Menoufia University
Faculty of Engineering
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Department of Electrical Engineering | **Time Allowed: 3 Hours**
Course Title: Analysis of Electric Power Networks | **Total Marks: 100**
Post-Graduate (M. Sc degree) Examination | **Date: 18 / 1 / 2015**

ANSWER THE FOLLOWING QUESTIONS:

1 - a) Define each of the following items:

Monitoring of a power system ---- Power system reliability and security ---- The power system network sensitivity factors.

1- b) The three-bus sample power system, shown in Fig.(1), is considered. Assume that the generator delivered power Pg1 is increased to the value 2.50 pu, calculate each of the following factors: $\alpha_{1\text{-}2,1}$, and $\alpha_{1\text{-}3,1}$. Also, calculate the system factors $d_{1\text{-}3,1\text{-}2}$, and $d_{1\text{-}2,2\text{-}3}$

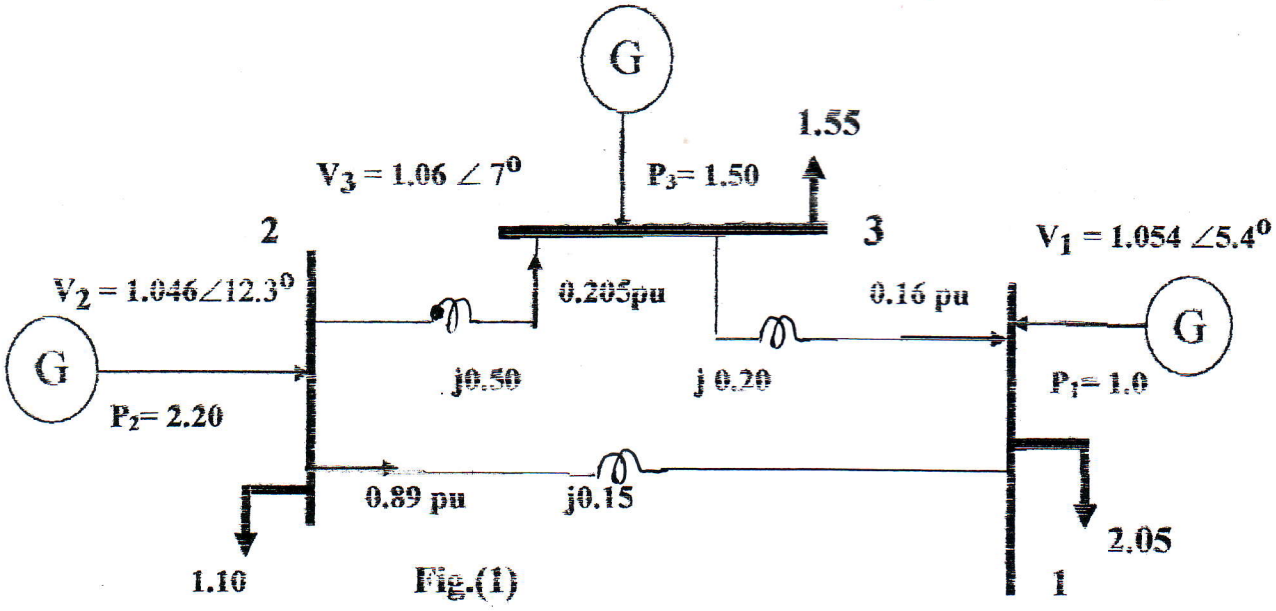


Fig.(1)

1 -c) It is considered a 6-bus power system, for which the following factors are determined:
$\alpha_{1\text{-}4,2} = -0.31$,and $\alpha_{1\text{-}4,3} = -0.29$.
The upper and lower generation limits are 37.5 MW $\leq P_{g2} \leq$ 150 MW and 45 MW $\leq P_{g3} \leq$180 MW. The steady-state generator output powers are: P_{g2}= 50 MW, and P_{g3}= 60 MW.

Show how can the power flow on the line connecting buses "1" and "4" be increased from 43.6 MW to 51 MW.

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

2- 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. Sketch the load current, voltage, and power to the base of the load impedance value. Then prove the condition under which the feeder connected load receives its maximum power, and deduce the equation by which that power is computed.

2– c) An electrical load is fed, through a transmission system, from a large power system which is represented by an infinite-bus, as shown in Fig.(2).When the load power factor is kept constant at *0.80 lag*, plot the P_L - V_L characteristic (take 0.05 pu, as a power step).

i- When the voltage regulation at the load terminals equals 4 %, find the load power margin.

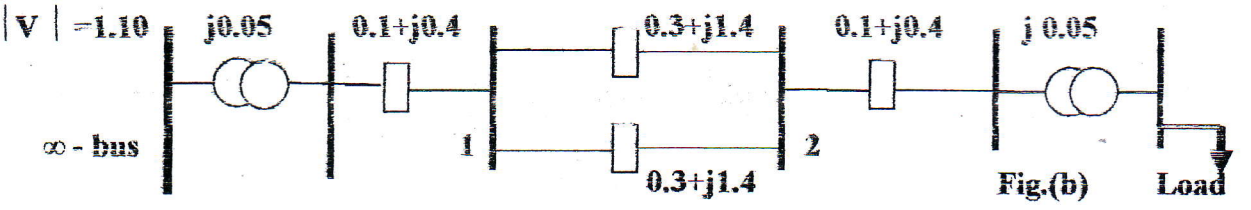
ii-Let the connected load to be represented by a constant impedance its angle is 36.9 deg. Find the load impedance value when the voltage across its terminals equals 0.90 pu. Also, find the load impedance value for which the voltage stability is critical.

iii- Let one of the two lines connecting buses "1" and "2" to be switched off (may be due to a routine maintenance), plot the P_L-V_L characteristic. Then assume that the load of the impedance $Z_L = 1.90/36.9^{o}$ was connected before the line isolation, does the load keeps its voltage stability after switching-off the considered line? If NO, give the reason.

Now, for the considered system construct the Q_n - V_L characteristic (start with Q = 0.09 pu, and take 0.05 pu, as a reactive power step), assuming the constant power load of the value 0.25 pu, to be connected with the system. Then, find:

1- The reactive power needed to be injected when the load voltage regulation equals 5%.

2- The load critical voltage. 3- The load voltage when the power factor at its bus is the unity.



3- a) Discuss each of the following items :

1- Characteristics and non-characteristic harmonics --- Zero-sequence harmonics and inter-harmonics.

2- Six effects of a power system harmonics

3- Five harmonic sources.

4- Five techniques used for a power system harmonic suppression.

3– b) An AC supply for which the instantaneous voltage is given as,

$$e(t) = 1000 \sin(314\,t) + 220 \sin(942\,t + \pi/3) + 90 \sin(1570\,t + 5\pi/6) + 35 \sin(2198t + 7\pi/6)$$

is applied to a series circuit consists of a 20 ohm resistor, a 10 mH inductance, and 200 μF.

Find :

1- The instantaneous voltage across each of the circuit three elements.

2- The circuit active power loss.

3 - The total harmonic distortion factors for the circuit current and voltage.

3- c) A bus-bar of 50Hz, 10 kV line-to-neutral supplies a six-pulse converter load , whose apparent power is equal to 78,1 MVA with power factor 0.77 lag. For improving the converter power factor to 0,95 lag, a shunt capacitor is used.Find the needed capacitor capacitive power.

Let the capacitor capacitance to be equally divided among a fifth-order and seventh-order single-tuned two filters. Design the elements of the considered two filters. Take the filter quality factor Q_f = 40 and the coil quality factor Q_c= 100. What is the value of the external resistance needed to be connected with each filter?