Updated: 5 Jan, 2016

Review Exercise 24(b): How do you solve this problem? For this question, should I use the matrix approach?

No, I will not use the matrix approach to solve this problem. What you need to do is to add up the reactance values of X_{T6}, X_{L3}, X_{T4} and X_{G2}. The total value of this branch should be around j1.0408 pu. Based on the symmetry nature of the circuit, the left branch will have the same reactance value of j1.0408 pu. When both the left and right branches are considered, the total reactance value is j1.0408 divided by 2 since they are connected in parallel. We would not need to add up the reactance values of T1, L1 and T2 because no current will flow through them (O.C.). Finally you compute the equivalent Thevenin impedance (jX) by paralleling j1.0408/2 and jX_{G3} (= j0.333). Next, the fault current can be computed using $I_f = V_f/jX = 1/jX$.

Review Exercise 25: I use the matrix approach. Y11= -j1.9036, Y12 = j2.1834, Y21 = Y12, Y22 = -j1.9036, to compute Zbus. Next I use If = Vf/Zff to find the receiving end current. But I cannot get the answer. Where do I go wrong? How do you solve this problem?

I would not want to use the Zbus matrix approach as it is very lengthy and unnecessary. Instead here is my solution:

I_f at receiving end = $1/Z_{series.}$ Z_{series} is simply the series impedance of the pi network in per-unit.

Tutorial 6 Q2: the answer given in the tutorial question is obtained from the pu unit current = -j2.5727 pu multiplied by a base current at the LV side. However, since the fault occurs at the HV side, I interpret as the opposite concept. Instead, I used the pu unit current = -j2.5727 pu multiplied by a base current, whereby my base current is calculated at the HV side and equals 251.022 A. So, the fault current I found is 645.8 A. Is my concept correct?

Remember that the fault current must be supplied by the generator. Even though the fault occurs at the HV side, the fault current is also fed by the generator. This question asks for the short-circuit current supplied by the generator and since the generator is connected at the LV side, you must use the base current at the LV side to compute the actual fault current. If the question asks for the short-circuit current supplied by the HV side of the transformer, then what you have computed would be correct.

Tutorial 6 Q2:
Using Vb = 13.4 kV, Sb = 60 MVA
per unit quantities,
Zg = 0.23289j
Zt = 0.15j
Ib = 2585.2 A

If,pu =-2.6117j
If = 6751.8 A
Vt = 5.25 kV

Using Vb=13.2kV, Sb = 60 MVA
per unit quantities,
Zg = 0.24j
Zt = 0.152j
Ib = 2624 A

If pu=-2.55j
If = 6693A
Vt = 5.28 kv

I wonder why these two answers differ and why they are different from the given tutorial solution.

In your first set of answers, if you choose Vb = 13.4 kV, then E = Vt at no load = 13.2 kV can no longer be at 1 pu. Hence, when you compute your fault current you must divide E at 13.2/13.4 pu by the combined impedance.

In your second set of answers, it appears that Zt = 0.152j is incorrect. It should be 0.15468j. Please check.

Realising that, for question 6.2 and 6.3 of tutorial 6, there was not much emphasis placed on these 2 portions of lecture (Namely, Fault Analysis using Vth, and current limiting reactors). As a matter of fact, I did not recall you going through these 2 sections. I was wondering if, it is sensitive for me to ask about the importance of the 2 sections as above, and consequently, the 2 questions in tutorial 6.

The concept used in Q6.2 is simply the per-unit ohm's law, i.e. E/j(Xs + Xt). The concept in Q6.3 is the Thevenin's theorem. We have covered the derivation of driving-point impedance matrix using the Thevenin's concept in Appendix D. To relate what you have learned from Circuit in Year 2 or Year 1, I have told the class that the driving-point impedance is actually the Thevenin's impedance. Hence if you do not wish to set up the impedance Z matrix, you could use the Thevenin's concept that you learned from Year 2 to figure out the driving-point (Thevenin's) impedance. This is done by replacing the voltage source by a short and the equivalent impedance looking into the 2-port network can be obtained by using the series and parallel impedance formulae.

May I know what actually does a 'fault' mean? Does it mean that particular section of the bus is short-circuited?

Yes, in our case we assume only balance three-phase fault.

The notes did not say much about this, I only got this reasoning implied from the tutorials.

Please see page 143, under three-phase symmetrical faults, last few words "(which we shall study)". Please see also page 144 for the diagram of three-phase faults.

Review Exercise 24 c) What is the MVA supplied by each generator under the conditions of the part(b) above? I have solved this question by Zbus matrix method but I have difficulty in attempting this part of the question using Thevenin's theorem. Can give me some pointers?

If you are able to get the fault current from part (b), then you should have If = 4.9219 pu (Magnitude only). The fault current If contributed by G3 is 1/j0.333 or 3 pu (Magnitude only). The fault current If contributed by G2 or G1 is 1/j1.0408 or 0.9608 pu (Magnitude only). Next you need to multiply each If contribution by each generator by Sb. This should be the MVA supplied by each generator since the pre-fault voltage is 1 pu.

Review Exercise 25: How do we find Is in this question? Is it equal to c Vr + D Ir?

Yes, you could use Is = C Vr + D Ir. Since Vr = 0 due to SC at the receiving end, Is = D Ir. Ir = (Vs,phase)/Zline if you use actual quantities or Ir, pu = (Vs,pu)/Zline,pu if use pu.

Tutorial 6 Q3: you derived the answers by using the Thevenin's method. In class you mentioned that the Zbus matrix method could also be used to solve it. I'm unsure on how to go about solving the question thru the Zbus method. How am I supposed to formulate the Y matrix from the diagram? Will it only be a 2X2 matrix with busbar A and B being the 2 terminals? I hope you can shed light into this little confusion.

Yes, you could set up the Ybus matrix. Its values are: Y11 = -j(5/3 + 1/X); Y12 = Y21 = j1/X; Y22 = -j (5 + 1/X). From here, invert Ybus to obtain Zbus. Z11 should be a function of X. Set Z11 = 0.4 and solve for X.

There is one question on Faults Analysis which I would like to seek your clarification. Why is it that when we are forming the Y Matrix, Yni = -yni, ie, why do we have to negate yni?

The details are given in Appendix D2. In the derivation of I1, we group the V coefficients into two categories Y11 and Y1i where i = 1, n. You can see that Y11 = y11 + y12 + y13 + ... y1n while Y1i = -y1i for i not equal to 1. Hence, we conclude that the off-diagonal Y element is obtained by negating y.