Menoufia University
Faculty of Engineering
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Department of Electrical Engineering
Course Title: Analysis of Electric Power Networks
Post-Graduate (M. Sc degree) Examination

Time Allowed: 3 Hours
Total Marks: 100
Date: 13 / 6 / 2015

ANSWER THE FOLLOWING QUESTIONS:

1- a) For a given power system define each of the following items: Voltage stability and voltage instability ---- Voltage drop and voltage collapse – a voltage stability criterion.

1- b) A constant impedance load $Z_L\angle\varnothing_L$, is supplied, through a radial feeder its impedance $Z_f\angle\varnothing_f$, from a large generator its constant terminal voltage is given as, $E_S\angle 0$. Let the load impedance value to be increased from zero to infinity, and sketch the load current, voltage, and power to the base of the load impedance value. Then prove the condition under which the connected load receives its maximum power, and deduce the equation by which that power can be computed.

1- c) A loading center is fed from a constant voltage bus, as shown in Fig.1. When the load power facto is kept constant at the value **0.92 lag**, Plot the P_L-V_L characteristic (take the power step of **0.10** pu). Then,

i- Find the load power margin when the voltage regulation at the load terminals equals **5 %**.

ii- When the load is represented by the constant impedance **Z_L= 0.45∠23.07°**, does the load maintain its voltage stability? If NO, give the reason.
Next find the load impedance value for which the load voltage stability is critical.

Now, when one of the two lines connecting buses "2" and "3" is opened, without a fault, and the load receives the constant power of the value **0.25** pu, with **0.92 lag** power factor, construct the Q_L-V_L characteristic (start with Q= **0.09** pu, and take **0.04** pu, as a reactive power step). Then,

i- Find the reactive power needed to be injected when the voltage regulation at the load terminals equals **4.0** %.

ii- Find the least injected reactive power needed for transmitting the given load, and the corresponding voltage regulation at the load terminals.

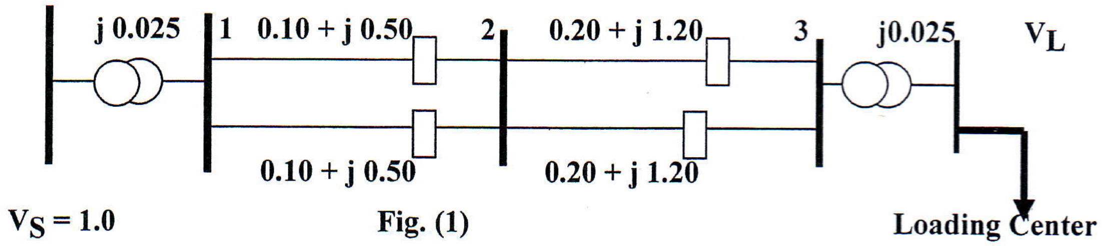

Fig. (1)

2-) A synchronous generator is connected through a double-circuit transmission system to a large power system, which is represented by an infinite-bus, as shown in Fig.2. Construct the generator pull-out curve. Then,

i- Find the generator steady-state stability limit (SSSL), and its corresponding apparent power.

ii- When the generator operates with power factor **0.79 lag**. find the generator largest active and reactive delivered powers. Can the generator deliver the obtained active power value with a leading power factor ?

iii- When the generator operates with power factor **0.90 lead**, find the generator largest delivered active power. Then for the obtained power value, find the generator corresponding delivered reactive power when it operates with power factor **0.85 lag**. Compare between the generator delivered apparent power values for the given two power factor values. Comment on the result.

iv-Prove that the generator cannot deliver the active power of 2.60 pu, with 0.97 lead power factor.
Then find the generator terminal voltage needed to deliver this power value. Construct the generator new pull-out curve, and find the generator largest delivered active power with unity power factor.

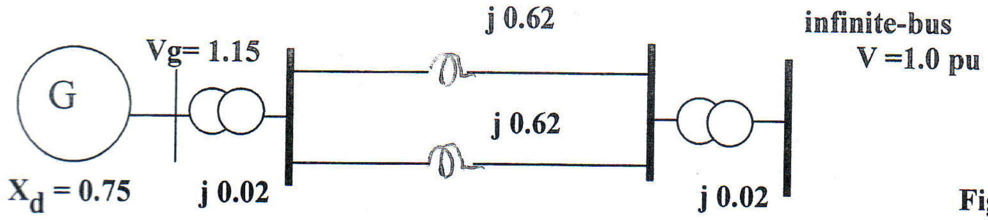

Fig.(2)

3– a) Discuss briefly each of the following items:
Power system reliability ---- Power system monitoring ----The power system network sensitivity factors.

3– b) The 3-bus sample power system, shown in Fig.3, is considered.

i- Assume that the output power for the generator connected at bus "1" is decreased to the value **0.80** pu, calculate each of the following factors: $\alpha_{1\text{-}3,1}$, and $\alpha_{2\text{-}3,1}$

ii- Calculate each of the factors: $d_{1\text{-}3,1\text{-}2}$, and $d_{2\text{-}3,1\text{-}2}$

3– c) For a given power system the following factors are given: $\alpha_{2\text{-}4,2} = +0.31$, and $\alpha_{2\text{-}4,3} = +0.22$. Apply the generation shifts to decrease the power on the system line connecting buses "2" and "4" from **33.1** MW, to **26** MW. The steady-state generators output powers are: Pg_2 = **50** MW and Pg_3= **60** MW. The power limits for the generators are **37.5** MW $\le Pg_2 \le$ **150** MW and **45** MW $\le Pg_3 \le$ **180** MW.

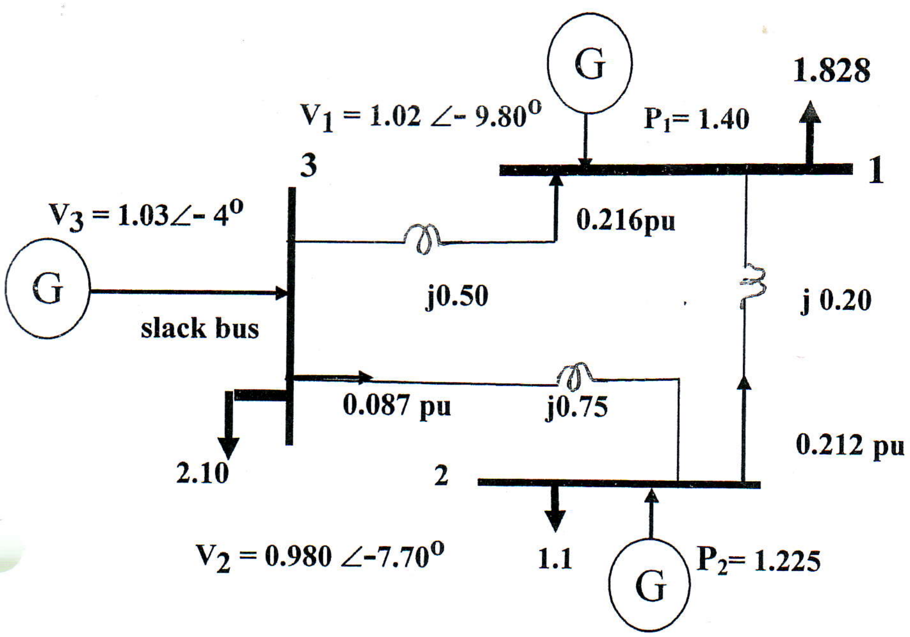

Fig (3)

4– a) Discuss, briefly, each of the following items:

i- Characteristic harmonics, and zero-sequence harmonic currents.

ii- Five effects of power systems harmonics. **iii**- Four techniques used for harmonic suppression.

iv- Series and shunt harmonic filters.

4– b) Two coils of the resistances **6** ohm and **4** ohm, and inductances **0.015** H and **0.005** H, respectively, are connected in series, and fed from an AC supply its voltage is given as,

$$e(t) = 100 \sin(314t) + 17 \sin(942t) + 11 \sin(1570t).$$

1- Find the circuit instantaneous current equation. 2- Compute the active power loss in each coil.

3 - Compute the supply current and voltage total harmonic distortion indices.

4– c) A 12-pulse converter load of the **40** MVA, rated power with power factor **0.85** lag, is connected to a 132 kV, 50 Hz, supply. Find the capacitance needed to improve the load power factor to **0.950** lag.

It is found that the converter generated 11th harmonic current exceeds the standard limit, and it is required to eliminate this current by using a single-tuned shunt filter. Design the filter needed elements values. Given the filter coil and the designed filter quality factors to be **100** and **40,** respectively.