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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMANATION
SEMESTER II
SESION 2011/2012

COURSE NAME	:	ELECTRIC POWER SYSTEM
COURSE CODE	:	BEE 3243 / BEX 32103
PROGRAM	:	BEE
DATE	:	JUNE 2012
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS PAPER CONSISTS OF **EIGHT** (8) PAGES

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Q1 (a) National Grid Malaysia is fully operated and owned by Tenaga Nasional Berhad (TNB) and its power generation capacity is about 18 391 MW.

(i) Define about National Grid Malaysia

(ii) List two (2) hydro power generation stations and thermal (coal) power generation stations that are connected in National Grid Malaysia

(5 marks)

(b) The one-line diagram of a three-phase power system is shown in Figure Q1(b). The three-phase power and line ratings for the system are listed below.

G1	:	50 MVA	13.8 kV	$X = 0.15$ pu
T1	:	60 MVA	13.2/161 kV	$X = 0.10$ pu
T2	:	25 MVA	13.2/161 kV	$X = 0.10$ pu
G2	:	20 MVA	14.4 kV	$X = 0.15$ pu
Load	:	25 MVA	0.8 pf lagging	

100 MVA and 154 kV are chosen as the base values in transmission line between bus 2 and bus 3.

(i) Determine the new per-unit impedance for each component of the electrical system

(ii) Sketch a per unit reactance diagram based on the values given in Q1(b)(i)

(12 marks)

(c) The impedance diagram for a simple three-bus power system is given in Figure Q1(c).

(i) Construct the bus admittance matrix, Y_{bus}, and bus impedance matrix, Z_{bus}, of the system

(ii) Determine the fault current, bus voltages and line current during the fault when a balanced three-phase fault with fault impedance $Z_f = 0.31$ p.u occurs on bus 2

(8 marks)

Q2 (a) Suggest two (2) ways to overcome the disadvantages of the wind power generation station.

(4 marks)

(b) A three-phase, 50 Hz, completely transpose 345 kV, 200 km line has the following parameters:

$r = 0.065\ \Omega/\text{km}$
$L = 1.6$ mH/km
$C = 0.05$ uF/km

Full load at the receiving end of the line is 150MW at 0.9 pf leading and at 93% of rated voltage. By using the nominal-π model of the line:

(i) Determine the per-phase sending end voltage, V_s and sending end current, I_s
(ii) Calculate the voltage regulation of the transmission line
(iii) Compute the transmission line efficiency at full load
(iv) Determine the new voltage regulation of the transmission line when pf is 0.9 lagging
(v) Compare and give your comment about the result obtain in Q2(b)(ii), Q2(b)(iii) and Q2(b)(iv)

(21 marks)

Q3 (a) Overhead power transmission line is classified based on the range of voltages. List four (4) class of voltage of the overhead line complete with its voltage range and users.

(4 marks)

(b) A power system network is shown in Figure Q3(b). The values marked are the impedances in per unit on a base of 100 MVA. The currents entering bus 1 and 2 are:

$I_1 = 1.38 - j2.72$ pu
$I_2 = 0.69 - j1.36$ pu

(i) Produce the bus admittance diagram of the given power system network
(ii) Construct the bus admittance matrix by inspection
(iii) Using Gaussian elimination, solve the nodal equations to find the bus voltage, V_1, V_2 and V_3

(12 marks)

(c) Figure Q3(c) shows the one line diagram of a simple three-bus power system with generation at bus 1. The voltage at bus 1 is $V_1 = 1.0\angle 0^0\ pu$. The scheduled load on buses 2 and 3 are marked on the diagram. Line impedances are marked in per unit on a 100 MVA base. Assume line resistance and line charging susceptances are neglected.

(i) Calculate the admittances of the network

(ii) Using Gauss-Seidel method and initial estimates of $V_2^{(0)} = 1.0 + j0$ pu and $V_3^{(0)} = 1.0 + j0$ pu, determine the V_2 and V_3. Perform two iterations

(iii) After several iterations the bus voltage converge to:

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

Analyze the performance of the line between bus 1 and 2 by using the line flow S_{12} and S_{21}

(9 marks)

Q4 (a) Give two (2) types of instrument transformers available in power system network.

(2 marks)

(b) Write down three (3) common low voltage protection devices for over current phenomenon in power system.

(3 marks)

(c) Consider a Δ/Y-connected, 15 MVA, 33/11-kV transformer shown in Figure Q4(c) with differential protection applied. The CT ratio at the secondary side is 2000/5 A and at the primary side is X/5 A. The minimum relay current setting is i_r=1.206 A with 125% overload.

(i) Calculate the relay current during full load

(ii) Calculate the CT current on the primary side when the current on the secondary side is 3.41 A

(iii) Determine the ratio of the CT at primary side

(13 marks)

(d) Figure Q4(d) shows the radial system with fault occurs at point *F1* and *F2*. With the aid of proper diagram and explanation, propose a suitable protection scheme for the given radial system.

(7 marks)

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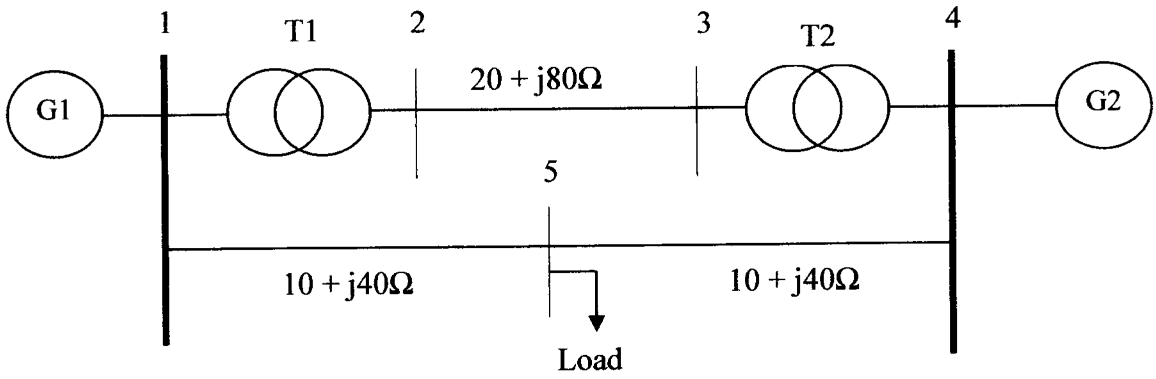

FIGURE Q1(b)

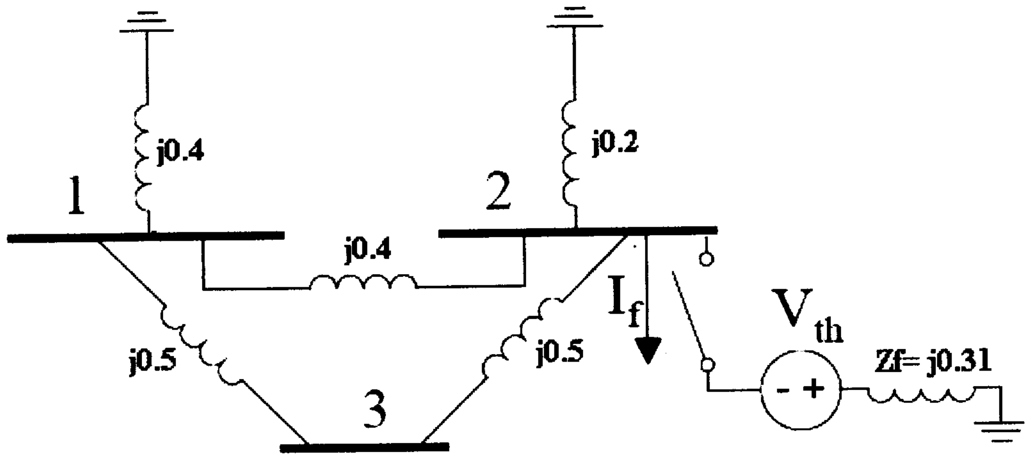

FIGURE Q1(c)

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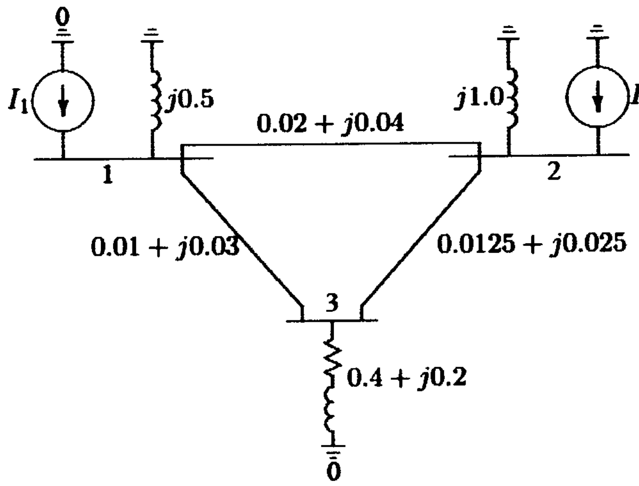

FIGURE Q3(b)

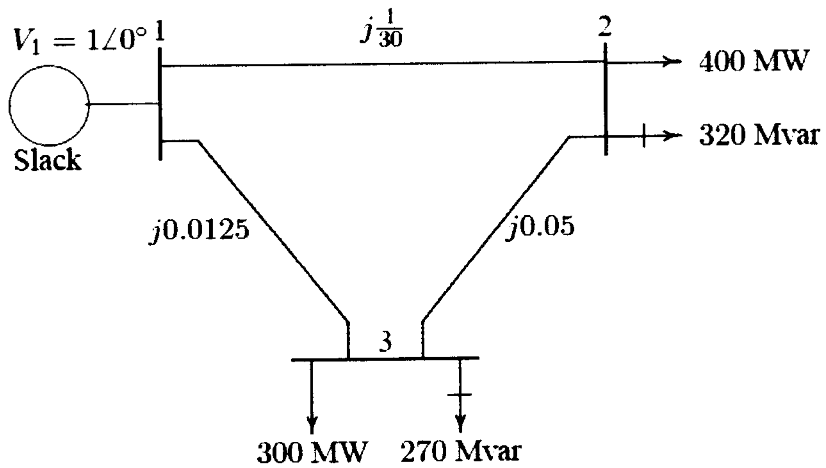

FIGURE Q3(c)

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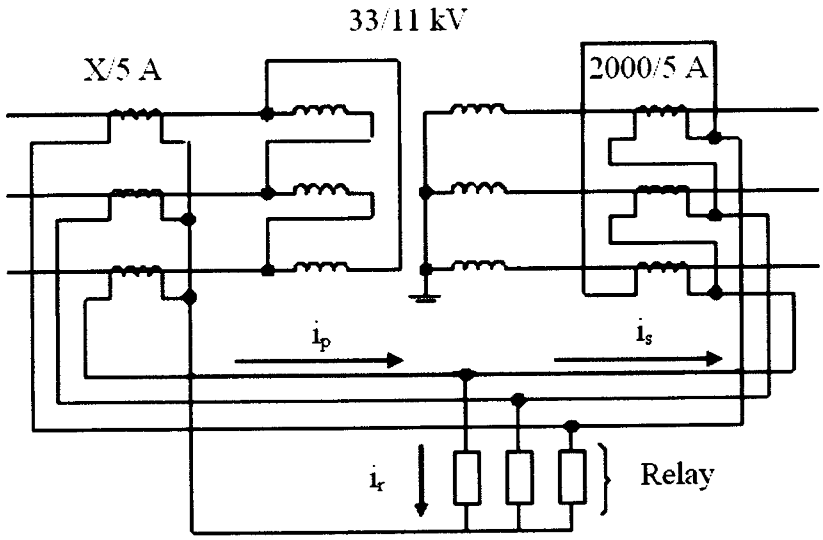

FIGURE Q4(c)

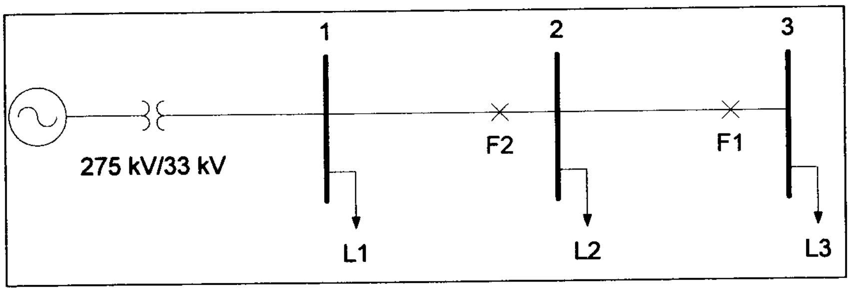

FIGURE Q4(d)

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Conversion of a given base per-unit impedance on a new base:

$$Z_{new(pu)} = Z_{old(pu)}\left(\frac{kV_{base(old)}}{kV_{base(new)}}\right)^2\left(\frac{MVA_{base(new)}}{MVA_{base(old)}}\right)$$

Short Transmission Line Equation (π – network circuit)

$$V_S = AV_R + BI_R$$
$$I_S = CV_R + DI_R$$

where:

A = 1, B = Z, C = 0, D = 1

Medium Transmission Line Equation (π – network circuit)

$$V_S = AV_R + BI_R$$
$$I_S = CV_R + DI_R$$

where:

$$A = D = \left(1 + \frac{ZY}{2}\right)$$

$$B = Z$$

$$C = Y\left(1 + \frac{ZY}{4}\right)$$

Nodal equation in matrix form

$$V_{bus} = Z_{bus}\, I_{bus}$$

Gauss-Seidel Power Flow Solution

$$v_i^{(k+1)} = \frac{\dfrac{P_i^{sch} - jQ_i^{sch}}{V_i^{*(k)}} + \sum y_{ij}V_j^{(k)}}{\sum y_{ij}} \qquad j \neq i$$