Code No: R32022

R10

Set No: 1

III B.Tech. II Semester Supplementary Examinations, January -2014
POWER SYSTEM ANALYSIS
(Electrical and Electronics Engineering)

**Time: 3 Hours**   **Max Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks
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1. A 100 MVA, 13.8 kV, 3-Phase generator has a reactance of 20%. The generator is connected to a 3-Phase transformer T_1 rated 100MVA 12.5/110 kV with 10%. Reactance. The HV side of the transformer is connected to a transmission line of reactance 100Ω. The far end of the line is connected to a step down transformer T_2, made of three single phase transformer each rated 30MVA, 60/10kV with 10% reactance the generator supplies two motors connected on the LV side T_2. The motors are rated at 25MVA and MVA both at 10KV with 15% reactance. Draw the reactance diagram showing all the values in per unit. Take generator rating as base.   [15]

2. In the power system network shown in below Fig bus 1 is a slack bus with $V1 = 1.0\angle0°$ per unit and bus 2 is a load bus with S2=289 MW+j60MVAr. The line impedance on a base of 100 MVA is Z=(0.02+j0.04) per unit.
   (i) Using Gauss-seidel method, determine V_2. Use an initial estimate of $V_2^° =1.0+j0.0$ and perform four iterations.
   (ii) If after several iteration voltage at bus 2 converges to V_2=0.90-j0.10, determine S_1 and the real and reactive power loss in the line.   [8+7]
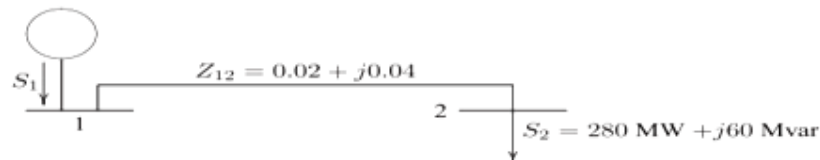
3. A Three bus power system shown in below fig. The systems parameters are given in table1 and load & generator date in table2. The voltage at bus 2 is maintained at 1.03 P.u. The max and min. Reactions power limits of the generation at bus 2 are 35 and 0 MVAr respectively. Taking bus 1 as slack bus obtain the load flow solution using N-R methods after first iteration.   [15]
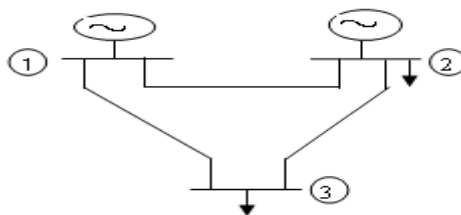
Table1 : Line Parameters

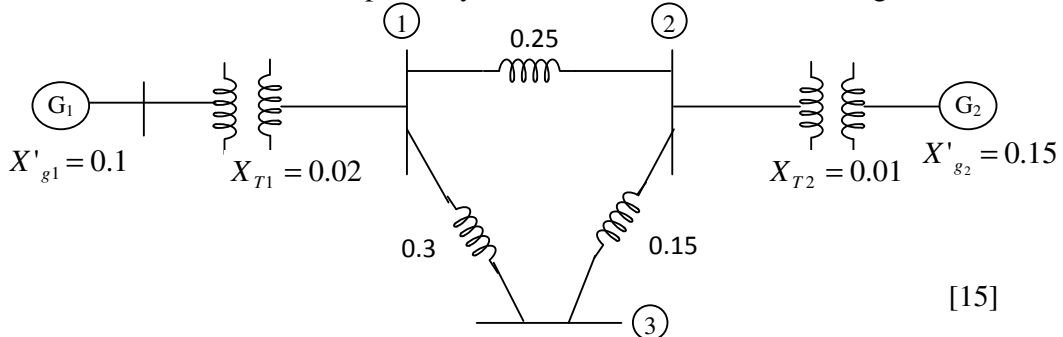| Bus Code i-K	Impedance Zik (P.u)
1 - 2	0.08 + j0.24
1 - 3	0.02 + j0.06
2 - 3	0.06 + j0.018

Table2: Scheduled generation, loads and Voltages

| Bus No i	Bus Voltage Vi	Generation		Load	
		MW	MVAr	MW	MVAr
1	1.05 + j0.0	-	-	0	0
2	1.03 +j0.0	20	-	50	20
3	-	0	0	60	25

4. Determine the Z_{bus} for the power system networks shown in below fig.

[15]

5. The system shown in Fig below shows an existing plant consisting of a generator of 100 MVA, 30 KV, with 20 percent sub transient reactance and a generator of 50 MVA, 30 KV with 15 percent reactance, connected in parallel to a 30-KV bus bar. The 30-KV bus bar feeds a transmission line via the circuit breaker C which is related at 1250 MVA. A grid supply is connected to the substation bus bar through a 500 MVA, 400/30KV transformer with 20 percent reactance. Determine the reactance of a current limiting reactor in ohm to be connected between the grid system and the existing bus bar such that the short –circuit MVA of the breaker C does not exceed.
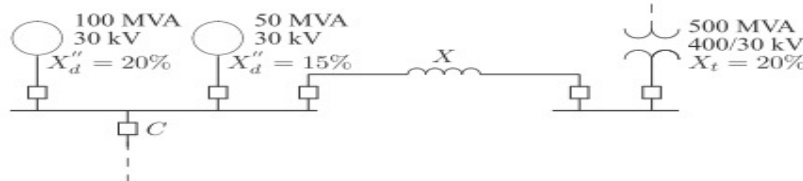

[15]

6. The one-line diagram of a simple power system is shown in Fig below. Each generator is represented by an emf behind the transient reactance. All impedances are expressed in per unit on a common MVA base. All resistances and shunt capacitances are neglected. The generators are operating on no load to their rated voltage with their emfs in phase. A three-phase fault occurs at bus 1 through a fault impedance of $Z_f=j0.08$ per unit.

(a) Using the venins theorems obtain thee impedance to the point of fault and the fault current in per unit.

(b) Determine the bus voltage and line current during fault.   [8+7]
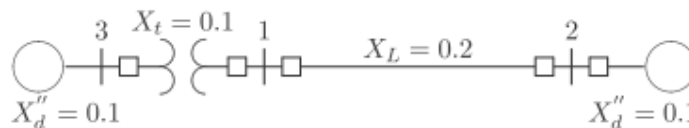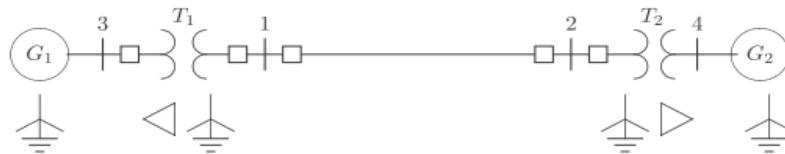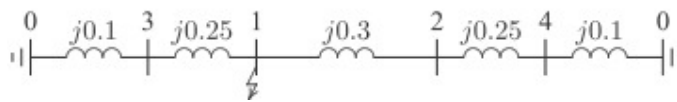
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7. The reactance data for the power system shown in fig below in per unit on a common base is as follows:

Obtain the thevenin sequence impedance for the fault at bus 1and compute the fault current in per unit for the following faults.

Positive sequence impedance network for the above problem

(a) A bolted three phase fault at bus 1.
(b) A bolted single line to ground fault at bus 1.
(c) A bolted line to line fault at bus 1.
(d) A bolted double line to ground fault at bus 1   .   [4+4+4+3]

8. (a) Explain the recent methods of maintaining transient stability   [8+7]
   (b) Discuss stability and instability of a system.

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III B.Tech. II Semester Supplementary Examinations, January -2014
POWER SYSTEM ANALYSIS
(Electrical and Electronics Engineering)

Time: 3 Hours   **Max Marks: 75**

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1. Two generators are connected in parallel to a 6.6 KV bus. One of the generator has a rating of 20 MVA and a reactance of 15 % while the second generator is rated at 15 MVA and has a reactance of 12 %. Calculate the P.u reactance of 50 MVA and 6.6 KV base. What is the P.u reactance of a single equivalent generator on 50 MVA and 6.6 KV base? [15]

2. In fig shows the one-line diagram of a simple three-bus power system with generation at bus 1is $V_1 = 1.0\angle 0^o$ per unit. The scheduled loads on buses 2 and 3 are marked on the diagram. Line impedances are marked in per unit on a 100 MVA base. For the purpose of hand calculations, line resistances and line charging susceptance re neglected.

   Using gauss-Seidel method and initial estimates of $V_2^{(0)} = 1.0 + j0$ and $V_3^{(0)} = 1.0 + j0$, determine V_2 and V_3. Perform two iterations. [15]
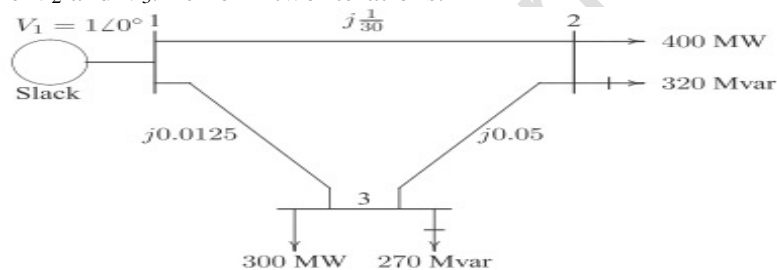
3. In the two bus system shown in fig below, bus 1 is a slack bus with $V1 = 1.0\angle 0°$ P.u. A load of 100 MW and 50 MVAr is taken from bus 2. The line impedance is $Z_{12}=(0.12+j0.16)$ pu on a base of 100 MVA. Using Newton-Raphson method, obtain the voltage magnitude and phase angle of bus 2. Start with an initial estimate of $|V2|^0 = 1.0$ and $\delta_2^{(0)} = 0^0$. Perform two iterations. [15]
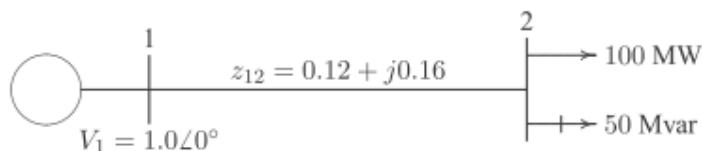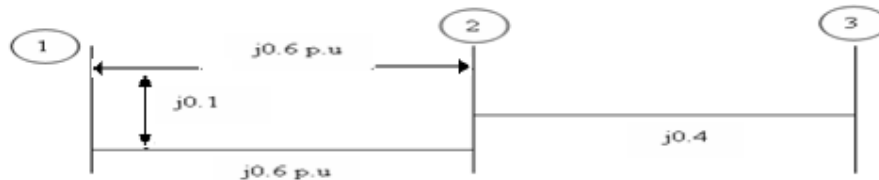
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4. (a) What are the applications of ZBUS in power system analysis?
(b) Obtain the Z_{BUS} by building algorithm for the network as shown in Fig. below with reactance values in P.u. Take bus-1 as the reference Bus?   [7+8]

5. The system shown in fig below is initially on No load with generators operating at their rated voltage with their emfs in phase. The rating of the generators and the transformers and their respective percent reactance are marked on the diagram. All resistances are neglected. The line impedance is j160 ohms. A three phase balanced fault occurs at the receiving end of the transmission line. Determine the short circuit current and the short circuit MVA.   [15]
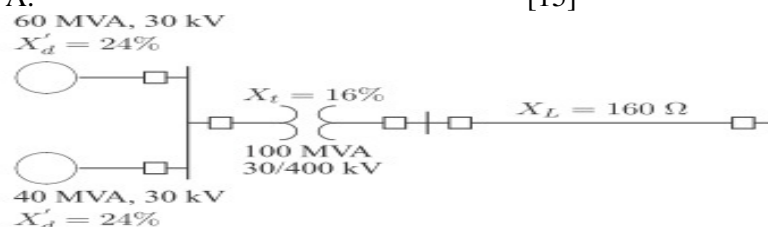
6. (a) Explain the physical significance of symmetrical components.
(b) The symmetrical components of a unbalanced power systems are

$I_{a0} = 30\angle 90^0\, A, I_{a1} = 50\angle -40^0\, A \text{ and } I_{a2} = 65\angle 0^0\, A$ Calculate the phase currents of the networks   [8+7]

7. Calculate the sub transient fault current in each phase for a dead short circuit on one phase to ground at bus 'q' for the system shown in below figure.
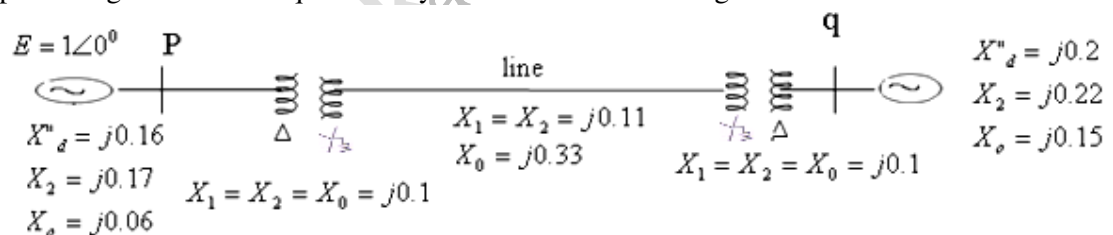
8. (a) Derive the formula for calculating critical clearing angle.
(b) Draw a diagram to illustrate the application of equal area criterion to study Transient stability when there is a sudden increase in the input of generator.   [7+8]

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R10   Set No: 3

Code No: R32022

POWER SYSTEM ANALYSIS
(Electrical and Electronics Engineering)

Time: 3 Hours   **Max Marks: 75**

Answer any FIVE Questions
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*****

1. A 500 MVA, 15 kV, 3ϕ generator has a sub transient reactance of 0.2 P.u. The generator supplies two motors over a transmission line having transformers at both ends of the system. The motor have rated inputs of 35 MVA and 15 MVA both 30 kV the with 0.13 P.u sub transient reactance. The rating of the sending end transformer, Tr_1 is 50MVA, 11/132 kV $\triangle = Y$ with leakage reactance of 0.1 P.u. Transformer, Tr_2 at the receiving end has 3 single phase transformers connected has a 3 phase unit. The rating of each individual transformer is 18 kVA, 33/76 kV with leakage reactance of 0.13 P.u. Series impedance of the line is (20+j50)Ω. Draw the impedance diagram with all impedance marked in P.u . Select the generator rating as the base.

2. In the fig shown in below the one line diagram of a simple three phase bus power system with generation at buses 1 and 3. The voltage at bus 1 is $V1 = 1.025\angle 0°$ per unit. Voltage at bus 3 is fixed at 1.03 P.u with a real power generation of 300 MW. A load consisting of 400 MW and 200 MVAr is taken from bus 2. Line impedances are marked in per unit on a 100 MVA base. For the purpose of hand calculations, line resistances and line charging susceptances are neglected.
(a) Using Gauss-Seidal method and initial estimates of
$V_2^{(0)} = 1.0 + j0 \, and \, V_3^{(0)} = 1.03 + j0$

(b) And keeping $|V_3| = 1.03$ pu determine the phasor values of V_2 and V_3 perform two iterations.   [8+7]
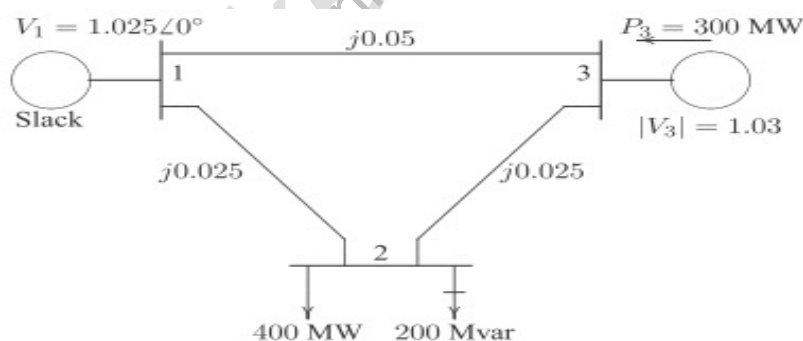

3. In the two bus system shown in fig below bus 1 is a slack bus with $V1 = 1.0\angle 0°$ P.u. A load of 150 MW and 50 MVAr is taken from bus 2. The line admittance is $y_{12} = 10\angle -73.74°$ P.u on a base of 100 MVA. The expression for real and reactive power at bus 2 is given by

$P_2 = |V_2||V_1|\cos(106.26^0 - \delta_2 + \delta_1) + 10|V_2|^2 \cos(-73.74^0)$

$Q_2 = -10|V_2||V_1|\sin(106.26^0 - \delta_2 + \delta_1) - 10|V_2|^2 \sin(-73.74^0)$

Using Newton-Raphson method, obtain the voltage magnitude and phase angle of

bus 2. Start with an initial estimate of $|V_2|^{(0)} = 1.0$ and $\delta_2^{(0)} = 0°$. Perform two iterations.   [5+5+5]

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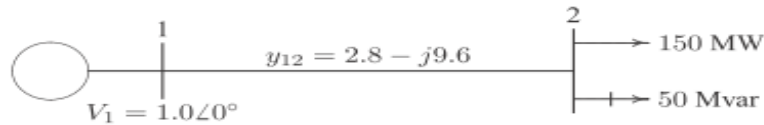
4. (a) What are the advantages of ZBUS building algorithm?

(b) $Z_{BUS}^{old} = \begin{bmatrix} 0.2 & 0 \\ 0 & 0.6 \end{bmatrix}$ find the modified Z_{BUS} if a branch having an impedance 0.4 P.u is added from the reference bus (Bus-1) to new bus? Also find the modified Z_{BUS} if a branch having an impedance 0.4 pu is added from existing bus (other than reference bus) to new bus? [8+7]

5. The one line diagram of a simple three bus power system is shown in fig below each generator is represented by an emf behind the subtransient reactance. All impedances are expressed in per unit on a common MVA base. All resistances and shunt capacitances are neglected. The generators are operating on no load at their rated voltage with their emfs in phase. A three phase fault occurs at bus 3 through a fault impedance of $Z_f=j0.19$ per unit.

(a) Using thevenins theorems obtain the impedance to the point of fault and the fault current in per phase.

(b) Determine the bus voltage and line currents during fault. [8+7]
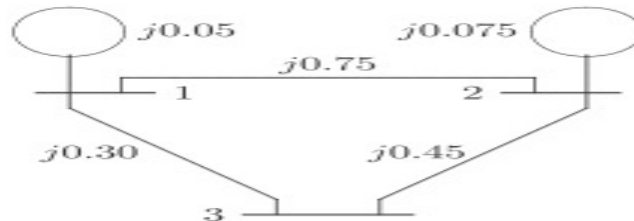
6. The line to line voltages in an unbalanced three phase supply are
$V_{ab} = 600\angle 36.87^0, V_{bc} = 800\angle 126.87^0, V_{ca} = 1000\angle -90^0$. A star-connected load with a resistance of 37 ohms per phase is connected to the supply. Determine
(a) The symmetrical components of voltage
(b) The phase voltages   (c) The line currents [5+5+5]

7. The zero, positive and negative sequence bus impedance matrices for a three bus power system are
$Z_{bus}^0 = j\begin{bmatrix} 0.20 & 0.05 & 0.12 \\ 0.05 & 0.10 & 0.08 \\ 0.12 & 0.08 & 0.30 \end{bmatrix}$ P.u and $Z_{bus}^1 = Z_{bus}^2 = j\begin{bmatrix} 0.16 & 0.10 & 0.15 \\ 0.10 & 0.20 & 0.12 \\ 0.15 & 0.12 & 0.25 \end{bmatrix}$ pu

Determine the pu fault current and the bus voltage during the fault for [4+4+4+3]
(a) A bolted three phase fault at bus 1. (b) A bolted single line to ground fault at bus 1.
(c) A bolted line to line fault at bus 1. (d) A bolted double line to ground fault at bus 1. [4+4+4+3]

8. (a) Derive an expression for the critical clearing angle for a power system consisting of a single machine supplying to an infinite bus, for a sudden load increment.

(b) A 4 Pole, 50Hz, 11kV generator is rated 75 MW and 0.86 P.f lag the machine rotor has a moment of inertia of 9000kg.m^2. Ffind the inertia constant in MJ/MVA and M constant or momentum in M-J sec/elec degree   [8+7]

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III B.Tech. II Semester Supplementary Examinations, January -2014
POWER SYSTEM ANALYSIS
(Electrical and Electronics Engineering)

Time: 3 Hours   **Max Marks: 75**

Answer any FIVE Questions
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*****

1. Draw the P.u impedance diagram for the power system shown in below fig. Neglect resistance and use a base of 100 MVA, 220kV in 50Ω line. The ratings of the generator, motor and transformers are

|			
Generator:	40MVA	25kV	X"=20%
Motor:	35MVA	11kV	X"=30%
Y-Y transformer:	40MVA	33 Y-220Y kV	$X=15\%$
Y-△ transformer	30MVA	11 △-220Y kV	X=15%
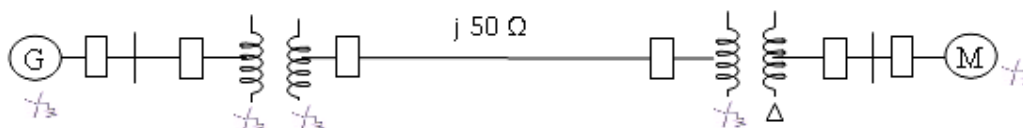
2. (a) Define the following w.r to graph theory
   (i) graph   (ii) true   (iii) tie set   (iv) cut set
   (b) Write an algorithm for Gauss Seidel method when consider all types of buses.

3. For the networks shown in below fig. Take bus 1 as slack bus. Obtain the bus voltages at the end of first ileration by using N.R method.

$$Y_{bus} = \begin{bmatrix} 3-j5 & -1.2+j6 & -1.5+j6 \\ -1.2+j6 & 4-j12 & -3+j6 \\ -1.5+j6 & -3+j6 & 5-j6 \end{bmatrix}$$

Bus number	Generation		Load		Bus voltage (P.u)
	MW	MVAr	MW	MVAr	
1	0	0	0	0	1.04 + j0.0
2	0	0	200	125	1.2 + j0.0
3	100	70	50	20	1.0 + j0.0

4. Impedances connected between various buses as follows:
   X_{10}=1.2 , X_{30} = 1.3, X_{12}=0.23, X_{23} = 0.35, X_{24} = 0.12 and X_{43} = 0.3,
   where '0' is reference bus. All impedances are in P.u. find the bus impedance matrix for the networks connecting above impedances

5. An interconnected generator reactor is shown in below figure the base values for the given percentage reactance are the rating of the individual pieces of equipment. A $3-\phi$ short circuit occurs at print F. Determine the fault current and fault MVA at F. Assume bus-bar voltage as 11kV
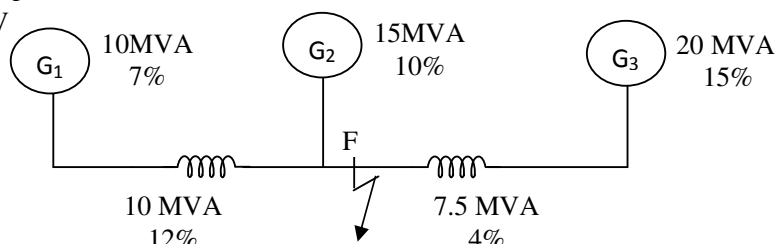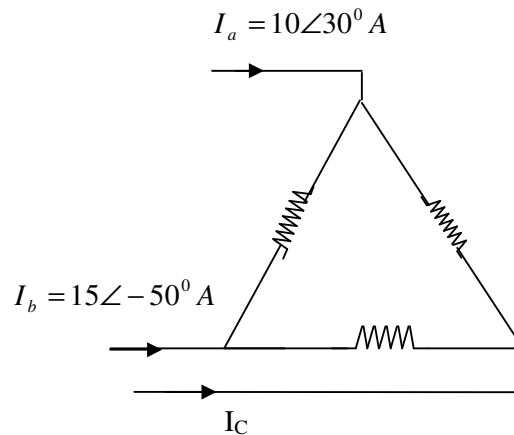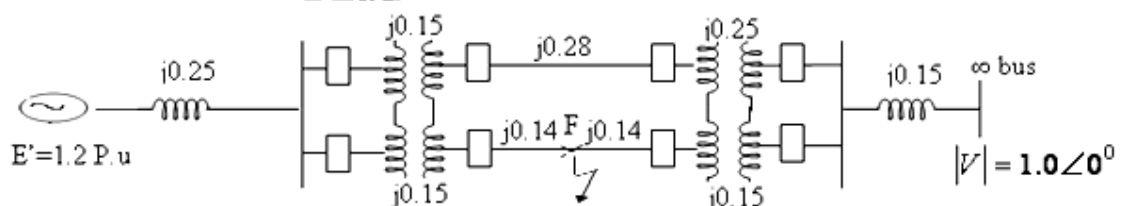
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6. (a) Derive the expression for power in terms of symmetrical components.

   (b) A delta connected balanced resisting load is connected across an unbalanced $3 - \phi$ supply as shown in below fig. With currents in lines 'a' and 'b' specified. Find the symmetrical components of the currents.

$$I_a = 10\angle 30^0 A$$

$$I_b = 15\angle - 50^0 A$$

I_C

7. An alternator of rating 10 MVA, 50Hz and has sequence reactance of 25%, 10 % and 5% to position. Negative and zero respectively. It is connected to a line of having 3 conductors of 1 CM diameter arranged triangle spacing of 4.5m side. The generator is excited to given 25kV on open circuit. Fine the current in the line when to lines are short circuited at a distance 15km long the line. Assume resistance is zero.

8. (a) Explain the steady state stability with power angle characteristics.

   (b) Find the critical clearance angle of the following system, for a $3 - \phi$ fault at the point F. The generator is delivering 1.0 P.u power under pre fault conditions

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