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Note : Remove "Table of Content" before including in CP Book

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15EEL76 : Power System Simulation LAB

A. LABORATORY INFORMATION

1. Lab Overview

Degree:	B.E	Program:	EE
Year / Semester :	4 / 7	Academic Year:	2018-19
Course Title:	Power system simulation Lab	Course Code:	15EEL76
Credit / L-T-P:	3 / 0-1-2	SEE Duration:	180 Minutes
Total Contact Hours:	30 Hrs	SEE Marks:	80 Marks
CIA Marks:	20	Assignment	1 / Module
Course Plan Author:	Mrs. shravanthi A	Sign	Dt :
Checked By:		Sign	Dt :

2. Lab Content

Unit	Title of the Experiments	Lab	Concept	Blooms Level
		Hours		
1	Formation for symmetric π /T configuration for Verification of AD	3	ABCD	L5
	-BC = 1, Determination of Efficiency and Regulation		Paramet	
			ers of	
			transmiss	
			ion line	
2	Determination of Power Angle Diagrams, Reluctance Power,	3	Salient	L5
	Excitation, Emf and Regulation for Salient and Non-Salient Pole		and Non-	
	Synchronous Machines		Salient	
			Pole	
			Synchron	
			ous	
			Machines	
3	To obtain Swing Curve and to Determine Critical Clearing Time,	3	Transient	L5
	Regulation, Inertia Constant/Line Parameters /Fault		Stability	
	Location/Clearing Time/Pre-Fault Electrical Output for a Single			
	Machine connected to Infinite Bus through a Pair of identical			
	Transmission Lines Under 3-Phase Fault On One of the two Lines.			
4	Y Bus Formation for Power Systems with and without Mutual	3	Bus	L5
	Coupling, by Singular Transformation and Inspection Method.		admittan	
			ce matrix	
			formulati	
			on	
5	Formation of Z Bus(without mutual coupling) using Z-Bus Building	3	Z-Bus	L5
	Algorithm.		Building	
			Algorithm	
6	Determination of Bus Currents, Bus Power and Line Flow for a	3	Bus	L5
	Specified System Voltage (Bus) Profile		current,	
			bus	
			power	
			and line	

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<u> </u>			flow	
			calculatio	
			ns	
7	Formation of Jacobian for a System not Exceeding 4 Buses (No PV	3	Jacobian	L5
	Buses) in Polar Coordinates		matrix	
			calculatio	
			n	
8	Load Flow Analysis using Gauss Siedel Method, NR Method and	3	Load flow	L5
	Fast Decoupled Method for Both PQand PV Buses.		analysis	
9	To Determine Fault Currents and Voltages in a Single Transmission	3	Short	L5
	Line System with Star-Delta Transformers at a Specified Location for		circuit	
	LG and LLG faults by simulation.		analysis	
10	Optimal Generation Scheduling for Thermal power plants by	3	Optimal	L5
	simulation.		generatio	
			n	
			schedulin	
			g	

3. Lab Material

Unit	Details	Available
1	Text books	
	Modern Power System Analysis, D. P. Kothari, McGraw Hill, 4 th Edition, 2011	In Lib
2	Reference books	
	Computer Methods in Power Systems Analysis, Glenn W Stagg, Ahmed H Ei -	In dept
	Abiad, McGraw Hill.	
	Power System Analysis, HadiSaadat, McGraw Hill, 2nd Edition, 2002	
3	Others (Web, Video, Simulation, Notes etc.)	
		Not Available

4. Lab Prerequisites:

-	-	Base Course:		-	-
SNo	Course	Course Name	Topic / Description	Sem	Remarks
	Code				
1	15EE71	Power system	Load Flow Studies, Optimal System	7	
		analysis-2	Operation, Symmetrical Fault Analysis ,		
			Swing Equation		
2	15EE43	Transmission and	Performance of transmission lines	4	Plan Gap Course
		Distribution			

Note: If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

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SNo	Instructions	Remarks
1	Observation book and Lab record are compulsory.	
2	Students should report to the concerned lab as per the time table.	
3	After completion of the program, certification of the concerned staff in-charge in	
	the observation book is necessary.	
4	Student should bring a notebook of 100 pages and should enter the readings	
	observations into the notebook while performing the experiment.	
5	The record of observations along with the detailed experimental procedure of	
	the experiment in the Immediate last session should be submitted and certified	
	staff member in-charge.	
6	Should attempt all problems / assignments given in the list session wise.	
7	It is responsibility to create a separate directory to store all the programs, so	
	that nobody else can read or copy.	
8	When the experiment is completed, should disconnect the setup made by	
	them, and should return all the components/instruments taken for the purpose.	
9	Any damage of the equipment will be viewed seriously either by putting penalty	
	or by dismissing the total group of students from the lab for the semester/year	
10	Completed lab assignments should be submitted in the form of a Lab Record in	
	which you have to write the algorithm, program code along with comments and	
	output for various inputs given	

6. Lab Specific Instructions

SNo	Specific Instructions	Remarks
1	Enter the command window of the MATLAB.	
2	Create a new M – file by selecting File - New – M – File	
3	Type and save the program in the editor window.	
4	Execute the program by pressing Tools – Run.	
5	View the results.	

B. OBE PARAMETERS

1. Lab / Course Outcomes

#	COs	Teach.	Concept	Instr	Assessment	Blooms'
		Hours		Method	Method	Level
1	Develop a program in MATLAB to assess	3	ABCD	Black	Slip Test +	L5
	the performance of medium and long		Parameters of	Board +	Viva	
	transmission lines by calculating the ABCD		transmission	Executio		
	parameters		line	n		
2	Develop a program in MATLAB to obtain	06	Salient and	Black	Slip Test +	L5
	the power angle characteristics of salient		Non-Salient	Board +	Viva	
	and non-salient pole alternator		Pole	Executio		
			Synchronous	n		
			Machines			
3	Develop a program in MATLAB to assess	07	Transient	Black	Slip Test +	L5

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	the transient stability under three phase		Stability	Board +	Viva	
	fault at different locations in a power			Executio		
	systems.			n		
4	Develop a program to compute admittance	03	Bus	Black	Slip Test +	L5
	matrix by inspection & singular		admittance	Board +	Viva	
	transformation method		matrix	Executio		
			formulation	n		
5	Develop a program to compute Z-bus using	03	Z-Bus	Black	Slip Test +	L5
	Z- bus algorithm		Building	Board +	Viva	
			Algorithm.	Executio		
				n		
6	Calculate bus currents, bus power and line	03	Bus current,	Black	Slip Test +	L5
	flow for given system, develop the program		bus power	Board +	Viva	
	and verify using MATLAB		and line flow	Executio		
			calculations	n		
7	Use Mi-Power package for the formation of	03	Jacobian	Black	Slip Test +	L5
	Jacobian		matrix	Board +	Viva	
			calculation	Executio		
				n		
8	Use Mi-Power package to study load flow	03	Load flow	Black	Slip Test +	L5
	analysis using NR method, Gauss Siedel		analysis	Board +	Viva	
	Method, Fast Decoupled method			Executio		
				n		
9	Use Mi-Power package to study	03	Short circuit	Black	Slip Test +	L5
	unsymmetrical faults at different locations in		analysis	Board +	Viva	
	radial power systems			Executio		
				n		
10	Use of Mi-Power package to study optimal	03	Optimal	Black	Slip Test +	L5
	generation scheduling problems for thermal		generation	Board +	Viva	
	power plants.		scheduling	Executio		
				n		
-	Total	42	-	-	-	-

Note: Identify a max of 2 Concepts per unit. Write 1 CO per concept.

2. Lab Applications

SNo	Application Area	CO	Level
1	To assess the performance of transmission lines by calculating ABCD parameters	CO1	L5
2	To study about the power versus torque angle characteristics for given salient pole	CO2	L5
	and non salient synchronous machine.		
3	Since we normally use synchronous generators to generate power in a grid, stability	CO3	L5
	refers to the ability of the synchronous generator to remain in synchronism. A swing		
	curve can be used to see how stable the generator will be after a disturbance. It is		
	basically a plot of the rotor angle with respect to time.		
4	Used to analyse the data that is needed in the load or a power flow study of the	CO4	L5
	buses.		
5	Important tool in other power system studies like short circuit analysis or fault studt .	CO5	L5
	The Zbus matrix can be computed by matrix inversion of the Ybus matrix		
6	Line flow analysis is very important tool for analysis of power systems which is used	CO6	L5
	at operational as well as planning stages of the system, like adding and installation of		
	new generation station, load balancing in dynamic running condition and transmission		

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	lines site selection.		
7	Load flow studies are one of the most important aspects of power system planning	CO7	L5
	and operation. Through the load flow studies we can obtain the voltage magnitudes		
	and angles at each bus in the steady state. This is rather important as the		
	magnitudes of the bus voltages are required to be held within a specified limit.		
8	Load flow studies are one of the most important aspects of power system planning	CO8	L5
	and operation. Through the load flow studies we can obtain the voltage magnitudes		
	and angles at each bus in the steady state. This is rather important as the		
	magnitudes of the bus voltages are required to be held within a specified limit.		
9	Determines the magnitude of the currents that flow during an electrical fault.	CO9	L5
	Comparing these calculated values against the equipment ratings is the first step to		
	ensuring that the power system is safely protected.		
10	To allocate the generation to each and every units in a plant for a given load such	CO10	L5
	that fuel cost is minimum subjected to equal and inequality constraints		

Note: Write 1 or 2 applications per CO.

3. Articulation Matrix

(CO - PO MAPPING)

-	Course Outcomes				F	Prog	am (Outc	ome	s				
#	COs	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	Level
		1	2	3	4	5	6	7	8	9	10	11	12	
15EEL76.1	Develop a program in MATLAB to	x	х			x								L5
	assess the performance of medium													
	and long transmission lines by													
	calculating the ABCD parameters													
15EEL76.2	Develop a program in MATLAB to	x	х			x								L5
	obtain the power angle													
	characteristics of salient and non-													
	salient pole alternator													
15EEL76.3	Develop a program in MATLAB to	x	х			x								L5
	assess the transient stability under													
	three phase fault at different													
	locations in a power systems.													
15EEL76.4	Develop a program to compute	x	х			x								L5
	admittance matrix by inspection &													
	singular transformation method													
15EEL76.5	Develop a program to compute Z-	x	х			x								L5
	bus using Z- bus algorithm													
15EEL76.6	Calculate bus currents, bus power	x	x			x								L5
	and line flow for given system,													
	develop the program and verify													
	using MATLAB													
15EEL76.7	Use Mi-Power package for the	x	x			x								L5
	formation of Jacobian													
15EEL76.8	Use Mi-Power package to study	x	х			x								L5
	load flow analysis using NR													
	method, Gauss Siedel Method, Fast													
	Decoupled method													
15EEL76.9	Use Mi-Power package to study	х	x			x								L5

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	unsymmetrica	al faults at different													
	locations in ra	adial power systems													
15EEL76.10	Use of Mi-Po	ower package to study	х	x			x								L5
	optimal ge	neration scheduling													
	problems for	thermal power plants.													
CS501PC.	Average														

Note: Mention the mapping strength as 1, 2, or 3

4. Mapping Justification

Марр	ing	Mapping	Justification
		Level	
СО	PO	-	-
CO1	PO1	L2	Knowledge on classification of overhead transmission line, Terms related to performance of transmission line.
CO1	PO2	L5	Analyzing the performance of medium transmission line by determining the voltage regulation and transmission efficiency
CO1	PO5	L3	Develop a program in MATLAB to assess the performance of medium and long transmission lines.
CO2	PO1	L2	Knowledge on Salient and Non-Salient Pole Synchronous alternator.
CO2	PO2	L5	To analyze the power angle characteristics of salient and non- salient pole alternator.
CO2	PO5	L3	Develop a program in MATLAB to obtain the power angle characteristics of salient and non-salient pole alternator.
CO3	PO1	L2	Knowledge on swing curve
CO3	PO2	L5	To assess the transient stability under three phase fault at different locations in a power systems.
CO3	PO5	L3	Develop a program in MATLAB to assess the transient stability under three phase fault at different locations in a power systems.
CO4	PO1	L2	Knowledge on bus admittance and bus impedance matrices of interconnected power systems.
CO4	PO2	L5	Bus admittance matrix formation for Power Systems with and without Mutual Coupling, by Singular Transformation and Inspection Method
CO4	PO5	L3	Develop programs in MATLAB to formulate bus admittance and bus impedance matrices of interconnected power systems.
CO5	PO1	L2	Knowledge on Z- bus algorithm.
CO5	PO2	L5	Formation of Z Bus using Z bus building algorithm
CO5	PO5	L3	Develop a program for formation of Z Bus using Z bus building algorithm
CO6	PO1	L2	Knowledge on load flow analysis
CO6	PO2	L5	To formulate Bus Currents, Bus Power and Line Flow for a Specified System Voltage (Bus) Profile.
CO6	PO5	L3	To formulate Bus Currents, Bus Power and Line Flow for a Specified System Voltage (Bus) Profile and verify the same by writing a program in MATLAB.
C07	PO1	L2	Knowledge on load Jacobian matrix calculation
CO7	PO2	L5	Formation of Jacobian for a System not Exceeding 4 Buses (No PV Buses) in Polar Coordinates.
CO7	PO5	L3	Formation of Jacobian for a System not Exceeding 4 Buses (No PV Buses) in Polar Coordinates and verifying the same using Mi- Power package.
CO8	PO1	L2	Knowledge on load Flow Analysis using Gauss Seidel Method, NR Method

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			and Fast Decoupled Method.
CO8	PO2	L5	Analyzing the techniques used for solving load flow problem for simple power systems.
CO8	PO5	L3	Analyzing the techniques used for solving load flow problem for simple power systems and verifying the same using Mi- Power package.
CO9	PO1	L2	Knowledge on different types of faults in a power system.
CO9	PO2	L5	To formulate the fault Currents and Voltages in a Single Transmission Line System with Star-Delta Transformers at a Specified Location for LG and LLG faults.
CO9	PO5	L3	To formulate the fault Currents and Voltages in a Single Transmission Line System with Star-Delta Transformers at a Specified Location for LG and LLG faults and verifying the same using Mi- Power package.
CO10	PO1	L2	Knowledge on optimal Generation Scheduling for Thermal power plants.
CO10	PO2	L5	To formulate the optimal generator scheduling for thermal power plants.
CO10	PO5	L3	To formulate the optimal generator scheduling for thermal power plants using Mi Power package.

Note: Write justification for each CO-PO mapping.

5. Curricular Gap and Content

SNo	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					
2					

Note: Write Gap topics from A.4 and add others also.

6. Content Beyond Syllabus

SNo	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					
2					

Note: Anything not covered above is included here.

C. COURSE ASSESSMENT

1. Course Coverage

Unit	Title	Teachi		No. of question in Exam						CO	Levels
		ng	CIA-1	CIA-2	CIA-3	Asg-1	Asg-2	Asg-3	SEE		
		Hours									
1	Formation for symmetric π /T	03	1	-	-	-	-	-	1	CO1	L5
	configuration for Verification of AD										
	- BC = 1, Determination of										
	Efficiency and Regulation										
2	Determination of Power Angle	03	1	-	-	-	-	-	1	CO2	L5
	Diagrams, Reluctance Power,										
	Excitation, Emf and Regulation for										
	Salient and Non-Salient Pole										
	Synchronous Machines										
3	To obtain Swing Curve and to	03	1	-	-	-	-	-	1	CO3	L5
	Determine Critical Clearing Time,										
	Regulation, Inertia Constant/Line										

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	Param	eters /Fault Lo	cation/Clearing										
	Time/P	re-Fault Elect	rical Output for										
	a Sing	gle Machine	connected to										
	Infinite	Bus throug	h a Pair of										
	Identica	al Transmissio	on Lines Under										
	3-Phas	e Fault On C	One of the two										
	Lines.												
4	Y Bus	Formation for	Power Systems	03	1	-	-	-	-	-	1	CO4	L5
	with a	nd without M	utual Coupling,										
	by Si	ngular Irans	formation and										
	Inspect	tion Method.											· -
5	Format	ion of Z Bus	(without mutual	03	-	1	-	-	-	-	1	CO5	L5
	couplin	ig) using Z	-Bus Building										
	Algorith	ım.											
6	Determ	ination of Bus	s Currents, Bus	03	-	1	-	-	-	-	1	CO6	L5
	Power	and Line Flow	tor a Specified										
	System	Noltage (Bus) Profile										
7	Format	tion of Jacobia	in for a System	03	-	1	-	-	-	-	1	C07	L5
	not Ex	kceeding 4 E	Buses (No PV										
	Buses)	in Polar Coor	dinates										· _
8	Load I	Flow Analysis	s using Gauss	03	-	-	1	-	-	-	1	CO8	L5
	Siedel	Method, NR M	lethod and Fast										
	Decoup	oled Method f	or Both PQand										
	PV Bus	ses.	<u> </u>										
9	IO De	termine ⊦ault	Currents and	03	-	-	1	-	-	-	1	CO9	L5
	voltage	es in a Single											
	Line	System wi	tn Star-Delta										
	ransto	ormers at	a Specified										
	Locatio	on for LG and	LLG faults by										
	simulat	lion.	O altra duditoria d									0040	
10	Optima	Generation	Scheduling for	03	-	-	1	-	-	-	1	CU10	L5
	i nerma	ai power plants	s by simulation.		-		-						
		Iotal		30	4	5	5	5	5	5	20	-	-

Note: Write CO based on the theory course.

2. Continuous Internal Assessment (CIA)

Evaluation	Weightage in Marks	СО	Levels
CIA Exam – 1	30	CO1, CO2, CO3, CO4	L1, L2, L3,L4
CIA Exam – 2	30	CO5, CO6, CO7,	L5, L6, L7
CIA Exam – 3	30	CO8, CO9,C010	L8, L9, L10
Assignment - 1	05	CO1, CO2, CO3, CO4	L1, L2, L3,L4
Assignment - 2	05	CO5, CO6, CO7,	L5, L6, L7
Assignment - 3	05	CO8, CO9,C010	L8, L9, L10
Other Activities – define –			
Slip test			
Final CIA Marks	40	-	-
-			

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SNo	Description	Marks
1	Observation and Weekly Laboratory Activities	05 Marks
2	Record Writing	10 Marks for each Expt
3	Internal Exam Assessment	25 Marks
4	Internal Assessment	15 Marks
5	SEE	80 Marks
-	Total	100 Marks

D. EXPERIMENTS

Experiment 01: Calculation of ABCD parameters

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Title	For	mation for sy	vmmetric π /	T configuration	on for Verific	ation of AD	-BC = 1,
		Det	ermination of	Efficiency ar	nd Regulation	•		
2	Course Outcome	Dev	elop a progra	am in MATLA	B to assess t	he performar	nce of mediun	n and long
	••	tran	ismission line	s by calculat	ing the ABCD	parameters		
3	Aim	To and	Calculate AB efficiency.	CD paramete	ers for a give	n transmissio	on line and fi	nd regulation
4	Material / Equipment	Lab	Manual, PC	loaded with I	MATLAB			
	Required							
5	Theory, Formula,	The	Transmissio	n System ca	n also be assi	umed to be a	four terminal	network
	Principle, Concept	with	n two input ter	minals where	e power enter	s the networl	k and two out	put terminals
		whe	ere power lea	ves the netw	ork.			
		Let	V _s = Sendin	g End Volta	ge; I _s = Seno	ding end cu	rrent; V _r = Re	eceiving End
		Volt	tage; I _r = Re	eceiving end	current; Th	e sending	end parame	ters can be
		exp	ressed in ter	ms of receiv	ing end para	meters throu	igh the set o	f parameters
		kno	wn as transm	ission line pa	arameters or <i>i</i>	ABCD param	eters.	
		Thu	is, $V_s = AV_r +$	BI _r ;				
		l _s =	C V _r + DI _r					
		The	transmissior	n network sho	ould be linear	passive and	l bilateral. The	e parameters
		А,	B, C and D	are comple	ex numbers a	and are call	ed as gener	alized circuit
		con	stants. The	method whi	ch is used f	or analysis	of transmiss	ion line has
		influ	ience on the	se constants	. Performanc	e calculation	of the line	can be done
		usir	ng these cons	tants.				
		Ter	ms Related to	Performanc	e of Transmis	sion Line:		
		1) \	oltage Regul	ation:				
		% V	/ _R = 100* (V _{NL}	– V _{FL})/ V _{FL}				
		But	V _{NL} = V _s (as	there is no	drop) and \mathcal{V}	′ _{FL} = V _R (on ∣	oad), hence	e percentage
		volt	age regulatio	n equation be	ecomes			
		% ∖	/R= 100* (V _s	– V _R)/ V _R .				
		ii)Tr	i)Transmission Efficiency:					
		% T	ransmission	efficiency, η=	 (receiving er 	nd power/sen	iding end pow	/er)* 100
		rece	eiving end po	wer= V _r I _r cos	(φ _r)			
		sen	ding end pow	ver= V _s I _s cos(φ _s)			

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			$\cos(\varphi_r)$ = receiving end power factor					
			and nower factor					
			$\cos(\phi_s)$ -sending end power factor					
			Case A: To find constants in medium transmission line repres	ented by Nominal ∏				
			In nominal I method of analysis of medium transmission	Ine the total line				
			capacitance is assumed to be iumped or concentrated at the	e center point of the				
			aide of the line. The constants are:	le lumped on either				
			Side of the line. The constants are: $\Lambda - 1 \pm (\sqrt{7})/2$					
			$\sum_{i=1}^{n-1} (1 - \sum_{i=1}^{n-1} (1 - \sum_{i=1}^{n-$					
			$B=Z^{(1+Y^{2}/4)}$					
			C=Y					
			$D = (1+Y^*Z/2)$					
			Case B: To find constants in medium transmission line repres	ented by Nominal T				
			circuit.					
			In nominal \prod method, the total capacitance is divided into the half at the receiving end and the other half at the sending end.	wo halves with one The constants are:				
			A=1+(Y*7)/2					
			B=Z					
			C=Y*(1+Y*Z/4)					
			$D = (1+Y^*Z/2)$					
6	Procedu	ire, Program	, Enter the command window of the MATLAB.					
	Activity,	Algorithm	n, Create a new M – file by selecting File - New – M – File					
	Pseudo	Code	Type and save the program in the editor window.					
			Execute the program by pressing Tools – Run.					
			View the results.					
			%Determination of ABCD constants,Efficiency and Regulation	<u>on of given Medium</u>				
			<u>%Transmission Lines with the help of recieving end data(Nominal-T)</u>					
			length=input('Enter the length of medium line in km=');					
			z=input('Enter the series impedance of the line per km= ');					
			y-input Enter the shuft admittance of the line per km-),					
			Z = 2 length, $T = y$ length, $y = 1 \pm (V \times 7)/2$, $d = y$, $b = 7 \times (1 \pm (V \times 7)/4)$, $c = V$.					
			$a = 1 + (1 \ge)/2, u = a, b = \ge (1 + (1 \ge)/4), c = 1,$					
			for $f(nA=0.15 Af+0.15 Af' real(a) imag(a))$					
			$\text{Tprintf}(\nA=\%15.4t+\%15.4ti, real(a), \text{Imag}(a));$					
			Iprintt(NB=%15.4f+%15.4f),real(b),Imag(b));					
			[printt(\nC=%15.4I+%15.4II',real(C),Imag(C)); forintf(\nD=%15.4f+%15.4fi',real(d),imag(d));					
			forintf('\nAD-BC=%f'.a*d-b*c):					
			Vr=input('\nEnter the receiving end line voltage in $kV=0$.					
			Pr=input('Enter the receiving end power in MW='):					
			PF=input('Enter the receiving end power factor ='):					
			pf a=acos(PF);					
			vph=Vr*1e3/sqrt(3);					

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			Ir=(Pr*1e6)/(3*vph*PF);					
			lrp=lr*cos(pf_a)-i*lr*sin(pf_a);					
			Vs=a*vph+b*lrp;					
			ls=c*vph+d*lrp;					
			fprintf('\nSending end voltage/ph =%15.4f+%15.4fi V',real(Vs),	imag(Vs));				
			fprintf('\nSending end current/ph =%15.4f+%15.4fi A',real(Is),ir	mag(ls));				
			Ps=real(3*Vs*Is)/1e6;					
			Efficiency=(Pr/Ps)*100;					
			Regulation=(abs(Vs/a)-abs(vph))*100/abs(vph);					
			fprintf('\nSending end power =%0.2f MW',Ps);					
			fprintf('\nEfficiency=%0.2f%%',Efficiency);					
			fprintf('\nRegulation=%0.2f%%',Regulation);					
			%Determination of ABCD constants, Efficiency and Regulation	on of given Medium				
			Transmission Lines with the help of recieving end data(Nomin	al-π)				
			clc					
			clear all					
			length=input/'Enter the length of medium line in km= '):					
			z=input/Finter the series impedance of the line ner km= '):					
			z = input (Enter the series impedance of the line per km =);					
			$7=7^{*}$ length: $Y=y^{*}$ length:					
			2-2 length, 1-y length, 2-1+(Y*7)/2: d-2: b-7: c-Y*(1+(Y*7)/4):					
			$a = 1 + (1 \ge)/2, u = a, b = z, c = 1 (1 + (1 \ge)/4),$ forintf('\nA B C&D contants are \n').					
			$forintf(\AA,B,C&D contants are: \n);$					
			$fprintt(\AA=\%15.41+\%15.411,real(a),Imag(a));$					
			$fprintf(\NB=\%15.4f+\%15.4fl,real(b),Imag(b));$					
			$fprintt(\nC=\%15.4f+\%15.4f',real(C),Imag(C));$					
			$forintf(\n\Delta D = \% f^{2} a^{+}d_{-}b^{+}c)$					
			$V_r=input('nEnter the receiving and line voltage in kV='):$					
			Pr=input('Inter the receiving end nower in MW=');					
			PE-input/Enter the receiving end power factor ='):					
			PF=input('Enter the receiving end power factor =');					
			pt_a=acos(PF);					
			vpn=vr^1e3/sqrt(3); //=/Dr*1e3/sqrt(3);					
			Ir=(Pr*1e6)/(3*vph*PF);					
			Irp=Ir^cos(pt_a)-i^Ir^sin(pt_a);					
			$v_{S-a} v_{PII+D} IIP$					
			$ IS=C^*vph+d^*Irp;$					
			$\frac{1}{100} = \frac{1000}{100} = \frac{1000}$	may(vs)),				
			$P_{\text{real}(2^*)}$ prime current/pri = % 15.41% 15.41 A ,real(IS),IM	ay(15)),				
			Ps=real(3*Vs*Is)/1e6;					
			Efficiency=(Pr/Ps)*100;					
			Regulation=(abs(Vs/a)-abs(vph))*100/abs(vph);					
			formet(\nDEfficiency=0(0.0f0(0(1Efficiency));					
			fprint(\nEfficiency=%0.21%%,Efficiency);					
			fprintf('\nRegulation=%0.2f%%',Regulation);					
	Block, (Circuit, Mode	• -					
[Diagram	n, Reactior	• -					

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Copyrie	Fountion Expected				
	Equation, Expected Graph	• -			
8	Observation Table,	Enter the length of medium line in km= 100			
	Look-up Table,	Enter the series impedance of the line per km= 0.1+0.2i			
	Output	Enter the shunt admittance of the line per km= 4e-13i			
		•			
		A.B.C&D contants are:			
		A=1.0000+0.0000j			
		B=10.0000+ 20.0000i			
		C= 0.0000+0.0000i			
		D=1.0000+0.0000i			
		AD-BC=1.000000			
		Enter the receiving end line voltage in kV=66			
		Enter the receiving end power in MW=10			
		Enter the receiving end power factor =0.8			
		Enter the length of medium line in km= 100			
		Enter the series impedance of the line per km= 0.15+0.50715i			
		Enter the shunt admittance of the line per km= 2.1615e-6i			
		A,B,C&D contants are:			
		A=0.9945+0.00161			
		B=15.0000+50.71501			
		C=-0.0000+0.00021			
		D=0.9945+0.0016			
		AD-BC=1.000000			
		Enter the receiving and line values in W/-220			
		Enter the receiving end line voltage in kV=220			
		Enter the receiving end power in $MW=60$			
9	Sample Calculations	• -			
Ŭ		• -			
		• -			
10	Graphs, Outputs	Sending end voltage/ph =40292.0506+1093.4664i V			
		Sending end current/ph =87.4773+-65.6080i A			
		Sending end power =10.79 MW			
		Efficiency=92.69%			
		Regulation=5.78%			
		Sending end voltage/ph =133631 7573+6727 6857i V			
		Sending end current/ph =156.7321 -69 4148i A			
		Sending end power =64 23 MW			
L					

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9	Copyrig	pht ©2017. cAAS. All rights reserved.	
			Efficiency=93.41%
			Regulation=5.92%
	11	Results & Analysis	
	12	Application Areas	Develop a program in MATLAB
	13	Remarks	Thus, the ABCD constants of the given medium transmission line were found
			using nominal Π and T method. Also, the efficiency and regulation of it were
			found for the given receiving end data.
	14	Faculty Signature with	
		Date	
_			

Experiment 02:Determination of power angle diagram for

a) Salient pole synchronous machine

b) Non salient pole synchronous machine

-	Experiment No.:	2	Marks		Date		Date		
					Planned		Conducted		
1	Title	Deterr	nination of I	Power Angle	Diagrams,	Reluctance Po	ower, Excitati	on, Emf and	
		Regula	egulation for Salient and Non-Salient Pole Synchronous Machines .						
2	Course Outcomes	Develo	velop a program in MATLAB to obtain the power angle characteristics of salient						
		and no	I non-salient pole alternator						
3	Aim	To de	termine the	power angl	le diagram,	reluctance po	ower, excitat	ion emf and	
		regula	tion of saller	it pole and no	on-salient po	le synchronou	s machine.		
4		Lар М	anual, PC lo	aded with MA	ATLAB				
	Equipment								
5	Theory Formula	Eor Sc	lient Dele						
5	Principle Concept	FUI Se			P				
		1.	Current	$V \mid = \frac{1}{\sqrt{3} * V}$	$\frac{1}{V_L * Cos\phi}$	Amperes			
		2.	Current I	= I ∠– Φ A	mperes in c	ase of lagging	g pf, Curre	nt I = I ∠Φ	
			Amperes i	n case of lea	ding pf.				
		3.	The equiva	alent voltage	$V_{eq} = V_{ph} + j$	(I* X _q) Volts			
		4.	Direct axis	current I _d =	lll * sin [∠V _e	_q – ∠I] Ampere	es		
		5.	The Excita	tion EMF or	Field effectiv	ve voltage V _{ef}	$ = V_{eq} + [($	$X_d - X_q$) * $ I_d $	
			Volts.						
		6.	%Regula	ation = $\frac{ V_e }{ V_e }$	$\left \frac{ V_{ph} }{ V_{ph} } \times \right $	100 %			
		7.	Net Salien	t (Excitation)	Power = 3 *	$ V_{ef} * V_{ph} *$	Sin δ / X _d M	N	
		8.	Net Reluct	ance Power	= 3 * <u> V_{ph} </u>	$\frac{{}^{2} * (X_{d} - X_{d})}{2 * X_{d} * \lambda}$	$\left(\frac{1}{N}\right) * Sin 2\delta$ X_q	мw	
		9.	Net Result MW	ant Power P	_{net} = (Net Ex	citation power	+ Net Reluct	ance Power)	
		10). To get the maximum power delivered, $\frac{d}{d\delta}P_{net} = 0$						
		11	. Solution of	$f \frac{d}{d\delta} P_{net} = 0$	0 (Quadratio	c equation) yie	lds the value	of δ at which	

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			the P_{net} will be maximum. Let this value of δ be	ð _{max} .
			12. The maximum net resultant power delivered is,	
			$P_{max} = 3 * \left\{ \frac{ V_{ref} * V_{ph} *}{X_{q}} \right\}$	$+ \sin(\delta_{\max}) +$
			$\frac{\left V_{ph}\right ^{2} * (X_{d} - X_{q}) * Sin(2 * \delta_{max})}{2 * X_{d} * X_{d}}$	
		V	$Z = \Lambda_d = \Lambda_q$	aine in W
		V	Φ = Power Eactor angle = Cos ⁻¹ (PE)	
			Ψ - Fower Factor angle - Cos (FF)	ronque machine in
		\sim	v_{L} = reminal voltage (line) of the given salient synchronic voltas.	ironous machine in
			V_{ph} = Terminal voltage (per phase) of the given s	alient synchronous
		n	nachine in Volts.	
			X _d = Direct axis reactance of the given salient synchrone	ous machine in Ω
			X_{α} = Quadrature axis reactance of the given salient sy	nchronous machine
		ir	ηΩ	
			δ = Angle by which Excitation EMF (V _{ef}) leads Termina	l Voltage (V _{ph}), load
		a	inale or toraue	
			angle	
		F	or non salient Pole	
		C	$Current \mid I \mid = \frac{P}{\sqrt{3} * V_L * Cos\phi} \text{ Amperes}$	
		C	Current I = II ∠– Φ Amperes	
		т	The Excitation EMF or Field effective voltage $ V_{ef} = (V_{ph} + j) ^*$	X) Volts.
		c	$\% \text{Regulation} = \frac{\left V_{ef} \right - \left V_{ph} \right }{\left V_{ph} \right } \times 100 \%$	
			let Non–Salient (Excitation) Power = 3 * $ V_{ef} $ * $ V_{ph} $ * Sin δ / X	MW
			Where, P = Power output of the given salient synchrono	ous machine in MW
			Φ = Power Factor angle = Cos ⁻¹ (PF)	
			V_1 = Terminal voltage (line) of the given s	salient svnchronous
			machine in Volts	,
			$V_{\rm res}$ = Terminal voltage (per phase) of the given	salient synchronous
			machine in Volts	
			X = Synchronous reactance of the given	non – salient nole
			synchronous machine in Q	
			$\delta = Angle by which Excitation EME (V.) lead$	ls Terminal Voltage
			$(V_{\rm ef})$ load angle or	
			(vpn/, load angle of	
6	Procedu	ire, E	Enter the command window of the MATLAB.	
	Program	n, Activity,	Create a new M – file by selecting File- New – M – File.	
	Algorith	m, Pseudo <mark>T</mark>	ype and save the program in the editor Window.	
	Code	E	Execute the program by pressing Tools – Run.	

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	V	/iew the results.		
	2	6POWER ANGLE CURVE FOR NON-SALIENT POLE	SYNCHRONOUS	
	Ν	<u>IACHINES</u>		
	с	lc		
	с	lear all		
	F	P=input('Enter the power output in MW=');		
	F	'F=input('Enter the power factor=');		
	\sim	<pre>/t=input('Enter the line to line voltage in KV=');</pre>		
	×	X=input('Enter the Synchronous reactance of the given machine	e in ohms=');	
	\sim	/ph=(Vt*1e3)/sqrt(3);		
	F	PF_A=acos(PF);		
	l'	1=P*1e6/(3*Vph*PF);		
	l=	=I1*cos(PF_A)-i*I1*sin(PF_A);		
	C)elta=0:1:180;		
	C	0elta_rad=Delta*(pi/180);		
	\sim	/ef=abs(Vph+(i*I*X));		
	F	Reg=((Vef-Vph)*100)/Vph;		
	N	letPowerNonSalient=(3*Vef*Vph*sin(Delta_rad))/X;		
	p	lot(Delta,NetPowerNonSalient,'r');		
	×	label('Delta (deg.)');		
	У	label('Three phase power (MW)');		
	ti	tle('Plot:Power angle curve for non salient pole synchronous m	achine');	
	le	egend('Net Non Salient Power');		
	fŗ	printf('\nExcitation EMF =%0.4f Volts/phase',Vef);		
	fŗ	printf('\nRegulation =%0.4f %%',Reg);		
	F	?max=(3*Vef*Vph)/(X*1e6);		
	fŗ	printf('\nThe max. power delivered by the given machine=%0.4	f MW',Pmax);	
	d	el=input('\n\nenter the torque angle delta=');		
	d	el_rad=del*(pi/180);		
	p	1=(3*Vef*Vph*sin(del_rad)/X)/1e6;		
	fŗ	printf('Three phase power delivered =%0.4f MW',p1);		
	2	6POWER ANGLE CURVE FOR SALIENT POLE SYNCHRON	OUS MACHINES	
	c	lc		
	c	lear all		
	F	P=input('Enter the power output of the given machine in MW=');		
	V	/t=input('Enter the line to line terminal voltage in KV=');		
	×	(d=input('Enter the Xd in ohms=');		
	×	q=input('Enter the Xq in ohms=');		
	F	'F=input('Enter the power factor=');		
	V	/t_ph=(Vt*1e3)/sqrt(3);		
	F	PF_A=acos(PF);		
	l=	=P*1e6/(3*Vt_ph*PF);		
	I_	_ph= I*cos(PF_A)-i*I*sin(PF_A);		
)elta=0:1:180;		
)elta_rad=Delta*(pi/180);		
	\sim	/eq=Vt_ph+(i*I_ph*Xq);		

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$(u-aus(i_pii) sin(angle(veq)-angle(i_pii)),$ (eq-abs()(eq)+((Veq)*(a))								
			Vel=abs(Veq)+((Xu-Xq) lu),					
			Reg-(ver-vi_pri) 100/vi_pri, Net NegSelieppewer=(2*)/of*)/t_ph*sin(Delte_red))/(Xd*1e6);					
			Net_NonSalienpower=(3*Vt_ph3*cip(2*Delta_rad))/(Au_red),	(a*106):				
			Net_Relucipower=(Net_NonSaliennower+Net_Reluctnower);	(q 1e0),				
			nlot/Delta Net_NonSalienpower 'r'\;					
			hold on					
			plot(Delta.Net Reluctpower.'v'):					
			hold on					
			plot(Delta,Resultantpower,'b');					
			xlabel('Delta (deg.)>');					
			ylabel('Three phase power (MW)>');					
			title('Plot: Power angle curve for salient pole synchronous machi	ne');				
			legend('Net_NonSalienpower','Net_Reluctpower','Resultant Pow	er')				
			iprintf('\nExcitation EMF =%0.4f Volts/phase',Vef);					
			<pre>iprintf('\nRegulation =%0.4f %%',Reg);</pre>					
				a=');				
			Delta max=acos(dP1(2:));					
			Delta_IIIdX-acos(uFT(2,.)), Pmax=(3*((Vef*Vt_nh*sin(Delta_max))/Xd)+(3*Vt_nh^2*(Xd-Xn)*	[;] sin(2*Delta_max))/				
	(2*Xd*Xd)/(1e6)							
for intf('The max_power delivered by the given machine=%0 4f MW' Pr				IW'.Pmax):				
			del=input('\nenter the torque angle delta=');	, - ,,				
			del_rad=del*(pi/180);					
			p1=(3*((Vef*Vt_ph*sin(del_rad))/Xd)+(3*Vt_ph^2*(Xd-Xq)*sin(2*del_rad))/					
			(2*Xd*Xq))/1e6;					
			<pre>iprintf('\nThree phase power delivered =%0.4f MW',p1);</pre>					
	_	0 1 1						
7	Block,	Circuit,	plot:power angle curve for non-salient pole syn mc					
	Nodel	Diagram,	160					
	Evporto	d Graph	140					
	Expecie	u Graph	€ 120					
			₹ <u>₹</u> 100					
			~ [~] бо					
			40					
			20					
			0 20 40 60 80 100 120 140 160 180 δ(deg)					
			graph-1					

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Copyright ©2017. cAAS. All rights reserv 8 Observation Table Look-up Table Output		ition Table, Table,	Inter the power output in MW=60 Enter the line to line voltage in KV=34.64 Enter the power output of the given machine in MW=60 Enter the power output of the given machine in MW=60 Enter the power output of the given machine in MW=60 Enter the power output of the given machine in MW=60 Enter the power output of the given machine in MW=60 Enter the power output of the given machine in MW=60 Enter the power output of the given machine in MW=60 Enter the power output of the given machine in MW=60 Enter the power output of the given machine in MW=60 Enter the power output of the given machine in MW=60 Enter the power output of the given machine in MW=60 Enter the line to line terminal voltage in KV=34.64 Enter the Xd in ohms=13.5	=13.5				
			Enter the Xq in ohms=9.83					
			Enter the power factor=0.8					
	<u> </u>	<u> </u>						
9	Sample	Calculation						
	Graphs,	Outputs	Regulation =65.0623 % The max. power delivered by the given machine=146.7135 MW					
			enter the torque angle delta=70					
			Three phase power delivered =137.8656 MW>>					
			Non Salient Pole Excitation EMF =32914.8841 Volts/phase Regulation =64.5792 %					
		-	Enter the coefficients of quadratic equation dPnet/d=[66.38 146.28 -33.18] The max. power delivered by the given machine=149.8361 MW enter the torque angle delta=100					
			Three phase power delivered =138.3868 MW					
11	Results	& Analysis	Thus, the power angle curves of a given salient pole synchro	nous machine were				
			drawn. Also, the excitation emf, Max. power delivered (P_{max}),	Non-Salient power,				
		I	reluctance power, resultant power and regulation of it were foun	ıd.				
			Excitation EMF = Volts	3				

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				Regulation =%	
				Max. power delivered (P _{max}) =	MW.
			Non Salient Pole		
			Thus, the power angle	curves of a given non – salient pole	e synchronous machine
			were drawn.		
			Also, the excita	ation emf, Non – Salient power an	d regulation of it were
			found.		
				Excitation EMF =V	′olts
				Regulation =%	
				Max. power delivered =	MW
12	Applicatic	on Areas			
13	Remarks				
14	Faculty	Signature			
	with Date				

Experiment 03: Determination of swing curve

-	Experiment No.:	3	Marks		Date		Date		
					Planned		Conducted		
1	Title	To ob	otain Swing C	Curve and to I	Determine Cr	itical Clearing	g Time, Regu	lation, Inertia	
		Const	nstant/Line Parameters /Fault Location/Clearing Time/Pre-Fault Electrical Output						
		for a	r a Single Machine connected to Infinite Bus through a Pair of identical						
		Trans	mission Line	s Under 3-Ph	ase Fault On	One of the tw	vo Lines.		
2	Course Outcomes	Deve	lop a progran	n in MATLAB	to assess the	e transient sta	ability under tl	hree phase	
		fault a	at different lo	cations in a p	ower systems	6.			
3	Aim	To de	etermine the S	Swing curve o	of a single ma	chine connec	ted to infinite	bus	
4	Material	Lab N	lanual, PC lo	aded with MA	ATLAB				
	Equipment								
	Required								
5	Theory, Formula	,Swing	g Equation d	lescribes the	relative mot	ion of the ro	tor (load ang	gle or torque	
	Principle, Concept	angle	or power an	gle δ) with re	spect to the s	tator field as	a function of	time. It is the	
		funda	mental equa	tion governin	ig the rotor d	ynamics of t	he synchrond	ous machine.	
		The s	solution of s	wing equation	on gives the	relation betw	veen rotor a	ngle δ as a	
		functi	on of time t.	Normally, it	t is solved in	digital comp	uters using s	step-by- step	
		metho	od or employ	ing numerica	I solution tec	hniques like	Euler's metho	od or Runge-	
		Kutta	's method. T	he Plot of δ	versus t is	called as the	swing curve	e. For simple	
		syste	ms like single	e machine co	nnected to in	finite bus or a	two machine	e system, it is	
		not ne	ecessary to s	olve the swin	g equation fo	r finding the t	ransient stab	ility. It can be	
		conve	eniently deter	mined using	the method	known as Eq	ual Area Crit	terion. Swing	
		curve	s are useful	in designing	the protective	ve devices fo	r the system	. Even in an	

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			SMIB system, we have to resort to a numerical technique to e	valuate the variation
		C	or o with time and to determine CCT. All numerical methods	use the concept of
6	Drood		Inscretization of the variables, over suitable time intervals.	a sector and infinite
6	Procedu	lre,	Excitation ENF E and transfer reactance X ₀ between line ge	nerators and infinite
	Algorith	n, Activity, _b	ous are determined for the specified output of the generato	or taking infinite bus
	Algonin	m, rseudo _N	voltage V as reference.	
	Coue	2	2. Pre-fault power characteristics is determined as	
		F	$P_a = (E ^* V ^* \sin \delta) / X_0$	
		V	Where E and V are magnitude of excitation EMF and voltage of	f infinite bus.
		3	3. Pre-fault power angle is obtained as	
		3	$5_0 = \sin^{-1} (P_{mech} / P_m)$	
		v	where P _{mech} is electrical output of generator before fault.	
			1. For the specified fault location the new transfer reactance	e X is determined
		-		r_1 is determined
		c	during the fault is obtained as	P- o characteristics
		F	$P_1 = (E ^* V ^* \sin \delta) / X_1 = P_{1m} \sin \delta$	
		5 r f	5. For the system configuration after the isolation of fault eactance X_2 and the corresponding post fault. The P- δ chara ault is obtained as	ty line, the transfer acteristics during the
		F	$P_2 = (E ^* V ^* \sin \delta) / X_2 = P_{2m} \sin \delta$	
		e t, id	5. The total time of transient stability study T, time at the insta _c , inertia constant H of the generator and normal system dentified from the system data.	int of fault clearance frequency f are all
		7	7. Critical clearing time is determined from the equation	
		ຍ s ti	B. For determining critical clearing time, solution for swing equisistained fault using point by point method for above equation ime is taken for the time corresponding to δ_c .	iation is obtained for ons. Critical clearing
		g	9. For calculation of swing curve for sustained fault, it is enough	n to assume t _c >T
		f	or ex: t _c =T+0.01s	

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 ,	
 10. For obtaining swing curve when the fault is cleared the procedure is similar, i.e., modified Euler method is applied to equations. to obtain incremental value of rotor swing during successive time steps and the rotor swing at the end of respective slips. It is important to use $P_c = P_1$ for intervals before fault clearance and $P_c = P_2$.	
for intervals after fault clearance.	
11. A plot of δ vs t gives the swing curve in both cases (sustained fault /fault cleared).	
12. Procedure is repeated for different values of inertia constant, fault location, fault	
clearing time, line reactance and pre-fault electrical output to study their effect on swing curve by changing the value of one of them at a time keeping other constant.	
%Program to find Swing curve critical clearing time for a single machine	
%connected to infinite bus through a pair transmission line 3 phase fault on %one of the line away from the sending end	
tfc=input('\nEnter fault clearing time=');	
mi=input('\nEnter momentum constant=');	
pm=input('\nEnter the mechanical power=');	
pmbf=input('\nEnter the value of maximum power before fault=');	
pmdf=input('\nEnter the value of maximum power during fault=');	
pmaf= input('\nEnter the value of maximum power after fault=');	
d=input('\nEnter the value of delta=');	
w=input('\nEnter the value of angular velocity omega=');	
n=input(`nEnter inertia constant=`);	
umax-pi-asin(pin/pinai),	
cosuc=(piii (uinax-u)+pinai cos(uinax)-pinui cos(u))/(pinai-pinui),	
$cc_angle=acos(cosoc) roo(p),$	
disp('\nCRITICAL_CLEARING ANGLE(IN DEG)');	
disp(cc angle):	
disp('\nCRITICAL CLEARING TIME(IN SEC)'):	
disp(cc time);	
fprintf('\n\t TIME(IN SEC)\t DELTA(IN DEG)\n');	
%finding ouot swing curve by Runge-Kutta Method	
for t=0:0.05:0.5	
if t <tfc< td=""><td></td></tfc<>	
pmax=pmdf;	
elseif t>=tfc	
pmax=pmaf;	
end	
k1=w*0.05;	
I1=(pm-pmax*sin(d))*0.05/mi;	
$k2=(w+0.5^{*}11)^{*}0.05;$	
I2=(pm-pmax ^s in(d+0.5*K1))*0.05/mi;	
$K_3 = (W + U.5^{-1}L)^{-1}U.U5;$	
$13 = (pm-pmax^{Sin}(0+0.5^{K}Z))^{*}0.05/ml;$	

Doc Code: SKIT.Ph5b1.F03 Date: 11-07-2018 Title: Course Plan Page: 22 / 49 Course Plan Page: 22 / 49 Course Plan Id=(pm-pmax*sin(d+k3))*0.05/mi; deld=(k1+2*k2+2*k3+k4)/6; delw=(l1+2*l2+2*l3+l4)/6; ded=(k1+2*k2+2*k3+k4)/6; ded=(dd=dd; dg=(d*180)/pi; fprintf('\t%6.3f\tt'\$6.3f\
Title: Course Plan Page: 22 / 49 Copyright 2017. dA& All rights reserved. If 4=(pm-pmax*sin(d+k3))*0.05/mi; deld=(k1+2*k2+2*k3+k4)/6; delw=(l1+2'12+2*l3+l4)/6; d=d=deld; d=d=deld; d=d=deld; d=d=deld; d=d=deld; d=d=deldw; end id addeldw; d=d=deldw; d=d=deldw; d=d=d=dw; end 7 Block, Circuit, Model Diagram, Reaction Expected Graph 8 Observation Enter fault clearing time=0.12 Look-up Enter momentum constant=0.0331 9 Enter the value of maximum power before fault=1.714 Enter the value of maximum power loads 8 Deservation Enter the value of maximum power after fault=1.333 9 Enter the value of angular velocity omega=0 Enter the value of angular velocity omega=0
Copyright 22017. cAAS. All rights reserved. Id=(pm-pmax*sin(d+k3))*0.05/mi; deld=(k1+2*k2+2*k3+k4)/6; delw=(11+2*l2+2*l3+l4)/6; d=d+deld; dg=(d*180)/pi; fprintf('l%6.3fk1t%6.3fkn',t,dg) w=w+delw; end 7 Block, Circuit, Model Model Diagram, Reaction Equation, Expected Graph 8 Observation Table, Enter fault clearing time=0.12 Look-up Table, Output 9 Enter fault clearing time=0.331 Enter the mochanical power=0.8 9 Enter the value of maximum power before fault=1.714 9 Enter the value of maximum power after fault=1.333 9 Enter the value of delta=0.485 9 Enter the value of angular velocity omega=0 9 Enter inertia constant=5.2
 A=[pm-pmax'sin(d+k3)*0.05/mi; deld=(k1+2*k2+2*k3+k4)/6; deld=(t1+2*l2+2*l3+l4)/6; d=d+deld; dg=(d*180)/pi; fprintf('t%6.3ftn',t,dg) w=w+delw; end Block, Circuit, Model Diagram, Reaction Equation, Expected Graph Observation Table, Enter fault clearing time=0.12 Look-up Table, Output Enter momentum constant=0.0331 Enter the mechanical power=0.8 Enter the mechanical power=0.8 Enter the value of maximum power during fault=1.714 Enter the value of maximum power during fault=0.63 Enter the value of maximum power after fault=1.333 Enter the value of delta=0.485 Enter the value of angular velocity omega=0 Enter inertia constant=5.2
7 Block, Circuit, Model Diagram, Reaction Equation, Expected Graph 8 Observation Table, Cutput 8 Observation Table, Enter momentum constant=0.0331 Enter the walue of maximum power before fault=1.714 Enter the value of maximum power during fault=0.63 Enter the value of maximum power after fault=1.333 Enter the value of delta=0.485 Enter the value of angular velocity omega=0 Enter inertia constant=5.2
7 Block, Circuit, Model Diagram, Reaction Equation, Expected Graph 8 Observation Table, Enter fault clearing time=0.12 Look-up Table, Output Enter the momentum constant=0.0331 Enter the value of maximum power before fault=1.714 Enter the value of maximum power during fault=0.63 Enter the value of maximum power after fault=1.333 Enter the value of delta=0.485 Enter the value of angular velocity omega=0 Enter inertia constant=5.2
a = a + delc; dg = (d*180)/pi; fprintf(1%6.3fk1t%6.3fk1,t,dg) w=w+delw; end 7 Block, Circuit, Model Model Diagram, Reaction Enter Reaction Equation, Expected Graph Enter fault clearing time=0.12 Look-up 8 Observation Table, Enter momentum constant=0.0331 Enter the mechanical power=0.8 Enter the value of maximum power before fault=1.714 Enter the value of maximum power during fault=0.63 Enter the value of maximum power after fault=1.333 Enter the value of delta=0.485 Enter the value of angular velocity omega=0 Enter inertia constant=5.2 Enter inertia constant=5.2
dg=(d^130)/p; fprintf('\t%6.3f\t\t%6.3f\t\t%6.3f\t\t%6.3f\t\t%6.3f\t\t%6.3f\t\t%6.3f\t\t%6.3f\t\t%6.3f\t\t%6.3f\t\t%6.3f\t\t%6.3f\t\t%6.3f\t\t%6.3f\t\t%6.3f\t\t%6.3f\t\t%6.3f\
 7 Block, Circuit, Model Diagram, Reaction Equation, Expected Graph 8 Observation Table, Enter fault clearing time=0.12 Look-up Table, Output Enter momentum constant=0.0331 Enter the mechanical power=0.8 Enter the value of maximum power before fault=1.714 Enter the value of maximum power during fault=0.63 Enter the value of maximum power after fault=1.333 Enter the value of delta=0.485 Enter the value of angular velocity omega=0 Enter inertia constant=5.2
7 Block, Circuit, Model Diagram, Reaction Equation, Expected Graph 8 Observation Table, Look-up Table, Output Enter fault clearing time=0.12 Look-up Table, Output Enter the mechanical power=0.8 Enter the mechanical power=0.8 Enter the value of maximum power before fault=1.714 Enter the value of maximum power during fault=0.63 Enter the value of maximum power after fault=1.333 Enter the value of delta=0.485 Enter the value of angular velocity omega=0 Enter inertia constant=5.2
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7 Block, Circuit, Model Diagram, Reaction Equation, Expected Graph 8 Observation Table, Look-up Table, Output Enter fault clearing time=0.12 Enter momentum constant=0.0331 9 Enter the mechanical power=0.8 Enter the value of maximum power before fault=1.714 9 Enter the value of maximum power during fault=0.63 Enter the value of maximum power after fault=1.333 9 Enter the value of delta=0.485 Enter the value of angular velocity omega=0 Enter inertia constant=5.2
7 Block, Circuit, Model Diagram, Reaction Equation, Expected Graph 8 Observation Table, Look-up Table, Output Enter fault clearing time=0.12 Look-up Table, 0utput Enter momentum constant=0.0331 Enter the mechanical power=0.8 Enter the value of maximum power before fault=1.714 Enter the value of maximum power during fault=0.63 Enter the value of maximum power after fault=1.333 Enter the value of delta=0.485 Enter the value of angular velocity omega=0 Enter inertia constant=5.2
7 Block, Chrolit, Model Diagram, Reaction Equation, Expected Graph 8 Observation Table, Enter fault clearing time=0.12 Look-up Table, Output Enter momentum constant=0.0331 Enter the mechanical power=0.8 Enter the mechanical power=0.8 Enter the value of maximum power before fault=1.714 Enter the value of maximum power during fault=0.63 Enter the value of maximum power after fault=1.333 Enter the value of delta=0.485 Enter the value of angular velocity omega=0 Enter inertia constant=5.2
Model Diagram, Reaction Reaction Equation, Expected Graph 8 Observation Table, Look-up Output Enter fault clearing time=0.12 Look-up Table, Output Enter momentum constant=0.0331 Enter the mechanical power=0.8 Enter the value of maximum power before fault=1.714 Enter the value of maximum power during fault=0.63 Enter the value of maximum power after fault=1.333 Enter the value of delta=0.485 Enter the value of angular velocity omega=0 Enter inertia constant=5.2
Reaction Equation, Expected Graph 8 Observation Table, Look-up Enter fault clearing time=0.12 Output Enter momentum constant=0.0331 Enter the mechanical power=0.8 Enter the value of maximum power before fault=1.714 Enter the value of maximum power during fault=0.63 Enter the value of maximum power after fault=1.333 Enter the value of delta=0.485 Enter the value of angular velocity omega=0 Enter inertia constant=5.2
8 Observation Table, Enter fault clearing time=0.12 Look-up Table, Output Enter momentum constant=0.0331 Enter the mechanical power=0.8 Enter the value of maximum power before fault=1.714 Enter the value of maximum power during fault=0.63 Enter the value of maximum power after fault=1.333 Enter the value of delta=0.485 Enter the value of angular velocity omega=0 Enter inertia constant=5.2 Enter inertia constant=5.2
Cook-up Table, Dutput Enter momentum constant=0.0331 Enter the mechanical power=0.8 Enter the value of maximum power before fault=1.714 Enter the value of maximum power during fault=0.63 Enter the value of maximum power after fault=1.333 Enter the value of delta=0.485 Enter the value of angular velocity omega=0 Enter inertia constant=5.2
Output Enter momentum constant=0.0331 Enter the mechanical power=0.8 Enter the value of maximum power before fault=1.714 Enter the value of maximum power during fault=0.63 Enter the value of maximum power after fault=1.333 Enter the value of delta=0.485 Enter the value of angular velocity omega=0 Enter inertia constant=5.2
Enter the mechanical power=0.8 Enter the value of maximum power before fault=1.714 Enter the value of maximum power during fault=0.63 Enter the value of maximum power after fault=1.333 Enter the value of delta=0.485 Enter the value of angular velocity omega=0 Enter inertia constant=5.2
Enter the mechanical power=0.8 Enter the value of maximum power before fault=1.714 Enter the value of maximum power during fault=0.63 Enter the value of maximum power after fault=1.333 Enter the value of delta=0.485 Enter the value of angular velocity omega=0 Enter inertia constant=5.2
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Enter the value of delta=0.485 Enter the value of angular velocity omega=0 Enter inertia constant=5.2
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Enter the value of angular velocity omega=0 Enter inertia constant=5.2
Enter the value of angular velocity omega=0 Enter inertia constant=5.2
Enter inertia constant=5.2
Enter inertia constant=5.2
INCRITICAL CLEARING ANGLE(IN DEG)
91.0818
9 Sample Calculation
0.3024
0.050 32 110
0 100 37 346
0 150 43 424
0.200 49.005
0.250 53.702
0.300 57.220
0.350 59.358
0.400 60.001

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			0.450	59.117	
			0.500	56.751	
11	Results &	& Analysis			
12	Applicati	on Areas			
13	Remarks	3			
14	Faculty	Signature			
	with Date	e			

Experiment 04: Ybus formation by

1. Inspection method.

2. Singular transformation method with and without Mutual coupling.

-	Experiment No.:	4	Marks		Date		Date		
					Planned		Conducted		
1	Title	Y Bus	s Formation f	or Power Sys	stems with ar	nd without Mu	utual Coupling	g by Singular	
		Trans	formation an	d Inspection I	Method.				
2	Course Outcomes	Deve	lop a progran	n to compute	admittance m	natrix by inspe	ection & singu	ular	
		transt	formation me	thod					
3	Aim	Bus a	admittance ma	atrix (Ybus) fo	ormation for p	ower system	s using inspe	ction method	
		and b	nd by singular transformation method with and without Mutual coupling.						
4	Material	Lab N	/lanual, PC lo	aded with MA	ATLAB				
	Equipment								
	Required								
5	Theory, Formula	Formula, Bus admittance matrix or Ybus is matrix which gives the information about the							
	Principle, Concept	admit	tances of line	es connected	to the node	as well as the	e admittance	between the	
		nodes	s. Principal di	agonal eleme	ents are calle	d self admitta	inces of node	and is equal	
		to the	e algebraic s	um of all the	admittances	terminating	at the node.	Off diagonal	
		eleme	ents are calle	d mutual adn	nittances and	are equal to	the admittan	ces between	
		the n	odes. The siz	ze of ybus is	n*n where n	is the numb	er of buses i	n the system	
		and n	n= n+1(the to	otal number o	f buses inclue	ding the refer	ence buses).		
		I _{bus} =	$Y_{bus} * V_{bus}$						
		where	e I _{bus} = vector	of impressed	bus currents	;			
		Y _{bus} =	bus admittar	nce matrix.					
		V _{bus} =	 vector of bit 	us voltages n	neasured wit	h respect to	reference bu	s. Inspection	
		methe	od makes use	e of KVL at al	I the nodes to	o get the curre	ent equations	. From these	
		equat	tions, Y _{bus} ca	an be directly	y written. It	is the simple	est and dired	ct method of	
		obtair	ning all the di	agonal eleme	ents as well a	s off diagona	l elements in	the matrix of	
		any p	ower system	n. Bus admitt	ance matrix	is a sparse i	matrix. It is c	often used in	
		solvir	ng load flow p	problems. Spa	arsity is one	of its greates	t advantages	as it heavily	
		reduc	es computer	memory and	time requirer	nents.			
		The	(Matrix ia da	aignated by)	/hup and call	ad the bus s	dmittanaa ma	triv. V motriv	
					triv that can	eu lite bus a	writes the ser	figuration of	
			r transmissio	in square me		me which a	noes une con		
4	Material Equipment Required Theory, Formula Principle, Concept	Bus a admit nodes to the eleme the n and n l _{bus} = V _{bus} = V _{bus} = V _{bus} = V _{bus} = N _{bus} = V _{bus} = N _{bus} = V _{bus} = N _{bu}	admittance n admittance n tances of line s. Principal di e algebraic s ents are calle odes. The siz n= n+1(the to $Y_{bus} * V_{bus}$ e lous = vector bus admittan = vector of bu od makes use tions, Y_{bus} ca hing all the di power system ng load flow p ces computer Y Matrix is de symmetric ar r transmissio	natrix or Ybu natrix or Ybu es connected agonal eleme um of all the d mutual adm ze of ybus is otal number o of impressed nce matrix. us voltages n e of KVL at al an be directly agonal eleme n. Bus admitt problems. Spa memory and signated by N ad square ma on lines. In r	s is matrix w to the node admittances nittances and n*n where n f buses includ l bus currents neasured witt l the nodes to y written. It ents as well a ance matrix arsity is one of time requirer f bus and call atrix that con realistic syste	which gives the as well as the d self admittant terminating are equal to is the numb ding the refer is the simple s off diagonant is a sparse to of its greates nents.	the informatic e admittance inces of node at the node. o the admittan er of buses in ence buses). reference bu ent equations est and direc I elements in matrix. It is o t advantages dmittance ma cribes the cor ire quite larg	g. on about between and is e Off diag aces betw n the syst s. Inspe s. From t ct metho the mate often use as it he as it he	

Doc Code:SKIT:Ph501.F03Date: 11-72-218The:Course PlanPage: 24 / 49course Vianhousands of buses, the Y matrix is quite sparse. Each bus in a real power system is usually connected to only a few other buses through the transmission lines. The Y Matrix is designated by Ybus and called the bus admittance matrix. Y matrix is a symmetric and square matrix that completely desribes the configuration of power transmission lines. In realistic systems which are quite large containing thousands of buses, the Y matrix is quite sparse. Each bus in a real power system is usually connected to only a few other buses through the transmission lines. Ybus can be alternatively assembled by use of singular transformation given by a graph theoretical approach. This alternative approach is of great theoretical and practical significance. Steps involving singular transformation: 1. Obtain the oriented graph. The size of this matrix is a "(n-1) where e is the number of elements in the graph and n is the number of nodes (A) 3. Get the primitive admittance matrix from the graph of size e*c. If mutual coupling between the lines is neglected then the resulting primitive matrix is a diagonal matrix(off diagonal elements of Bus Admittance Matrix (self admittance or driving point admittance) are, $Y_i = \Sigma_{Y_{in}}$ k=11. Line impedance $z_n = (R_n + j X_n) \Omega$ 2. Line Admittance y are, $Y_i = \Sigma_{Y_{in}}$ k=12. The diagonal elements of Bus Admittance Matrix (self admittance or transfer admittance) are, $Y_i = \Sigma_{Y_{in}}$ k=13. The diagonal elements of Bus Admittance Matrix (self admittance or transfer admittance) are, $Y_i = \Sigma_{Y_{in}}$ k=14. The off diagonal elements of Bus Admittance Matrix (mutual admittance or transfer admittance) are, $Y_i = Y_i = -y_k$ Wh	SA MET	TUTE OF IS	SKIT	Teaching Process	Rev No.: 1.0
Title:Course PlanPage: 24.49thousands of buses, the Y matrix is quite sparse. Each bus in a real power system is usually connected to only a few other buses through the transmission lines. The Y Matrix is designated by Ybus and called the bus admittance matrix. Y matrix is a symmetric and square matrix that completely describes the configuration of power transmission lines. The in realistic systems which are quite large containing thousands of buses, the Y matrix is quite sparse. Each bus in a real power system is usually connected to only a few other buses through the transmission lines. Thus can be alternatively assembled by use of singular transformation given by a graph theoretical approach. This alternative approach is of great theoretical and practical significance. Steps involving singular transformation: 1. Obtain the oriented graph for the given system. 2. Get the bus incidence matrix which is the one which indicates the incidence of all the elements to nodes in connected graph. The size of this matrix is e "(n-1) where e is the number of delements in the graph and n is the number of nodes (A) 3. Get the primitive admittance matrix from the graph of size e [*] . If mutual coupling between the lines is neglected then the resulting primitive matrix is a diagonal matrix(off diagonal elements of Bus Admittance Matrix (self admittance or driving point admittance) are, $r_{\chi} = \Sigma \ y_{\chi},$ k=11. Line impedance $z_{\mu} = (R_{\mu} + j X_{\mu}) \Omega$ 2. Line Admittance matrix $(P_{\mu} = X_{\mu} = -y_{\mu})$ Where, i and k are the buses in the given network. n is the no. of buses.3. NGULAR TRANSFORMATION METHOD (WITHOUT MUTUAL COUPLING)1. Primitive Admittance matrix $(P_{irm}) = 1/(P_{irm})$ 3. Bus Admittance Matrix $Y_{\mu_{\mu}} = Y_{\mu} = -y_{\mu}$ Where, A – Bus incidence matrix $(P_{irm}) = 1/(P_{irm})$ 3. Bus Admittance			Doc Code:	SKIT.Ph5b1.F03	Date: 11-07-2018
housands of buses, the Y matrix is quite sparse. Each bus in a real power systemis usually connected to only a few other buses through the transmission lines. TheY Matrix is designated by Ybus and called the bus admittance matrix. Y matrix is aymmetric and square matrix that completely describes the configuration of powertransmission lines. In realistic systems which are quite large containing thousandsof buses, the Y matrix is quite sparse. Each bus in a real power system is usuallyconnected to only a few other buses through the transformation given by a graphheteretical approach. This alternative approach is of great theoretical and practicalsignificance.Steps involving sigular transformation:1. Obtain the oriented graph for the given system.2. Get the bus in cichence matrix which is the one which indicates the incidence of allthe elements to nodes in connected graph. The size of this matrix is e'(n-1) wheree is the number of elements in the graph and n is the number of nodes (A)3. Get the primitive admittance matrix from the graph of size e's. If mutual couplingbetween the lines is neglected then the resulting primitive matrix is a diagonalmatrix(off diagonal elements are zero)([y]) 4. Ybus can be obtained from theequation, Ybus = A'* [y] "A1. Line impedance $z_n = (R_n + j X_n) \Omega$ 2. Line Admittance) are, $r_n = r_n$ $r_n = \sum_{k=1}^n y_{k-1}$ 1. Line impedance $z_n = (R_n + j X_n) \Omega$ 2. Line Admittance or driving point admittance) are, $r_n = r_n$ $r_n = \sum_{k=1}^n y_{k-1}$ 1. Line impedance $z_n = (R_n + j X_n) \Omega$ 2. The diagonal elements of B	Convrid	GALORE +		Course Plan	Page: 24 / 49
 a Procedure, 6 Procedure, Cutation, Frost Property (Construction) Construction (Construction) Construction) Construction (Construction) Constru	Gopying		t ii: S t t t t t t t t t t t t t t	housands of buses, the Y matrix is quite sparse. Each bus in a is usually connected to only a few other buses through the trans Y Matrix is designated by Ybus and called the bus admittance in symmetric and square matrix that completely describes the con- ransmission lines. In realistic systems which are quite large co- of buses, the Y matrix is quite sparse. Each bus in a real power connected to only a few other buses through the transmission alternatively assembled by use of singular transformation heoretical approach. This alternative approach is of great theo- significance. Steps involving singular transformation: . Obtain the oriented graph for the given system. 2. Get the bus incidence matrix which is the one which indicates the elements to nodes in connected graph. The size of this matrix is the number of elements in the graph and n is the number of B. Get the primitive admittance matrix from the graph of size e* optimize the lines is neglected then the resulting primitive matrix (off diagonal elements are zero)([y]) 4. Ybus can be	a real power system smission lines. The matrix. Y matrix is a nfiguration of power ontaining thousands er system is usually lines. Ybus can be given by a graph retical and practical s the incidence of all trix is e*(n-1) where nodes (A) e. If mutual coupling natrix is a diagonal obtained from the
6 Procedure, %FORMATION OF Y-BUS BY INSPECTION METHOD			L S S	nspection method. 1. Line impedance $z_{ik} = (R_{ik} + j X_{ik}) \Omega$ 2. Line Admittance $y_{ik} = 1/z_{ik} = 1/(R_{ik} + j X_{ik})$ mho. 3. The diagonal elements of Bus Admittance Matrix of driving point admittance) are, $Y_{ii} = \sum y_{ik}$, k=1 4. The off diagonal elements of Bus Admittance Matrix (metransfer admittance) are, $Y_{ik} = Y_{ki} = -y_{ik}$ Where, i and k are the buses in the given network. n is the no. of buses. SINGULAR TRANSFORMATION METHOD (WITHOUT MUTUA) 1. Primitive Impedance matrix [Zprim] = [(R + j X)] 2. Primitive Admittance Matrix Y _{BUS} = A ^T * Y * A Where, A – Bus incidence matrix and Y – Primitive admittance matrix Compared to the set of the	(self admittance or nutual admittance or AL COUPLING) natrix DUPLING)
	6	Procedu	re, <u>9</u>	6FORMATION OF Y-BUS BY INSPECTION METHOD	

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Algorith	m, Pseudoc	sic	
Code	C	clear all	
	e	e=input('\n enter the number of elements:=');	
	r	n=input('\n enter the number of nodes:=');	
	ע	/bd=input('\n enter the oriented graph:=');	
	f	rom=ybd(:,1);to=ybd(:,2);rse=ybd(:,3);xse=ybd(:,4);y=ybd(:,5);	
	r	nl=length(from);	
	r	nb=max(max(from,to));	
	z	z=rse+i*xse;	
	ע	/bus=zeros(nb);	
	f	or a=1:nl	
		yse=1/z(a);	
		ybus(from(a),from(a))=ybus(from(a),from(a))+i*y(a)+yse;	
		ybus(to(a),to(a))=ybus(to(a),to(a))+i*y(a)+yse;	
		ybus(from(a),to(a))=ybus(from(a),to(a))-yse;	
		ybus(to(a),from(a))=ybus(from(a),to(a));	
		end	
		ybus	
	o	% FORMATION OF Y-BUS BY SINGULAR 1	FRANSFORMATION
	N	METHOD(WITHOUT MUTUAL COUPLING)	
		- ()	
	c	clear	
	e	e=input('\n Enter the number of elements=');	
	r	n=input('\n Enter the number of nodes='):	
		/bd=input('\n Enter the oriented graph=');	
	f	rom=vbd(: 1):to=vbd(: 2):rse=vbd(: 3):	
	×	(se=vbd(: 4):	
	r	h=length(from).	
	r	nb=max(max(from to)).	
		n=zeros(e*e).	
	, ,	A=zeros(nl nh)	
	,	vse=rse+i*xse	
	r	brow=nl+1:	
	f	or $a=1$ nl:	
	"	$v_0(a = 1.11),$	
		$\Delta(a \text{ from}(a))=1$	
		A(a, hoh(a)) = 1;	
		A(a, b(a)) = 1, A(arow from(a)) = 1:	
		A(110W,11011(a)) = 1; A(prow+1 to(a)) = 1;	
		A(1110W+1,to(a)) - 1,	
		110w-110w+z,	
	e,		
	У	/bus-A yp A,	
		bus_aumittance_mathx=yDus	
		<u>/////////////////////////////////////</u>	
	<u>n</u>		
		1	
	C		
	C	ciear;	
	e	e=input('\nenter the number of elements=');	

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			n=input(\nenter the number of nodes=);	
			R=input('InEnter the reference node='):	
			from=dm(: 1):	
			$t_{n} = dm(\cdot, \tau),$	
			$z_{se=dm(,2)}$	
			nl=length(from):	
			nb=max(max(from.to));	
			A=zeros(nl,nb);	
			zp=diag(zse);	
			zp(2,3)=input('\nenter mutual impedence=');	
			zp(3,2)=zp(2,3);	
			yp=inv(zp);	
			for a=1:nl;	
			A(a,from(a))=1;	
			A(a,to(a))=-1;	
			end	
			A(.,R)-[], A1-A:	
			Αι-Α, Yhus=Δ1'*vn*Δ	
7	Block,	Circuit,		
	Model	Diagram,		
	Reaction	Equation,		
0	Expecte	d Graph	enter the number of classester-7	
Ø	Observa	tion Table,	enter the number of elements:=/	
	Cutout	i abie,	enter the number of nodes:=5	
	Output		enter the number of hodes.=3	
			enter the oriented graph:=[1 2 0.02 0.06 0.030;1 3 0.08 0.24 (0.025;2 3 0.06 0.18
			0.020;2 4 0.06 0.18 0.020;2 5 0.04 0.12 0.15;3 4 0.01 0.03 (0.01;4 5 0.08 0. 24
			0.025];	
		,	SINGULAR TRANSFORMATION METHOD(WITHOUT MUTUA	L COUPLING)
			enter the number of elements=3	
			Enter the number of nodes=3	
			Enter the oriented graph=[1 2 0.02 0.08;1 3 0.02 0.08;2 3 0.02 0).08]
		,	SINGULAR TRANSFORMATION METHOD/WITH MUTUAL CC	UPLING)
		-		<u></u>
			enter the number of elements=4	

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			enter the number of nodes=5	
			enter the oriented graph=[1 5 i;2 1 0.4i;3 1 0.5i;3 4 0.2i;4 2 0.25	i]
			Enter the reference node=1	
			enter mutual impedence=0.2i	
9	Sample	Calculation		
10	Graphs,	Outputs	ybus =	
				0
		0 E	2000-18.09001 -0.0000+10.00001 -1.2000+3.70001 0	
		-0 2.50	.0000+15.00001 10.8555-52.26001 -1.0007+5.00001 -1. .00+7 5000i	.0007+5.00001 -
		_1	2500+3 7500i _1 6667+5 0000i _12 9167-38 6950i _10 0000	+30 0000i 0
		-1.		2 9167-38 6950i
		1.25	00+3.7500i	
			0 -2.5000+7.5000i 0 -1.2500+3.7500i 3.	7500-11.0750i
			bus_admittance_matrix =	
			5.8824 -23.5294i -2.9412 +11.7647i -2.9412 +11.7647i -2.9412 +11.7647i 5.8824 -23.5294i -2.9412 +11.7647i -2.9412 +11.7647i -2.9412 +11.7647i 5.8824 -23.5294i	
			Ybus =	
			0 - 7 1250i 0 + 1 2500i 0 + 4 0000i 0	
			0 + 1.2500i $0 - 7.5000i$ $0 + 5.0000i$ 0	
			0 + 4.0000i 0 + 5.0000i 0 - 9.0000i 0	
			0 0 0 0 0-1.0000i	
11	Results	& Analysis	Thus, the Bus Admittance matrix (Y-Bus) for a give	en power system is
		-	determined by using inspection method	
			Y _{Bus} =	
			Thus, the Bus Admittance matrix (Y – Bus) for a g	given power system
			without mutual coupling was determined by using singular trans	formation method.
			Y _{Bus} =	
			Thus the Due Admitteres metric (V Due) for a minute	
			Thus, the bus Admittance matrix (Y – Bus) for a giver	power system with
			and without mutual coupling is determined by using singular tra	nsformation method.

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			Y _{Bus} =	
12	Applicatio	on Areas		
13	Remarks			
14	Faculty	Signature		
	with Date	;		

Experiment 05: Z-Bus Building Algorithm.

-	Experiment No.:	5	Marks		Date		Date		
4	T:41a	F a 1990	ation of 7 Dur		Planned			uitle vee	
1		Form	ormation of \angle Bus(without mutual coupling) using \angle -Bus Building Algorithm.						
2		Eorm	ation of 7 Bur	without mut			Ruilding Algo	rithm	
<u> </u>	Material /	lah	lanual PC lo	aded with MA					
	Equipment								
	Required								
5	Theory, Formula,								
	Principle, Concept								
6	Procedure,	%Z-B	us Building A	lgorithm					
	Program, Activity,	clc							
	Algorithm, Pseudo	clear							
	Code	z=inp	ut('\n enter th	e bus data:');					
		[m n]:	=size(z);						
		zbus=	=[];						
		curre	ntbusno=0;						
		for a=	:1:m						
		[ro	ws cols]=size	(zbus);					
		fb=	z(a,2);						
		tb=	z(a,3);						
		val	ue=z(a,4);						
		nev	wbus=max(fb	,tb);					
		ref	=min(fb,tb);						
		%	type 1 modifie	cation					
		if n	ewbus>curre	ntbusno & re	f==0				
		1	:ype=1						
		2	zbus=[zbus z	eros(rows,1)					
			zeros(1,col	s) value]					
		(currentbusno	=newbus;					
		(continue						
		ene	b						
		%	type 2 modifi	cation					
		if	newbus>curr	entbusno & r	ef~=0				
		typ	be=2						

SI SI		SKIT			Teaching Process	Rev No.: 1.0
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Copyrig	ght ©2017. cA	AS. All rights reserve	d. zbuc-[zb		(· rof)	
			ZDUS-[ZL		(., [e])	
			ZDUS(IE	er,.) valu		
			currentb	usno=ne	ewbus	
			continue			
			end			
			% type 3	s modific	ation	
			if newbu	us<=curr	entbusno & ref==0	
			type=3			
			zbus=zb	ous-1/(zt	ous(newbus,newbus)+value)*zbus(:,nev	vbus)*zbus(newbus,:)
			continue	e		
			end			
			% type	4 modifi	cation	
			if new	bus<=cu	ırrentbusno & ref~=0	
			type=4	4		
			zbus=	zbus-1/	(value+zbus(fb,tb)+zbus(tb,tb)-2*zbus (fb,tb))*((zbus(:,fb)-
			zb	us(:,tb))	*((zbus(fb,:)-zbus(tb,:))))	
			continue	e		
			end			
			end			
7	Block,	Circuit,				
	Model	Diagram,				
	Reactio	n Equation,				
	Expecte	d Graph				
8	Observa	ation Table,	enter the bus	s data:[1	1 0 0.25;2 2 1 0.1;3 3 1 0.1;4 2 0 0.25;	5 2 3 0.1]
	LOOK-up	i able,	tuno -1			
	Output		type – i			
			zbus =			
			0.2500			
		1	type =2			
			20US -			
			0.2500	0.2500		
			0.2500	0.3500		
			currentbusno	o = 2		
		·	type =2			
0	Somela	Coloulation				
10	Granhe		zhus =			
	Staphs,	Jupuis	L000 -			
			0.2500	0.2500	0.2500	
			0.2500	0.3500	0.2500	

MS	TITUTE OF TA	SKIT			Teaching Process	Rev No.: 1.0
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			0.2500	0.2500	0.3500	
			currentbus	no = 3		
			type = 3			
			zbus =			
			0.1458	0.1042	0.1458	
			0.1042	0.1458	0.1042	
			0.1458	0.1042	0.2458	
			type = 4			
			zbus =			
			0.1386	0.1114	0.1214	
			0.1114	0.1386	0.1286	
			0.1214	0.1286	0.1628	
11	Results	& Analysis				
12	Annlicat	ion Areas				
13	Remark	s				
14	Faculty	Signature				
	with Dat	e				

Experiment 06: Determination of bus currents, bus power and line flows for a specified Bus system profile.

-	Experiment No.:	6	Marks		Date Planned		Date Conducted	
1	Title	Deter profile	Determination of bus currents, bus power and line flows for a specified Bus system profile.					
2	Course Outcomes	Calculate bus currents, bus power and line flow for given system, develop the program and verify using MATLAB						
3	Aim	To de	etermine the b	ous currents, b	us power an	d line flows f	or any power	system
4	Material / Equipment Required	Lab N	Lab Manual/PC loaded with MATLAB					
5	Theory, Formula, Principle, Concept	The I and b buses with s	ast step in th ous power or s i and k. The series admitta	he load flow an In the various I Ine and trans Ance Y _{ik} and tw	nalysis is con ines of the former at ea o shunt adm	mputing the network. Cor ich end can k ittances Y _{iko}	power flows, nsider the lin be represente and Yk _{io} as sl	bus currents e connecting d by a circuit nown below.



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			busdata=input('\nEnter the bus data>');	
			fr=linedata(:,1);	
			to=linedata (:,2);	
			r=linedata (:,3);	
			x=linedata (:,4);	
			b=linedata(:,5);	
			z=r+i*x;	
			y=1./z;	
			ysh=i*b;	
			nbr=length(fr);	
			nbus=max(max(fr),max(to));	
			bus_no=busdata(:,1);	
			volt_mag=busdata(:,2);	
			angle_d=busdata(:,3);	
			%bus voltages in rectangular form	
			for n=1:nbus	
			v_bus(n)=(volt_mag	(n)*cos(angle_d(n)*pi/180))
		-	⊦i*(volt_mag(n)*sin(angle_d(n)*pi/180));	
			end	
			v_bus	
			%line current	
			for m=1:nbr	
			lik(m)=(v_bus(fr(m))-v_bus(to(m)))*y(m)+ (v_bus	(fr(m))*ysh(m));
			lki(m)=(v_bus(to(m))-v_bus(fr(m)))*y(m)+(v_bus(to(m))*ysh(m));
			end	
			lik	
			lki	
			%complex power flow	
			for m=1:nbr	
			Sik(m)=v_bus(fr(m))*conj(lik(m));	
			Ski(m)=v_bus(to(m))*conj(lki(m));	
			end	
			Sik	
			Ski	
			%line losses	
			for m=1:nbr	
			SI(m)=Sik(m)+Ski(m);	
			end	
			SI	

ST INSTITUTE OF IS		SKIT	Teaching Process	Rev No.: 1.0			
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Convrie	ANGALORE *	Title:	Course Plan	Page: 33 / 49			
		AD. All lights reserve	%bus power				
			s bus=zeros(nbus,1);				
			for n=1:nbus				
			s_bus(n)=0;				
			for m=1:nbr				
			if fr(m)==n				
			s_bus(n)=s_bus(n)+Sik(m);				
			elseif to(m)==n				
			s_bus(n)=s_bus(n)+Ski(m);				
			end				
			end				
			end				
			s_bus				
			%bus current				
			i_bus=zeros(nbus,1);				
			for n=1:nbus				
			i_bus(n)=0;				
			for m=1:nbr				
			if fr(m)==n				
			i_bus(n)=i_bus(n)+lik(m);				
			elseif to(m)==n				
			i_bus(n)=i_bus(n)+lki(m);				
			end				
			end				
			end				
			i_bus				
7	Block, Model	Circuit, Diagram					
	Reaction	n Equation,					
	Expecte	d Graph					
8	Observa	ition Table,	enter the line data=[1 2 0 0.2 0;1 3 0 0.15 0;1 4 0 0.1 0;2 3 0 0.1	0;2 4 0 0.15 0]			
	Output	rabie,	enter the bus data=[1 1 0:2 1 4.41:3 1 -4.24:4 1 -5.1]				
9	Sample	Calculation					
10	Graphs,	Outputs	vb =				
				1889i			
			I =				

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			0 -0.3845 - 0.0148i 0.4929 - 0.0182i 0.8889 - 0.0	396i
			$0.3845 \pm 0.0148i$ 0 $1.5083 \pm 0.0022i$ $1.1052 \pm 0.0022i$	00671
			$-0.4929 \pm 0.0182i$ $-1.5083 - 0.0022i$ 0 0	
			-0.8889 + 0.0396i -1.1052 + 0.0067i 0 0	
			e –	
			5 -	
				0306
			0 -0.3843 + 0.0146i 0.4929 + 0.0162i 0.8869 + 0.000000 + 0.000000 + 0.00000 + 0.00000 + 0.00000000	03901
			-0.4929 + 0.0182i - 1.5040 + 0.1137i = 0.0010101010101010101010101010101010101	03101
			-0.4323 + 0.0396i - 1.0040 + 0.016i 0 0	
			SI =	
			0 + 0.0296i 0 + 0.0365i 0 + 0.0792i 0 + 0.2275i	0 +
			0.1832i	
			bp =	
			0.9974 + 0.0726i 2.9899 + 0.2202i -1.9969 + 0.1320i -1.990	04 + 0.1312i
			ibus =	
				0 0 0 400'
			0.9974 - 0.07261 2.9980 + 0.01041 -2.0012 + 0.01601 -1.994	2 + 0.04621
11	Deeritte	9 Analysia	Thus the line surrents line langes has surrents have	nower and line flow
11	Results	& Analysis	Thus, the line currents, line losses, bus currents, bus	power and line flow
			for a power system network with a specified system voltage	e (bus) profile were
			determined.	
			Line Currents I _{ik} = Bus cu	ırrents I _i =
			Line Currents I _{ki} = Bus po	ower S _i =
			Line power S _{ik} =	s S. =
			Line power Sk=	-
12	Applicat	ion Areas		
13	Remark	S		
14	Faculty	- Signature		
	with Dat	e		
		-		

Experiment 07: Jacobian Matrix Calculation

-	Experiment No.:	7	Marks	Date	Date	
				Planned	Conducted	

SA INSTITUTE OF IS		SKIT	Teaching Process	Rev No.: 1.0				
		Doc Code:	SKIT.Ph5b1.F03	Date: 11-07-2018				
04	A MGALORE +	Title:	Course Plan Page: 35					
Copyrig 1	Title	AS. All rights reserve	d. Formation of Jacobian for a System not Exceeding 4 Buses Coordinates	(No PV Buses) in Polar				
2 3	Course Aim	Outcomes	formation of Jacobian Formation of Jacobian for a system not exceeding 4 buses coordinates	*(no PV buses) in polar				
4	Material Equipmo Require	/ ent d	Lab manual, PC loaded with MATLAB					
5	Theory, Principle	Formula, e, Concept	1. Real Power P _i = $ V_i * \Sigma V_k * Y_{ik} * \cos (\theta_{ik} + \delta_k - \delta_i)$. k=1					
			2. Reactive Power Q _i = $- V_i * \Sigma V_k * Y_{ik} * sin (\theta_{ik} + \delta_k - k=1)$	- δ _i).				
			3. Jacobian elements $H_{ii} = -Q_i - (B_{ii}^* V_i ^2)$, $N_{ii} = P_i$ $(G_{ii}^* V_i ^2)$ and	+ $(G_{ii}^* V_i ^2)$, $J_{ii} = P_i -$				
			$L_{ii} = Q_i - (B_{ii}^* V_i ^2).$					
			4. Jacobian elements $H_{ij} = \partial P_i / \partial \delta_j = L_{ij} = \partial Q_i / \partial V_j = - $	$V_i * V_j * Y_{ij} *sin (\theta_{ij} -$				
			$\delta_i + \delta_j$).					
			$N_{ij} = \partial P_i \ / \ \partial \left \ V_j \right = - \ J_{ij} = - \ \partial Q_i \ / \ \partial \delta_j$	$= V_i * Y_{ij} * \cos (\theta_{ij} - \delta_i)$				
			+ δ_j).					
			5. Jacobian matrix = H N					
			J L					
			Where, i & k are no. of buses,					
			V _i is the bus voltage at bus i,					
			$Y_{\mbox{\tiny ik}}$ is the corresponding element in bus adm	nittance matrix,				
			θ_{ik} is angle of Y_{ik} in the corresponding elements	ment of bus admittance				
			matrix,					
			δ_i is the angle of bus voltage at bus i,					
			B_{ii} is the susceptance of bus i = $ Y_{ii} ^*$ sin θ_i	i,				
			G_{ii} is the conductance of bus i = $ Y_{ii} * \cos \theta$) _{ii} ,				
6	Procedu	ıre,	clc					
	Program	n, Activity,	clear all					
	Algorithi Code	n, Pseudo	y_bus=input('Enter the bus admittance matrix ==>');					
	Jue		busdata=input('\nEnter the bus data ==>');					
			y=abs(y_bus);					
			th=angle(y_bus);					
			bus no=busdata(:,1);					

SAMSTITUTE OF IS		SKIT	Teaching Process	Rev No.: 1.0			
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S * BAI	MGALORE +	Title:	Course Plan	Page: 36 / 49			
Copyrig	nt ©2017. cA	AS. All rights reserve	v mag=busdata(:.2);				
			v ang=busdata(:.3):				
			nbus=max(bus no):				
			slackhus=1				
			for p=1:pbus				
			$p_{c}(p)=0$				
			$p_{C}(p) = 0;$				
			$q_0(p) = 0$,				
			if(n~=slackbus)				
			n(p - side kous)	$(n, a)^* cos(th(n, a) + v, ana(a))$			
			$pc(p)-pc(p)/(v_mag(p)/v_mag(q)/y)$	(p,q) cos(in(p,q) v_ang(q)			
			$x_{ang}(p)$	(n, a)*cip(th(n, a)+y, cpa(a)			
			$qc(p)-qc(p)-(v_mag(p), v_mag(q))$	(p,q) sin(in(p,q) v_ang(q)-			
			v_ang(p))),				
			end				
			and				
			p = 1.00				
			$p_{cal}(p) = p_{c}(p),$				
			q_cal(p)=qc(p);				
			end				
			p_cal				
			q_cai				
			% formation of H N J L				
			I=1;				
			for p=1:nbus				
			j=1;				
			for q=1:nbus				
			if(p~=q)&(p~=slackbus)&(q~=slackbus)				
			H(i,j)=-v_mag(p)*v_mag(q)*y(p,q)*sin(th(p,q)-v_ang(p)+v_ang(q));			
			N(i,j)=(v_mag(p)*y(p,q))*cos(th(p,q)-v_ang(p)+v_ang(q));			
			J(i,j)=-N(i,j);				
			L(i,j)=H(i,j);				
			j=j+1;				
			end				
			if(p==q)&(p~=slackbus)&(q~=slackbus)				
			H(i,i)=-q_cal(p)-(y(p,p)*sin(th(p,p))*v_mag(p	o)^2);			
			N(i,i)=p_cal(p)+(y(p,p)*cos(th(p,p))*v_mag(p)^2);			
			J(i,i)=p_cal(p)-(y(p,p)*cos(th(p,p))*v_mag(p)^2);			
			L(i,i)=q_cal(p)-(y(p,p)*sin(th(p,p))*v_mag(p)	^2);			

ST MSTITUTE OF TH		SKIT	Teaching Process Rev No.: 1.0				
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× 04	AGALORE	Title:	Course Plan Page: 37 / 49				
Copyri	ght ©2017. cA	AS. All rights reserve	a. i=i+1:				
			and				
			ena				
			if(p~=q)&(p~=slackbus)&(q~=slackbus)				
			i=i+1;				
			end				
			end				
			Н				
			Ν				
			J				
7	Block	Circuit	5acobian – [1110, 5 L]				
.	Model	Diagram,					
	Reaction	n Equation,					
	Expecte	d Graph					
8	Observa	ition Table,	Enter the bus admittance matrix ==>[6.25-18.75i -1.25+3.75i -	5+5i;			
	LOOK-UP	i abie,	-1.25+3.751 2.916667-8.751 -1.6667+51;-5+151 -1.6667+51 6.6	667-201]			
	Output		Enter the bus data ==>[1 1.04 0:2 1 0:3 1 0]				
9	Sample	Calculation					
10	Graphs,	Outputs	p_cal =				
			0 00500 00000				
			0 -0.0500 -0.2000				
			q_cal =				
			0 -0.1500 -0.6000				
			H =				
			8.9000 -5.0000				
			-5.0000 20.6000				
			N =				
			2.8666 -1.6667				
			-1.6667 6.4667				
			J =				
			-2.9667 1.6667				

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			1.0007 -0.0007	
			L=	
			8.6000 -5.0000	
			-5.0000 19.4000	
		,	Jacobian =	
			8 9000 -5 0000 2 8666 -1 6667	
			-5.0000 20.6000 -1.6667 6.4667	
			-2.9667 1.6667 8.6000 -5.0000	
			1.6667 -6.8667 -5.0000 19.4000	
11	Results	& Analysis	Thus, the Jacobian matrix for a power system which	has only PQ buses
			was formed.	
			P =	
			Q =	
			Matrix H =	
			Matrix N =	
			Matrix J =	
			Matrix L =	
			Jacobian Matrix =	
12	Applicat	ion Areas		
13	Remark	S		
14	Faculty	Signature		
	with Dat	e		

Experiment 08: Load Flow Analysis

-	Experiment No.:	8	Marks		Date		Date		
					Planned		Conducted		
1	Title	Load	Load Flow Analysis using Gauss Siedel Method, NR Method and Fast Decoupled						
		Meth	Method for Both PQand PV Buses.						
2	Course Outcomes	Use I	Use Mi-Power package to study load flow analysis using NR method, Gauss Siedel						
		Methe	Method, Fast Decoupled method						
3	Aim	Load	I flow analysis	s using Newto	on Raphson M	/lethod/Gaus	s seidel meth	od.	
4	Material	Lab N	lanual, P.C l	baded with M	ipower packa	ge			
	Equipment								
	Required								

1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	STITUTE OF	SKIT	Teaching Process	Rev No.: 1.0				
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St 0	WGALORE	Title:	Course Plan	Page: 39 / 49				
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5	Theory,	Formula,	Load flow solution is a solution of a network under steady state	condition subjected				
	Principle	, Concept	to certain inequality constraints under which the system	n operates. These				
	constraints can be in the form load nodal voltages, reactive power generation of the							
			generators, the tap setting of the tap changing transformer unde	r load conditions.				

The load flow solution gives the nodal voltages and phase angles and hence the power injection at all the buses and power flows through interconnecting power channels (through transmission line). Load flow solution is essential for designing a new power system and for planning extension of the existing one for increased load demand. These analysis require the calculations numerous load flows under both normal and abnormal operating conditions. Load flow solution also gives the initial conditions of the systems in the transient behavior of the system is to be obtained. Load flow solution for power network can be worked out both ways accordingly as it is operating under balanced and unbalanced conditions. The following treatment will be for a system operating under balanced conditions. For such a system single phase representation is adequate. A load flow solution of the power system requires mainly the following steps. 1) formulation or network equation 2) Suitable mathematical technique for solution of the equation. 3) The load and hence the generation are continuously varying in a real power system. We will assume here that loads and hence generations are fixed at a particular value over a suitable period of time. Example $(\frac{1}{2} hr)$

Bus classification In a power system each bus or a node is associated with four quantities a) real power b) reactive power c) bus voltage magnitude d) phase angle of the voltage. In a load flow solution two out of four quantities are specified and remaining two are required to be obtained. Depending upon which quantities are specified buses are classified as 1) generator bus 2) slack bus 3) load bus Generator bus (voltage controlled bus) Any bus of the system at which voltage magnitude is kept constant is called voltage controlled bus. At each bus to which there is a generator connected, the megawatt generation can be controlled by adjusting the prime mover and the voltage magnitude can be controlled by adjusting the generator excitation. Therefore at each generator bus we may properly specify Pgi and |Vi|. Thus at the bus I angle delta and Qgi are the unknown quantities. Therefore it is also called as PV Bus.

Load bus (PQ bus) At each non generator bus called bus both Pgi and Qgi are zero and real power Pdi and reactive power Qdi are drawn from the system by the load. The two unknown quantities are voltage magnitude and voltage angle (V and δ)

Slack bus The losses remain unknown until the load flow solution is complete. It is for this reason generally one of the generator buses is made to take the additional real and reactive power to supply transmission losses that is why this bus is known as slack bus or swing bus. At this bus the voltage magnitude V and phase angle δ are specified where as Pgi and Qgi are unknown. The voltage angle of the slack bus serves as a reference for the angles of all other bus voltages.

Techniques of solving load flow problems The development of any method for the load flow studies on the digital computer requires the following main consideration

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	<u>nr ©2017. CAA</u>	S. All rights reserved	1) mathematical formulation of the load flow problem 2) applies the chnique to solve these problems. The mathematical form problem is a system of non linear algebraic equations. The non-linear algebraic equations can be solved by the solutions iterative methods 1) Gauss method 2) Gauss- Seide Raphson method Gauss Seidel method In this method the calculated for any bus immediately replace the previous valuation in case of gauss method the calculated bus voltage reporting at the end of iteration. Due to this Gauss Siedel method the provide the provide the the differences in the bus voltages from one cufficiently small.	blication of numerical nulation of load flow ution techniques such I method 3) Newton value of bus voltages lues in the next step lace the earlier value converges faster than quation in rectangular e iteration another are
			Newton Raphson method It's a powerful method of solving equation. It works faster and is sure to converge in most of th to the GS method. It is indeed a practical method of load power networks. Its only drawback is the large requirement Convergence can be considerably speeded up by perform through the GS method and using the values so obtained terations. This method solves the polar form of the power fle and δq mismatches, at all buses fall within the tolerance.	i non-linear algebraic e cases as compared flow solution of large of computer memory. ing the first iteration I for starting the NR ow equations until δp
		 	Fast Decoupled NR method When solving large scale power strategy for improving computational efficiency and reducin requirements is the decoupled load flow method. Incorporation the decoupled method into the jacobian matrix makes the matrices J_{12} and J_{21} zero.	transmission systems ng computer storage n of approximations of elements of the sub
		- , , , ,	Therefore the modified jacobian now consists of the sudject J_{22} . However J_{11} and J_{22} are still interdependent. The complicat J_{12} can be overcome by introducing further simplifications whi physics of transmission line power flow. Such a method is call method.	Ib matrices J_{11} and ions in solving J_{11} and ch are justified by the ed as fast de coupled
6	Procedui	re,	Gauss Siedel Method	
	Program Algorithn Code	, Activity, n, Pseudo	To begin, double-click on the "PowerWorld Simulator icon". Simulator is used to create new cases.	This starts Simulator.
		:	2.Select Network > required components from the Individual I the Draw ribbon tab. This prepares Simu components.	nsert ribbon group on lator to insert a new

3.Left-click on the oneline background at the location where you want to place the new bus. This invokes the component Option Dialog.

0099.18	
	4 .Draw the given single line diagram using suitable components with their specification.
	5 .Run the system by Click on Run Mode button in the Mode ribbon group.
	6 .Press the Play button in the Power Flow Tools ribbon group on the Tools ribbon tab to begin the simulation. Alternatively, to perform a Power Flow Solution, click on Gauss Seidel power flow option in the solve ribbon group.
	It will solve the network and update all the filed values as per solution results on single line diagram.
	 Click on model explore to check the results. The corresponding bus voltages, Y- bus are noted down and verified.
	Newton raphson method
	1.To begin, double-click on the "PowerWorld Simulator icon". This starts Simulator. Simulator is used to create new cases.
	 Select Network > required components from the Individual Insert ribbon group on the Draw ribbon tab. This prepares Simulator to insert a new components.
	 Left-click on the online background at the location where you want to place the new bus. This invokes the component Option Dialog.
	4. Draw the given single line diagram with the specification of components.
	5. Run the system by Click on Run Mode button in the Mode ribbon group.
	 Press the Play button in the Power Flow Tools ribbon group on the Tools ribbon tab to begin the simulation. Alternatively, to perform a Power Flow Solution, click on newton raphson power flow option in the solve ribbon group.
	7 . It will solve the network and update all the filed values as per solution results on

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			single line diagram.	
			 Click on model explore to check the results. The correspond bus are noted down and verified. 	ding bus voltages, Y-
7	Block, Model	Circuit, Diagram,		
	Reaction Expected	n Equation, d Graph		
8	Observa	tion Table,		
	Look-up	Table,		
	Output			
9	Sample	Calculation		
		:	Example:-The computations are performed at buses 3, 4 and 5 Gauss Seidel iteration. And the results are displayed as shown Screen showing mismatches after first iteration:	to complete the first below:
		-	Case Information Draw Onelines Tools Options Add Ons Window Edit Mode Ruu Mode Image: American Street St	Power Flow List Quick Power Flow List AUX Export Format Desc
			204 MW 43 Mvar 1.000 pu 0.000 Deg 0.000 Deg 0.2.327 Deg	Fo
			X Dus Real and Reactive Power Mematches X OPE Areas. X Der Merades X OPE Areas. X Der Medels I Iff. Iff.<	29 Two 29 800 MW 280 Mwar
			The magnitude of the MW and Muar mennatch	
		1	Newton raphson method	
			Example:	
			Screen showing jacobian matrix at first iteration:	



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			Thus, the load flow solution for a given power system netw raphson method was performed with the help of Powerworld	vork using newton l software package.
12	Applicatio	n Areas		
13	Remarks			
14	Faculty	Signature		
	with Date			

Experiment 09: Short Circuit Analysis

-	Experiment No.:	9	Marks		Date		Date	
					Planned	·	Conducted	
1	litle	lo de	o determine fault currents and voltages in a single transmission line systems with					
		star-c	lelta transforr	ners at a spe	cified location	for SLGF, D	LGF.	<u> </u>
2	Course Outcomes	Use I	Ni-Power pac r systems	kage to study	y unsymmetri	cal faults at o	different local	ions in radial
3	Aim		termine fault	currents and	l voltages in r	a single trans	mission line	evetome with
		star-c	ar-delta transformers at a specified location for SLGF, DLGF.					
4	Material /	Lab N	/lanual, P.C lo	paded with M	ipower packa	ge		
	Equipment							
	Required							
5	Theory, Formula,	Shor	t circuit studi	es and hence	e the fault an	alysis are ve	ry important f	for the power
	Principle, Concept	syste	m studies sir	nce they prov	ride data suc	h as voltages	s and current	s during and
		after	the various f	types of fault	s which are	necessary in	n designing t	he protective
		scher	nes of the po	wer system.	There are diff	ferent types o	of faults in a p	ower system
		which	n can be b	proadly divid	ed into syr	nmetrical ar	nd unsymme	trical faults.
		Symr	netrical fault	is the solid s	short circuit.	This is an al	onormal syste	em behavior.
		Such	conditions ar	e			<i>.</i> .	
		cause	ed in the sys	tem accident	ally through i	nsulation fail	ure of equipr	nent or flash
		over	of lines initia	ted by a ligh	tning stroke	or through a	ccidental fau	ity operation.
		of he	avv short cir	cuit currents	by disconne	cting the fau	Ity part of th	e system by
		mear	is of circuit br	eaker operate	ed by protecti	ve relaying.	ity part of th	e system by
		The	unsymmetrica	al faults requ	uire special t	tools like sy	mmetrical co	mponents to
		analy	ze the unbal	anced opera	tion of the s	ystem. Thoug	gh symmetric	cal faults are
		rare,	this leads to i	most severe f	ault current			
		flow a	against which	the system n	nust be prote	cted.		
						<u> </u>		
6	Procedure,	1	To begin,	double-click	on the "Po	werWorld Sir	mulator icon'	. This starts
	Algorithm, Activity,	Simu	lator. Simulat	or is used to	create new ca	ases.		
	Code	2	. Select Net	work > requ	ired compon	ents from th	e <u>Individual</u>	Insert ribbon
			group on	the Draw rib	bon tab. Thi	s prepares S	Simulator to	insert a new
			componer	its.				
		3	. Left-click o	n the online I	background a	it the location	where you	want to place

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Copyright ©2017. o	Title: AAS. All rights reserved	 Course Plan the new bus. This invokes the component Option I 4. Draw the given single line diagram using suitable component option. 5. Set the software to the 'Run Mode' & select 'Fault A' 'Tool Menu'. It will open 'Fault Analysis' window. 6. Click on 'Fault Options'tab to enter the fault impedant fault profile and conditions. 7. Click on 'Fault Data' tab, select the fault location(Bus of type, faulted busor line and unit type for fault cur 'calculate' tab to run analysis. 8. Tabular report of the fault analysis for all the network end by selecting different elements. 9. Click on 'Fault data' tab and select 'online Display' to vi on single line diagram for all phases or individual phase 	Page: 45 / 49 Page: 45 / 49 Dialog.
7 Block, Model Reaction Expect 8 Observ	Circuit, Diagram, on Equation, ed Graph vation Table,		
LOOK-U Output	p lable,		
9 Sample	e Calculation		
10 Graphs	s, Outputs	<complex-block></complex-block>	Generations Cher Cher Cher Cher Cher Cher Cher Cher

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			Unsymm	Care information Draw Code Care information Draw Code Care information Draw Code Strap Strap Strap Code Code Code Code Code Code Code Code	S: Case Exampled Spein: Status Pased [Smulder:] 5 Evaluation Torus Galaxie Add Oni Window Torus Case Campled Spein: Status Pased [Smulder:] 5 Evaluation Torus Case Campled Spein: Cale Case of Smulder: Torus Case of Sm	Convectors Other -	Constance. Consta
			3	0 📋 0 🚺		- Nr 19 - 4	40 11:17 PM 8/28/2011
11	Results	& Analysis	Thus, the fau	ult currents	and voltages in single transmission li	ne system	s with star-
			delta transfo	rmers at a s	pecified location for SLGF, DLGF wer	e determir	ned.
12	Applicat	ion Areas					
13	Remark	S					
14	Faculty	Signature					
	with Dat	e					

Experiment 10: Optimal Generation Scheduling

-	Experiment No.:	10	Marks		Date Planned		Date Conducted	
1 Title Optimal Generation Scheduling for Ther			for Thermal p	ower plants b	by simulation	<u> </u> .		
2 Course Outcomes Use of Mi-Power package to study optimal generation scheduling thermal power plants.				scheduling	problems for			
3	Aim To determine the economic load dispatch or optimum generation schedule given power system.				chedule for a			
4	Material , Equipment Required	PC lo	aded with Mi	power, Lab n	nanual			
5	Theory, Formula Principle, Concept	For a costs cost i If we then	a power plan , but we will s the only im e let P stand Fig. shows a	It the total co assume that portant one. for the powe typical curve	st of operation changes in o er output in me of cost versus	includes fue utput are rela gawatts MW power outpu	I, maintenan atively small /) and C be it.	ce, and labor , so that fuel the fuel cost,

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Copyrig	oht ©2017. cA	AS. All rights reserved	d.					
			Cost \$/br					
			ļ					
				Pmin P, MW Pmax				
			<u>г</u> :т		a a la at			
			Figure: I quadratic maximum of the pla more po thermody above a c	ypical Fuel-Cost curve for a single power that the cost curve is increasing and polynomial is often used to fit fuel-co values of P, Pmax and Pmin, correspon nt. The need for an upper limit should be wer than it is designed for. The namic and/or practical considerations, e certain value or the flame goes out.	Pr plant concave upward. In practice, a st data. There are minimum and nding to feasible limits of operation clear; a given plant can't produce lower limit usually comes from a.g. the fuel burning rate has to be			
6	Procedu Program Algorithr	n, Activity, n, Pseudo	1. To b Simu	egin, double-click on the "PowerWo ator. Simulator is used to create new c	orld Simulator icon". This starts ases.			
	Code		2. Selec on the	t Network > required components from Draw ribbon tab. This prepares Simulat	the Individual Insert ribbon group or to insert a new components.			
		:	3. Left-cl new b	ick on the oneline background at the loc us. This invokes the component Optio	cation where you want to place the n Dialog.			
			4. Draw 1	he given single line diagram with the sp	ecification of components.			
		ł	5. Selec clickin	t fields around generator 'IC'(Increme g on generator symbol and selecting the	ntal cost of generator-λ) by right e field IC.			
			6. Right inform the wir	click anywhere on the single line diagra ation Dilog from the pop up menu. Sele ndow and enable different types of cont	m except on symbols, select 'Area ct 'Economic Dispatch Control ' in rols for the study. Then click OK.			



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7	Block, Model Reactior Expecte	Circuit, Diagram, n Equation, d Graph		
8	Observa Look-up Output	ition Table, Table,		
9	Sample	Calculation		
10	Graphs,	Outputs		
11	Results	& Analysis	Thus, the economic load dispatch or optimum generation sc	hedule for a given
40	، جالم المعالم	ion Areas	power system was determined.	
12	Applicat	ion Areas		
13	Remarks	Signature		
14	raculty with Dat	Signature e		