>Full Screen</u> 	🗙 Abort		
Run Mode	Simulator	Solution +	Oneline		Misc Options +	Custom Hint Values		🔚 Log		
	Options	Case Info Options +	Options	Draw Grid 🔹		Default Drawing	Find Text in Oneline	Script -		
Mode	C	ase Options		Snap To 🕯			I Options	Log		^
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				Draw Gri						
				Grid Line		Draw Grid Lines				
					z. Show 2	÷				
						*				
				Disable A	Anchors					
Draw Grid Line	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.



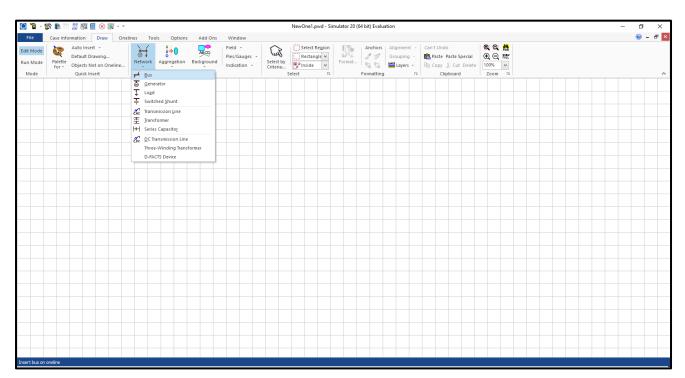
2-5 4-5	0.0045 0.00225	0.05		0 0	0.88 0.44	12.0 12.0
Bus-to-Bus	R per unit	X per unit	G _c per unit	B _m per unit	Maximum MVA per unit	Maximum TAP Setting per unit
1-5	0.00150	0.02	0	0	6.0 10.0	_
	Bus-to-Bus	R per Bus-to-Bus unit	R X per per Bus-to-Bus unit unit	R X G _c per per per Bus-to-Bus unit unit unit	R X G _c B _m per per per per Bus-to-Bus unit unit unit unit	R X G _c B _m Maximum per per per per MVA Bus-to-Bus unit unit unit per unit



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
	$P_3 = P_{G3} - P_{L3} = 4.4$	
4	$P_4 = 0, Q_4 = 0$ $P_5 = 0, Q_5 = 0$	V_4, δ_4 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:





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	e 15.0000 kV	
Labels	no labels	
Balancing Authority Zone Ch Owner Ch	Number Name ange 1 1 ange 1 2 Display Attached Devices	Geography Custom
Bus Voltage Voltage (p.u.) Angle (degrees		Bus Voltage Regulator Devices
ОК	Save Save to A	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:

			BIRZEIT UN	بَجْافِيَعْهُرُ IVERSITY				
🔘 Bus Voltage	Regulating D	evices Dialog					×	
Bus	3	Thre]			
Area	1	1]			
Zone	1	1]			
Owner	1	1]			
Substation	not assigned to	o substai	assigned to subs	tation]			
Voltage (p.u.)	1.0000	Volta	ge (kV) 15.000	0]			
🧱 📄 🏨 考	k +.0 .00 Å	Records	·▼ Geo ▼ Set	▼ Columns ▼		▼ Ender XXXX ▼ 124 ABED	f(x) 🕶 🏢	~
[Device	Device Type	Reg Voltage Max	Reg Voltage Min	Device Voltage Target	Transformer Regulation Target Type	Device Voltage Target High	
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:

🔘 🖥 - t	👺 🔝 👯 📓 🖓	📃 🛞 📱					N	ewOne1 - S	imulato	or 20 GSO						- 6	×
File	Case Information	Draw	Onelines	Tools Option	Add On:	s Window										0	- 8 ×
Edit Mode Run Mode		/Zone	85% 110% Limit onitoring	Network - Aggregation - Solution Details -	Difference Case *	Simulator Options	Case Sun	cription mary Case Info	Quick	r Flow List Power Flow Export Forma	Bus View	Substation View	Oneline Viewer	Data View	Open Windows *		
Mode			nformation			-	Cas	e Data					Views				^
					l B Q Ir N	us Information us View us View us Palette issert Connecte Iove Equipmen jir Bus	ow List d Buses										
						ormat Bus											
						dd New Fields	Around B	JS									
					C p	pply Default D opy Format Fr aste Format In nap Bus To Gri	om Bus to Bus	To Bus									
					C	reate a Case In	formation	from Sele	tion								
					_												

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
		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 Remove Field	X Cancel	? Help



Second: inserting generators

1. 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 Bus Name One Find By Name Open Generator MVA Base ID 1 Find Image: Open Generator MVA Base ID 1 Find Image: Open Generator MVA Base ID 1 Find Image: Open Generator MVA Base ID 1 Find Type Unknown Image: Open Generator MVA Base ID 1 Fuel Type Unknown Image: Open Generator MVA Base Labels Ino labels Unit Type Unknown Image: Open Generator MVA Base Display Information Power and Voltage Control Costs Fault Parameters Owners, Area, etc Custom Stabili 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 0.000 Regulated Bus Number 1 Min Mvars -9900.000 Was Capability Curve Remote Reg % 100.0 Max Mvars 9900.000 <	ty
Bus Name One Find By Name Generator MVA Base ID 1 Find ID.0.00 Area Name 1 Fuel Type Unknown ID.0.00 Labels no labels Unit Type UN (Unknown) ID.0.00 Display Information Power and Voltage Control Costs Fault Parameters Owners, Area, etc Custom Power Control MW Output 0.000 Part. Factor 10.00 Min. MW Output 0.000 Available for AGC Max. MW Output 1000.000 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 Power Factor 100.0	ty
ID 1 Find Fuel Type Unknown 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 Stabili 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 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	ty
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 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 Power Factor Power Factor	ty
Display Information Power and Voltage Control Costs Fault Parameters Owners, Area, etc Custom Stability Power Control 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 Power Factor 100.0	ty
Power Control 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 Power Factor 100.0	ty
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 Power Factor 100.0	
Min. MW Output 0.000 Available for AGC Max. MW Output 1000.000 Enforce MW Limits during automatic control Voltage Control Min Mvars -9900.000 Min Mvars -9900.000 Available for AVR SetPoint Voltage 1.000000 Max Mvars 9900.000 Use Capability Curve Wind Control Mode Power Factor	
Max. MW Output 1000.000 Image: 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	
Voltage Control Regulated Bus Number 1 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	
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	
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	
Max Mvars 9900.000 Use Capability Curve Remote Reg % 100.0 Wind Control Mode Power Factor	
Wind Control Mode Power Factor	
Power Factor	
Mode None V 1.0000	
MW	
Min Mvar	
Max Mvar	
<	>
OK Save Save 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	tions									-		х
Transformer Number Name Area Name Nominal kV Labels	From 1 One 1 (1) 15.00 no labo	els	To Ba 5 Five 1 (1) 345.0	JS	Circuit 1] 	Fir Fir	d By Numbers nd By Names nd om End Metere ner (Same as F		us)		
Display Parame	eters	Transformer Control	Fault In	nfo Owr	ner, Area,	Zone	e, Sub 🛛	Custom Stabi	ility			
Status		Per Unit Impedance	e Parame	eters		N	MVA Limits	, 	_	1		
Open		Series Resistance (R)	0.00150	00	Li	imit A	600.000	^			
Closed		Series Reactance (X)	0.02000	00	Li	imit B	600.000		•		
Branch Device T	Shunt Charging (B)	0.000		00	Lir		600.000					
Transformer		Shunt Conductance	onductance (G)		0.000000		imit D	0.000				
Allow Consoli	dation	Magnetizing Condu	ctance	0.0000	00	Li	imit E	0.000				
Length 0.0	00	Magnetizing Suscep	otance	0.000000		Li	imit F	0.000				
Calculate Impedances		the system MVA and	ces above are in per unit on nd Voltage bases. Click dedit on Transformer Bases.				imit G imit H imit I	0.000	l			
Normal Status		Specify Transforme	r Bases	and Impe	dances			0.000				
 Open Closed 		Has Line Shunts		Line S	hunts		imit J imit K	0.000				
Convert Tr D-FACTS D	evices (on the Line	Has D-F	ACTS			Canc		¥		1	
OK	Sa	ve Save to Aux					Cano		Hel			

- 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.

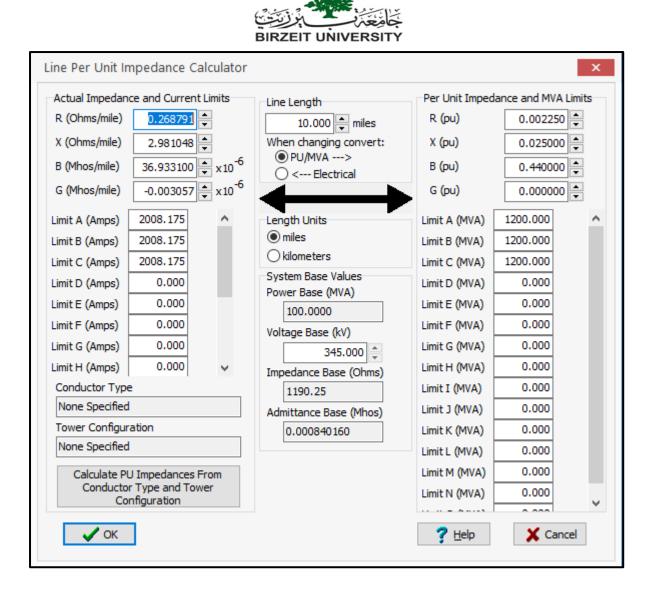


> Fourth: inserting transmission line

- 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:

C Branch Opt	tions									-	x
Line Number Name Area Name Nominal kV Labels	From 5 Five 1 (1) 345.0 no labe	ls		To Bi 4 Four 1 (1) 345.0		1	■ Fi	d By Numbers nd By Names nd om End Metere ner (Same as F)	
Status Open Oclosed Branch Device Ty Line Allow Consoli	ype dation 00 • >	Per Unit Series R Shunt Cl Shunt C Has I	Impedance P esistance (R) eactance (X) harging (B) onductance (.ine Shunts	Parame	eters 0.0025 0.4400 0.0000 Line	250 200 200	MVA Limits Limit A Limit B Limit C Limit C Limit E Limit F Limit G Limit H Limit I Limit J Limit K	1200.000 1200.000 1200.000 0.000 0.000 0.000 0.000 0.000 0.000	~		
ОК	Sav	re Sar	ve to Aux				Cano	el	Help		

- 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:

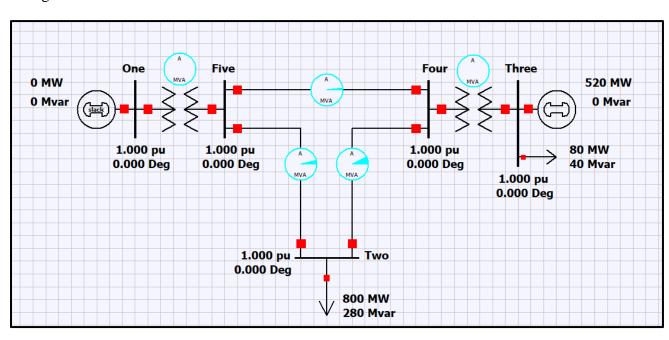
C Load Op	tions		- 🗆 X									
Bus Number	8	Find By Number	Status O Open									
Bus Name	Three	Find By Name	Closed									
ID	1	Find	Closed									
Labels	no labels											
	Number	Name										
Area Cha	ange 1	1										
Zone Cha	ange 1	1										
Substation												
Owner Cha	ange 1	1										
	Same Own	er as Terminal Bus										
Load Informa	tion OPF Load Disp	atch Custom Stability										
	Constant Con	stant Constant	Distributed Generation									
		rent 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	Orientation										
Display S	Size 6.00	Orientation Right Left										
Scale V	Vidth with Size											
Display Wi	dth 2.25 📥	✓ Anchored										
Pixel Thickne	Pixel Thickness 2 Link To New Load											
OK Save Save to Aux Cancel Help												

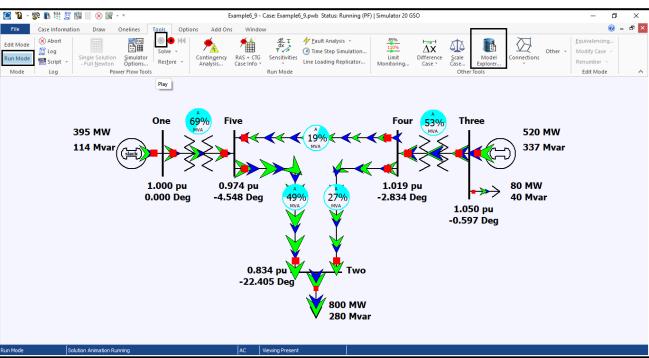
- 2. The data you have to insert is shown in the indicated boxes in the figure above, this data is taken from tables of example 6.9.
- 3. Other loads are inserted similarly.



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:



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	1200.000	● Percent	18.8
= -	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:

-																			-
💽 🎦 - 📽 🖪 🖽 🖉 🟭	📃 🗙 🏭				Model E	xplorer: Bu	ses - Case:	Example6_9	.pwb Status: P	aused Simul	lator 20 GSC)						o ×	
File Case Information	Draw One	lines T	fools (Options A	Add Ons	Window											(0 - 5	×
Edit Mode Abort	m		🕒 🗎 k	KI 🖌		<u>.</u>	<u>df</u> ∓	✓ Eault /	Analysis +	859	16	⊢ →1	xtx		$\overline{\mathbf{\Lambda}}$		Equivalencing		
🔚 Log			Solve +	- <u>-</u>	4 1	H	df dx ₹↓7		tep Simulation	859 110		Δx	SIS		∇Z	Other -	Modify Case		
Run Mode Allah Sir		ptions	Restore	Contin Analy		5 + CTG 5 e Info +	Sensitivitie	s Line Load	ing Replicator.	··· Monito		ference Case +	<u>S</u> cale Case	Model Explorer	Connection	s	Renumber -		
Mode Log		Flow Tools	-	Analy	JiJ Cuj		un Mode			monito		, and the second s		er Tools			Edit Mode		^
Explore 4	Buses																		
	📴 💟 🖽	** :0 ;	···· ··· ··· ···	🚯 🗮 Rec	ords v Geo	• Set • C	olumns -		. AUSD - 💎 🗎		0nt	ions •							
Explore Fields				NCD -11 1100						NPLP									
V Network	Filter Advar	nced 🗸 Bu	IS		~				nd Remove										
> 🧾 Branches By Type	Nur	nber	Name	Area Name	Nom k\	/ PU	Volt	Volt (kV)	Angle (Deg)	Load MW	Load Mva	r Ge	n MW	Gen Mvar	Switched Shunts Mvar	Act G Shunt MW	Act B Shunt Mvar	Area Num	
Branches Input Branches State	1	1 On	ie	1	15	5.00	1.00000	15.000	0.00				394.83	114.24	Situates invar	0.00	0.00		1
Buses	2	2 Tw		1			0.83380	287.661	-22.41	800.00						0.00	0.00		1
DC Transmission Lin		3 Thr 4 For		1			1.05000	15.750 351.661	-0.60 -2.83	80.00	40	.00	520.00	337.43		0.00	0.00		1
> 💾 Generators	5	5 Fiv		1			0.97430	336.132	-4.55							0.00			1
Impedance Correction																			
Line D-FACTS Device Line Shunts																			
> Ine shunts																			
Mismatches																			
> Multi-Terminal DC																			
Switched Shunts																			
Three-Winding Tran																			
Transformer Control																			
> 💾 Voltage Control Gro																			
VSC DC Transmission																			
Areas																			
Balancing Authoriti																			
Bus Pairs																			
Data Maintainers																			
> 💾 Injection Groups																			
> 💾 Interfaces																			
Islands																			
Multi-Section Lines																			
MW Transactions																			
> 💾 Nomograms 👻	<																		>
Open New Explorer	Search					Search	Now Op	tions 🕶											
Edit Mode																			

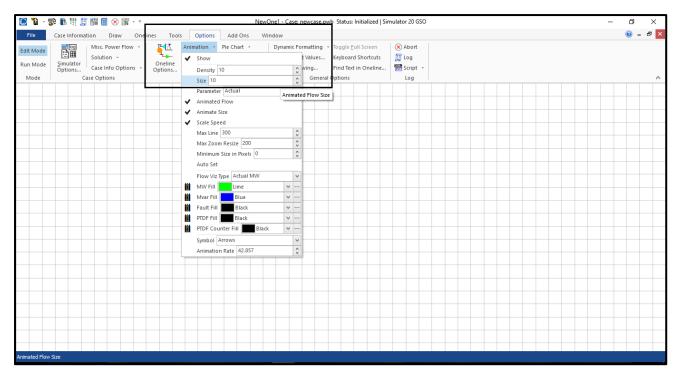
You can find other information regarding the system e.g. to view the bus admittance matrix Y matrix by scrolling down to "solution details" and selecting Ybus.

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.

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> P Nomograms	_	1		3.73 - j49.72	005	2 003	, <u>,</u>		-3.73 + j49.	70				
Owners Substations	-	2	2 Two	3.73 -]49.72	2.68 - j28.	46		-0.89 + j9.92						
Super Areas	-	3	3 Three		2.00 j20.	7.46 - j		-7.46 + j99.44	1.79 - 119.					
Tielines between		4	4 Four		-0.89 + j9			11.92 - j147.96	-3.57 + j39.	68				
Tielines between Tielines between		5	5 Five	-3.73 + j49.72	-1.79 + j1	9.84		-3.57 + j39.68	9.09 - j108.	58				
Transfer Direction	s													
Solution Details Bus Zero-Impeda Fast Decoupled E Mismatches More Flow Post Power Flow Post Power Flow Post Power Flow Post Power Flow The Step Action: Yous Contingency Analysis Optimal Power Flow Tools and Add Ons Tansient Stability User-Defined	PI PF So bia sec													
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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 Opt	tions					-		x
Line Number Name Area Name Nominal kV Labels Display Parame	From Bus 5 Five 1 (1) 345.0 no labels eters Fault Info	To 4 Four 1 (1) 345. Owner, Area, Zo	0	Fir Fir	d By Numbers nd By Names nd om End Metered ner (Same as Fr			
Zero Sequence R: 0.1 X: 0.1 C: 0.1 Secondary Zero R2: 0.1 X2: 0.1	005625 062500 440000 o Sequence Imp 000000 000000	-Zero Sequence I From G: From B: To G: To B: Neutral Impedar Neutral R : Neutral X :		R : X : X2 :	-			
ОК	Save Sa	ive to Aux		Canc	el	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 chronous machine	Bus	Machine Subtransient Reactance— X''_d (per unit)
data for SYMMETRICAL	1 3	0.045 0.0225
program*		
TABLE 7.4	Bus-to-Bus	Equivalent Positive-Sequence Series Reactance (per unit)
YMMETRICAL ORT CIRCUITS program	2-4 2-5 4-5	0.1 0.05 0.025
TABLE 7.5		Leakage Reactance—X
TABLE 7.5 nsformer data for YMMETRICAL	Bus-to-Bus	Leakage Reactance—X (per unit)



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 1 Bus Name One ID 1 Area Name 1 Labels no labels Display Information Power and Voltage Control Generator Impedances Veutral Grounded	Find By Number Status Find By Name Open Generator MVA Base 100.00 Fuel Type Unknown Unit Type UN (Unknown) Costs Fault Parameters Owners, Area, etc Custom Generator Step Transformer R: 0.00000 0
Internal Sequence Impedances R: X: Positive 0.00000 0.04500 Negative 0.00000 0.00 Zero 0.00000 0.0	X: 0.00000 Tap: 1.00000 Neutral-to-Ground Impedance R: 0.00000 X: 0.00000
OK Save Save to Aux	Cancel Help



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

Diranch Op	tions					-	
Transformer	From Bus	1	o Bus	Circuit	Find By Nur	mbers	
Number	3	4		1	Find By Na		
Name	Three	Fou	ur		Find		
Area Name	1 (1)	1 (1)		From End I	Metered	
Nominal kV	15.00	34	5.0	✓ Defz		ne as From Bus)	
Labels	no labels						
Display Param	eters Transform	er Control Fau	lt Info Owne	r, Area, Zone,	Sub Custom	Stability	
Treat as op	en circuit in zero s	equence					
Zero Sequence	e Impedance	Zero Sequence	e Line Shunt A	dmittance	Ground Imped	dance	
R : 0.	.000000	From G:	0.000000		R: 0.000		
X: 0.	.010000	From B:	0.000000		X: 0.000		
C: 0.	.000000	To G:	0.000000		R2: 0.000		
Secondary Zer	o Sequence Imp	To B:	0.000000		X2: 0.000	0000	
R2: 0.	.000000	Neutral Imped	ance				
X2: 0.	.000000	Neutral R	: 0.000000				
		Neutral X	: 0.000000				
Configuration	Unknown			\sim			
	Note: Configurat Phase shift	ion only determir ters must be ente					
ОК	Save	ave to Aux			Cancel	Help	



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:

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File Case Infor			Tools Option	ns Add Ons	Windo	N										🥑 –	8×
Edit Mode Run Mode Mode	- run <u>re</u> circo	on Simulator Options Power Flow Tools	Solve - Restore -	Contingency Analysis	RAS + CTG Case Info *	df dx ₹✓ Sensitiv Run Mo	vities Lin	^r <u>F</u> ault Analysis Time Step Simi ne Loading Repl		Limit Ionitoring	Difference	Scale M	lodel Conr lorer	Othe T	r • Modify Renum		^
····· Fault Definitions	Run Faults	Abort	Units ● p.u. ○ Amp	os Inserts a Note - If	temporary bi Unchecked: i	us to repre f Fault Loc	sent ti Fa ation >= :	ult Analysis h a Su then Fault Loo	Branch. WARN ation = ToBus,	IING: Will make , else Fault Loca	solution slower ation = FromBu:	5					
> Single Fault		s ∃ * * t.8 ;08 ∲	A Parand	s ▼ Set ▼ Colu	mns v 🖾 v	8030 - 8		₩ - SORT 124 ABED f(x)	• 🎟 🛛 Ontic	nns *							
> · Sequence Data		Fault Name		ed Fault Obie		Type for		Fault	Fault Reactance	Fault 1 Current Mag	Fault 1 Current Ang	Fault 1 Subtrans Mar A (pu)	Fault 1 Subtrans Ma B (pu)	Fault 1 g Subtrans Mag C (pu)	Fault 1 Thev R	Fault 1 Thev)	(Fa Curre
	<u>Fione</u>		Defined														>
		Auto Insert	Load Data	Save Data	1										Close	? Hel	p
Run Mode	Solution Animation	Stopped			AC	Viewing Pr	esent										

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

💽 🖥 - 黔 陆 坩 🖉 🏭 🗮 🛞 朦 - * Fault Analysis - Case: Example7_5.pwb Status: Paused Simulator 20 GS	0	– 0 ×		
File Case Information Draw Onelines Tools Options Add Ons Window		@ - & ×		
Edit Mode	Difference Case * Case Explodel Other Tools	Other - Equivalencing Modify Case - Renumber - Edit Mode		
Run Faults Abort Fault Definitions Single Fault Fault Definitions Single Fault Bus Records Calculate Lines Calculate Concose the Faulted Bus Oncose the Faulted Bus Choose the Faulted Bus Sort by O Name Options Sort by O Name Sequence Data I (Once) [15:00 kV] 4 (Four) [345.0 kV]	R : 0.00000 If Scaled Mag: 0.000	(e) 3 Phase Balanced Double Line-to-Ground Subtransient Phase Current p.u. A 0.000 0.00 B 0.000 C 0.000 C 0.000 C 0.000		
Bus Records Lines Generators Loads Switched Shunt Buses Y-Bus Matrices I III				
< >>				
Auto Insert Load Data Save Data		👖 Close 💡 Help		
Run Mode Solution Animation Stopped 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

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File Case Informatio		@ -	₽×
Edit Mode Run Mode Mode Mode Kapping Kappin	Single Solution Simulator	Terence Case Scale Case Connections Other Connections Other Tools	^
	Run Faults Abort		
 ✓ Fault Definitions ✓ Single Fault 	Single Fault		
Bus Records	Calculate Clear Clear/Close		
···· Generators ···· Loads	choose the residence bas	ault Location Fault Type Bus Fault O Single Line-to-Ground 3 Phase Balanced	
	• Sort by O Name O Number	Dir-Line Fault O Line-to-Ground O Double Line-to-Ground	
> Y-Bus Matrices			
Options Sequence Data	2 (Two) [345.0 kV]	Scale Current By: 1.00000 Subtransient Phase Current	
	4 (Four) [345.0 kV]	ault Impedance If Magnitude: 37.536 p.u. A 37.536 -90.00	1
	5 (Five) [345.0 kV] R :	: 0.00000 If Scaled Mag: 37,536 p.u.	
	X:	: 0.00000 If Angle: -90.00 deg. B 37.535 150.00	
		Units C 37.535 30.00	
	Bus Records Lines Generators Loads Switched Shunt Buses Y-Bus Matrices		
	🛄 🦳 🌐 🎋 🞎 🚜 🌺 Records - Geo - Set - Columns - 📴 - 酇 - 🌹 賟 - 蹴 f(x) - 田 Options -		
	Number Name Phase Volt A Phase Volt B Phase Volt C Phase Ang A Phase Ang B Phase Ang C		
	1 One 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 0.73043 -0.00 -120.00 120.00		
	4 4 Four 0.58841 0.58841 -0.00 -120.00 120.00 5 5 Five 0.28406 0.28406 -0.00 -120.00 120.00		
< >			
	Auto Insert Load Data Save Data	I Close 7 Hel	lp
Run Mode Sol	ution Animation Stopped 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

