UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Pertama
Sidang Akademik 2003/2004

September/Oktober 2003

EEK 362 – ANALISIS SISTEM KUASA

Masa : 3 jam

ARAHAN KEPADA CALON:

Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEPULUH (10)** muka surat bercetak dan **ENAM (6)** soalan sebelum anda memulakan peperiksaan ini.

Jawab **LIMA (5)** soalan.

Agihan markah bagi soalan diberikan disut sebelah kanan soalan berkenaan.

Jawab semua soalan di dalam Bahasa Malaysia.

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1. Suatu generator sinkron kutub-tertonjol A 34.64-kV, 60-MVA, tiga fasa mempunyai suatu reaktans paksi terus 13.5Ω dan reaktans paksi kuadratur 9.333Ω. Kerintangan armatur diabaikan.

A 34.64-kV, 60-MVA, three-phase salient-pole synchoronous generator has a direct axis reactance of 13.5Ω and a quadrature-axis reactance of 9.333Ω. The armature resistance is negligible.

(a) Merujuk kepada diagram pemfasa generator kutub-tertonjol tertera dalam Rajah 1, terbitkan sudut kuasa δ.

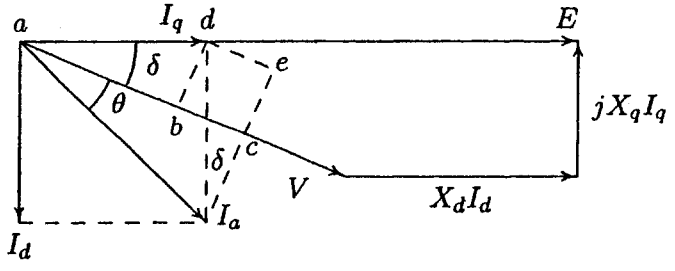
Referring to the phasor diagram of a salient-pole generator shown in Figure 1, derive the power angle δ.

(50%)

(b) Hitung sudut beban δ dan voltan eksitasi per fasa E bila generator membekalkan MVA terkadar, factor kuasa menyusul 0.8 ke bas bar infinit 34.64-kV voltan talian-ke-talian.

Compute the load angle δ and the per phase excitation voltage E when the generator delivers rated MVA, 0.8 power factor lagging to an infinite bus bar of 34.64-kV line-to-line voltage.

(50%)



Rajah 1
Figure 1

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2. Rajah 2 menunjukkan diagram satu-garis suatu system kuasa tiga bas sederhana dengan penjanaan pada bas 1. Voltan pada bas 1 ialah $V_1 = 1.0\angle 0^0$ per unit. Beban-beban berjadual pada bas 2 dan 3 ditandakan atas diagram. Impedans talian ditandakan dalam per unit di atas suatu bes 100MVA. Untuk tujuan perhitungan tangan, kerintangan talian dan susseptans mengecas talian diabaikan.

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

(a) Dengan menggunakan kaedah Gauss-Seidel dan anggaran awal $V_2^{(0)} = 1.0 + j0$ dan $V_3^{(0)} = 1.0 + j0$, tentukan V_2 dan V_3. Laksanakan dua iterasi.

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.

(50%)

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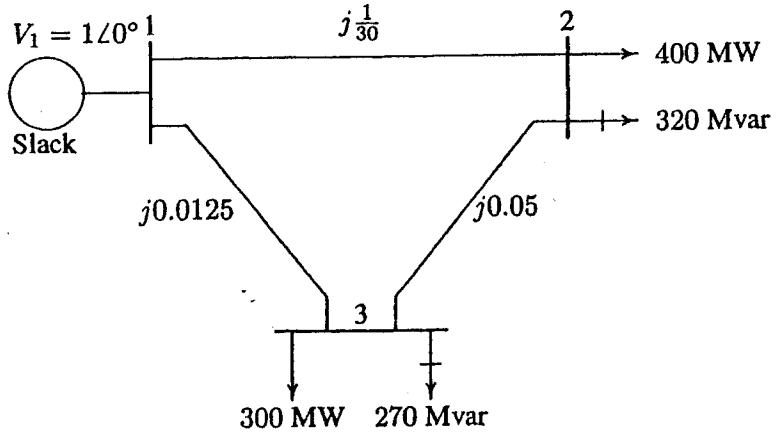
(b) Jika selepas beberapa iterasi voltan bas menumpu ke
If after several iterations the bus voltages converge to

$$V_2 = 0.90 - j0.10 \text{ pu}$$
$$V_3 = 0.95 - j0.05 \text{ pu}$$

Tentukan kuasa nyata dan reaktif untuk aliran talian dan rugi-rugi talian dan slack bus. Binakan diagram aliran kuasa dan tunjukkan arah aliran talian.

Determine the line flows and line losses and the slack bus real and reactive power. Construct a power flow diagram and show the direction of the line flows.

(50%)



Rajah 2
Figure 2

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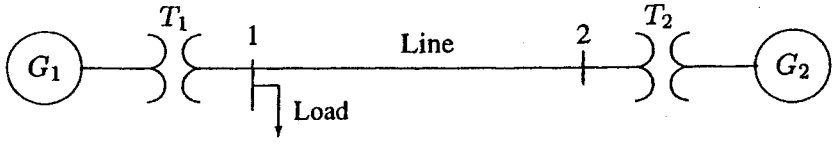
3. Lakaran diagram impedans untuk sistem kuasa elektrik yang tertera dalam Rajah 3 menunjukkan semua impedans dalam per unit atas bes 100-MVA. Pilih 20kV sebagai bes voltan bagi generator. Kuasa tiga fasa dan kadaran talian-ke-talian diberikan seperti di bawah.

Draw an impedance diagram for the electric power system shown in Figure 3 showing all impedances in per unit on a 100-MVA base. Choose 20kV as the voltage base for generator. The three-phase power and line-to-line ratings are given below.

G_1	:	90MVA	20kV	X=9%
T_1	:	80MVA	20/200kV	X=16%
T_2	:	80MVA	200/20kV	X=20%
G_2	:	90MVA	18kV	X=9%
Line	:		200kV	X=120Ω
Load	:		200kV	S=48MW + j64 Mvar

(100%)



Rajah 3
Figure 3

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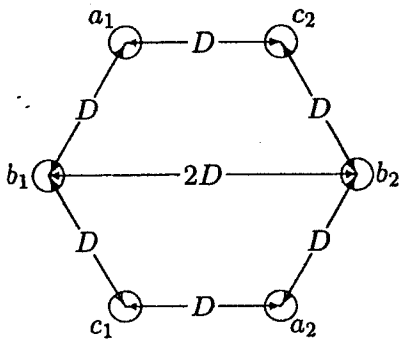
4. (a) Konduktor talian transmisi dua-litar tiga-fasa diletakkan pada penjuru segienam seperti tertera dalam Rajah 4(a). Kedua-dua litar adalah selari dan berkongsi beban seimbang sama banyak. Konduktor litar adalah identik, masing-masing mempunyai jejari r. Anggap bahawa talian ditranspos secara simetri. Menggunakan kaedah GMD, tentukan suatu ungkapan untuk kapasitans per fasa per meter talian tersebut.

The conductors of a double-circuit three-phase transmission line are placed on the corner of a hexagon as shown in Figure 4(a). The two circuits are in parallel and are sharing the balanced load equally. The conductors of the circuits are identical, each having a radius r. Assume that the line is symmetrically transposed. Using the method of GMD, determine an expression for the capacitance per phase per meter of the line.

(50%)



Rajah 4(a)
Figure 4(a)

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(b) Suatu talian transmisi tiga-fasa tak transpos dan suatu talian telefon disokong atas menara yang sama seperti dalam Rajah 4(b). Talian kuasa membawa arus seimbang 60 Hz, 200 A per fasa. Talian telefon diletakkan betul-betul di bawah fasa b. Dengan menganggap arus seimbang tiga-fasa dalam talian kuasa, cari voltan per kilometer yang diaruh dalam talian telefon.

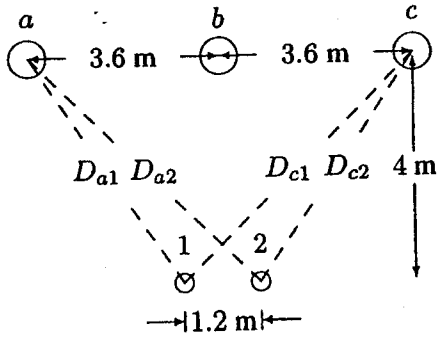
Pautan fluks luaran antara konduktor 1 dan 2 akibat arus I_a ialah

A three-phase untransposed transmission line and a telephone line are supported on the same towers as shown in Figure 4(b). The power line carries s 60 Hz balanced current of 200 A per phase. The telephone line is located directly below phase b. Assuming balanced three-phase currents in the power line, find the voltage per kilometer induced in the telephone line.

The external flux linkage between conductors 1 and 2 due to current I_a is

$$\lambda_{12(I_a)} = 0.2 I_a \ln \frac{D_{a2}}{D_{a1}} \text{ mWb/km}$$

(50%)



Rajah 4(b)
Figure 4(b)

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5. Pemalar-pemalar ABCD talian transmisi 500kV tanpa rugi tiga-fasa adalah
The ABCD constants of a lossless three-phase, 500kV transmission line are

$$A = D = 0.86 + j0$$
$$B = 0 + J130.2$$
$$C = J0.002$$

(a) Tentukan kuantiti-kuantiti hujung pengirim dan regulasi voltan bila talian membekalkan 1000MVA pada factor kuasa menyusul 0.8 pada 500kV. Untuk memperbaiki prestasi talian, kapasitor siri dipasangkan pada kedua-dua hujung dalam setiap fasa talian transmisi. Hasil daripada ini maka konstan-konstan ABCD terpampas menjadi

Obtain the sending end quantities and the voltage regulation when line delivers 1000MVA at 0.8 lagging power factor at 500kV.
To improve the line performance, series capacitors are installed at both ends in each phase of the transmission line. As a result of this, the compensated ABCD constants become

$$\begin{bmatrix} A' & B' \\ C' & D' \end{bmatrix} = \begin{bmatrix} 1 & -\frac{1}{2}jX_c \\ 0 & 1 \end{bmatrix} \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} 1 & -\frac{1}{2}jX_c \\ 0 & 1 \end{bmatrix}$$

Di mana X_c ialah reaktans total kapasitar bersiri. Jika $X_c = 100\Omega$.
Where X_c is the total reactance of the series capacitor. If $X_c = 100\Omega$.

(40%)

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(b) Tentukan konstan-konstan ABCD terpampas.
Determine the compensated ABCD constants. (30%)

(c) Tentukan kuantiti-kuantiti hujung pengirim dan regular voltan bila talian membekalkan 1000MVA pada faktor kuasa 0.8 menyusul pada 500kV.

Determine the sending end quantities and the voltage regulation when line delivers 1000 MVA at 0.8 lagging power factor at 500kV.

(30%)

6. Suatu talian 463 km panjang, 60HZ tiga-fasa 420kV dan dianggap tanpa rugi. Talian ditenagakan dengan 420kV pada hujung pengirim. Bila beban pada hujung penerima disingkirkan, voltan pada hujung penerima ialah 700kV dan arus per fasa hujung pengirim ialah $646.6\angle 90^0$ A.

A three-phase 420kV, 60HZ transmission line is 463 km long and may be assumed lossless. The line is energized with 420kV at the sending end. When the load at the receiving end is removed, the voltage at the receiving end is 700kV and the per phase sending end current is $646.6\angle 90^0$ *A.*

(a) Tentukan konstan fasa β dalam radian per Km dan impedans pusuan Z_c dalam Ω.

Find the phase constant β *in radians per Km and the surge impedance* Z_c *in* Ω.

(50%)

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(b) Reaktor unggul dipasang pada hujung penerima agar mengekalkan $|V_S| = |V_R| = 420kV$ bila beban disingkirkan. Tentukan reaktans per fasa dan Mvar tiga fasa yang diperlukan.

Ideal reactors are to be installed at the receiving end to keep $/V_S/ = /V_R/ = 420kV$ when load is removed. Determine the reactance per phase and the required three-phase Mvar.

(50%)

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