Power Systems-EE309

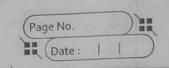
Assignment 5

Group Members:

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Question1

| E E | (1 osec) 22 | Page No. Date: |
|----------|---|--|
| (D) | Conven: 212 = 0.12+j0.16 | a distributed to the |
| | y12= 1 = (3-4j)== | = 5 \(-53.13° |
| (2102 - | 22 LANT 01 + (2+ 1- 78 201) 20 NEW | en- |
| | Lead power => part - 100 MW. | |
| | Qact = -50 MVAR. | - 05 - 15 - 15 - 15 - 15 - 15 - 15 - 15 |
| | Sout = - (100 + 50j) MUR | +. |
| ec.s | $S_{i}^{act} = -(100 + 50i) = (-100)$ | 1-0.5j) pu |
| | Using Newton Raptison method, | Conf one |
| | 12 = 5 V2 V1 cos (126.87° - 62+81) Q2 = -5 V2 V1 sin (126.87° - 52+81) | $1 + 5 v_1 ^2 \cos(-53.13^\circ)$ $1 - 5 v_2 ^2 \sin(-53.13^\circ)$ |
| | $V_1 = 1 \angle 0^{\circ} pu$ $ V_2^{(0)} = 1 \delta_2^{(0)} = 0.0$ | |
| . 3) | $R_{2}^{(6)} = 5(1)(1) \cos(126.87^{\circ}) + 5(1)$ | |
| | $Q_{\chi}^{(0)} = -5(1)(1) \sin((26.87^{\circ}) - 5($ | |
| | SP2 = Pact - P2(0) = -1-0 = | -1 pu |
| | $\Delta q_{\chi}^{(0)} = Q_{\chi}^{(0)} = Q_{\chi}^{(0)} = -0.5 - 0$ | = -0.5 pu |



& elements of Jacobian matrix)

$$J_{11} = \frac{\partial P_2}{\partial S_2} = \frac{5}{5} |V_2| |V_1| \sin(126.87^2 - S_2 + S_1)$$

$$J_{R} = \frac{\partial P_{2}}{\partial N_{4}} = \frac{5|V_{1}| \cos(126.87^{\circ} - 52 + 51)}{600} + \frac{10|V_{2}| \cos(-53.13^{\circ})}{100}$$

$$J_{1} = \frac{\partial Q_{2}}{\partial S_{2}} = +0 5|V_{2}|V_{1}| \cos(126.87^{\circ} - S_{2} + S_{1})$$

$$J_{22} = \frac{\partial Q_{\perp}}{\partial N_{2}} = -5 N_{1} \sin(126.87^{\circ} - 5.45_{1}) - 10 |V_{2}| \sin(-53.13)$$

For 1st iteration,

$$J_{11}^{(0)} = 5(1)(1) \sin(126-87^{\circ}) = 3.99.$$

$$J_{R}^{(0)} = 5(1) \cos(126.87^{\circ}) + 10(1) \cos(-53.13^{\circ}) = 3.$$
 $J_{R}^{(0)} = 5(1)(1) \cos(126.87^{\circ}) = -3.$

$$J_{22}^{(0)} = -5(1)$$
 sin $(26.87^{\circ}) - 10(1)$ sin $(-53.13^{\circ}) = +3.99$

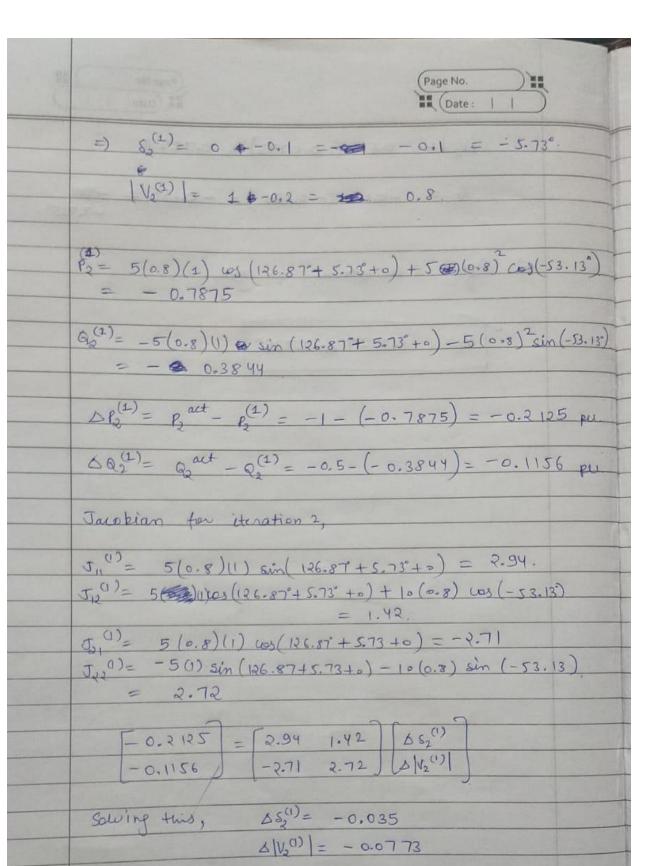
For 1st iteration, set of linear eg =)

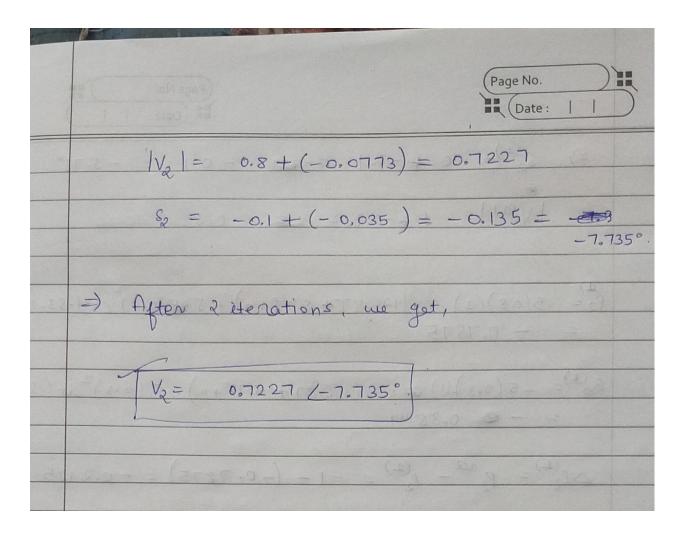
$$\begin{bmatrix} -1 \\ -0.5 \end{bmatrix} = \begin{bmatrix} 3.99 & 3 \\ -3 & 3.99 \end{bmatrix} \begin{bmatrix} \Delta S_2^{(0)} \\ \Delta | V_2^{(0)} | \end{bmatrix}.$$

Solving this,
$$\Delta S_2^{(0)} = -0.1$$
.
$$\Delta |V_2^{(0)}| = -0.2$$

$$S_{2}^{(1)} = S_{2}^{(0)} + \Delta S_{2}^{(0)}$$

$$|V_{2}^{(1)}| = |V_{2}^{(0)}| + \Delta |V_{2}^{(0)}|$$





Question 2

Final results:

```
Y =
```

```
0.8824 - 3.4994i -0.2941 + 1.1765i -0.5882 + 2.3529i 0.0000 + 0.0000i -0.2941 + 1.1765i 0.8627 - 3.0276i -0.3333 + 1.0000i -0.2353 + 0.9412i -0.5882 + 2.3529i -0.3333 + 1.0000i 1.2157 - 4.4694i -0.2941 + 1.1765i 0.0000 + 0.0000i -0.2353 + 0.9412i -0.2941 + 1.1765i 0.5294 - 2.0576i
```

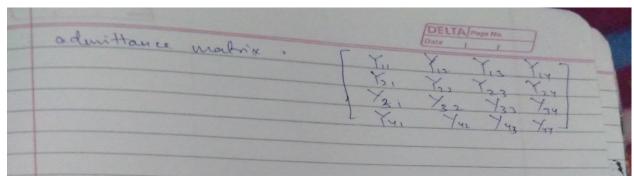
M =

```
3.6089 1.2127 2.4254 0
1.2127 3.1482 1.0541 0.9701
2.4254 1.0541 4.6318 1.2127
0 0.9701 1.2127 2.1247
```

Ph =

Theoretical Calculations

| 00 | | | DELTAMAN |
|------------|-----------------|-------------------|---------------|
| 00 | | 8.01+50 | 10.02 |
| | 2-3 | 03 + 10.9 | 10.03 |
| | 2-4 | 1 250 | 1004 |
| | 3-4 | 0.2 + 70.8 | je er |
| T. 0. | 1-3 | 0.1 4 90.4 | 3001 |
| - supertir | or metter d - | | - |
| | Au. Au. | 1 = 1 = = | 0.29-11.17 |
| | | Z12 0-20jo-8 | |
| | | | |
| | Jes : 733 0 | 1 - 1 - 3 | 0.33- |
| | | 3 23 03-10-3 | |
| | Jan . Jus . | 1.1 | 10-23-10-94 |
| | | 5-24 0-25 4) | |
| | 24 " Y24 | - - | , 0.29- 11.19 |
| | | 234 0.3+10+ | |
| | Y = 9 = = | 1 - 1 | 1 0-52-102-31 |
| | 20 | 213 0-1-10-4 | |
| | | | |
| | Diagonal: | | |
| | T Y. | + 912 + 91 " 0.8= | 1-3.49; |
| | 3" 4 | + 7-2 - 7-7 . 0 | 85 -3.021 |
| | 722 721 | 103 px 13 | 1.58 - 4.46; |
| | 33)3 | - Jan Jan Ja | 52 - 2.05: |
| | * 44 y | 4 24 24 2 = 0 | |
| | | | 100 |
| | of digonal | elements. | |
| | - | | |
| | V , Y | , - 1/12 = - 6 | 29+117 |
| | Y > Y > 2 | | 0.33 + 1 |
| | 123 > 132 | -2.23.2 | 10.99 |
| | Y24 2 940 | 2 -0.23+ | 1/13 |
| | Y 24 2 Y45 | 2 -0.51- | |
| | Y 2 = 13 | 0.58 Lj. | 2-3) |
| | 13 | J | |
| | | | |
| | College College | | |



We have verified our results by using intuitive method and theoretical calculation for the same is given.

Question 3

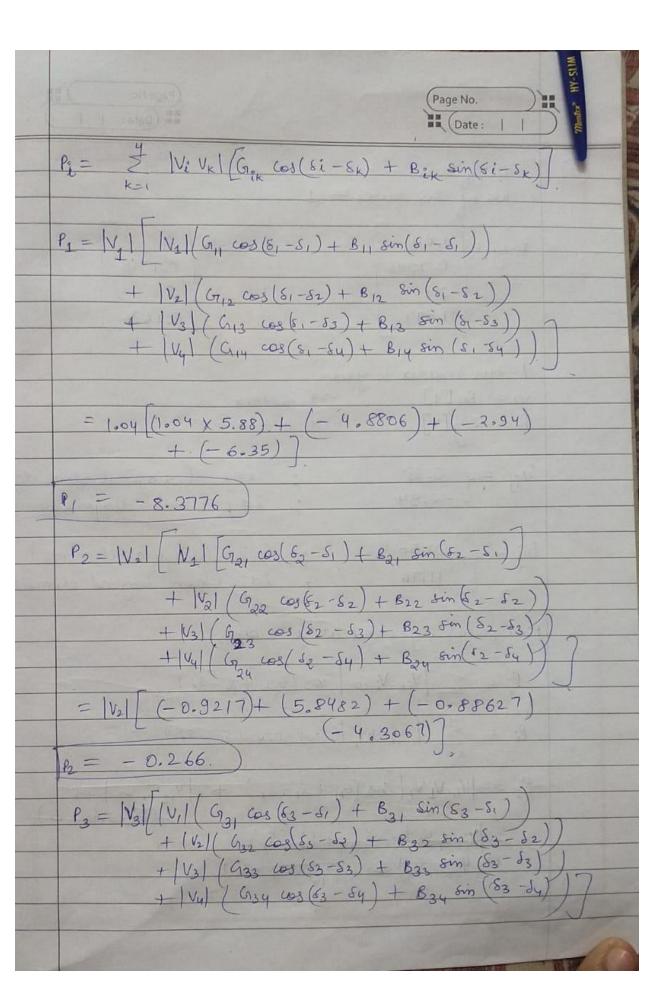
Final result:

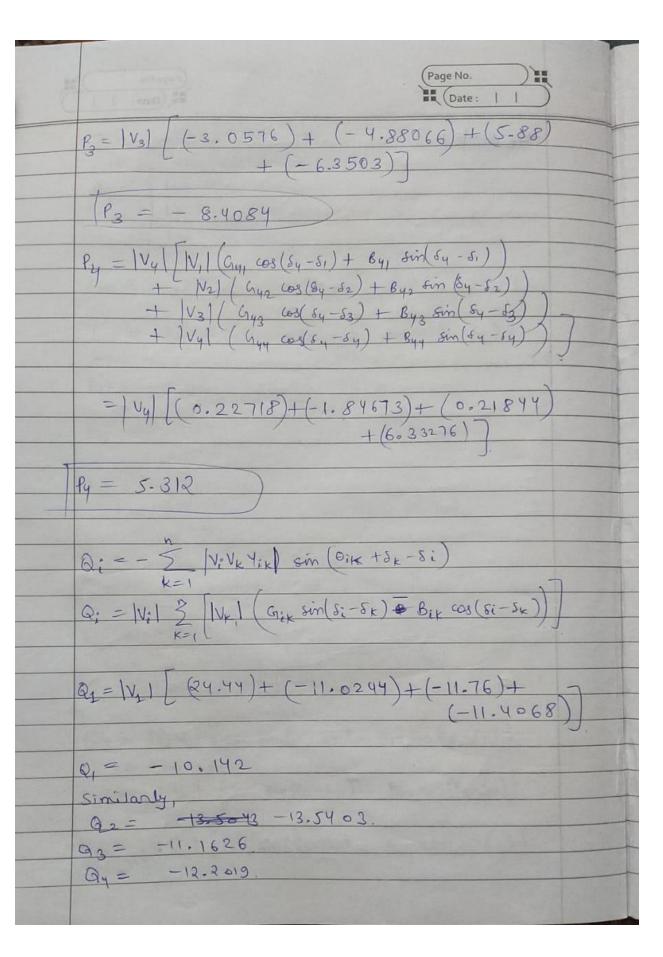
Jacobian Matrix =

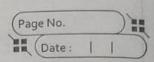
[36.7888 -12.0246 -12.2586 -4.2842 -11.0250 34.6626 -11.4072 -6.3504 -12.8325 -13.0536 39.4619 12.1328 1.9886 -0.2352 -1.5088 15.0581]

Theoretical Calculation:

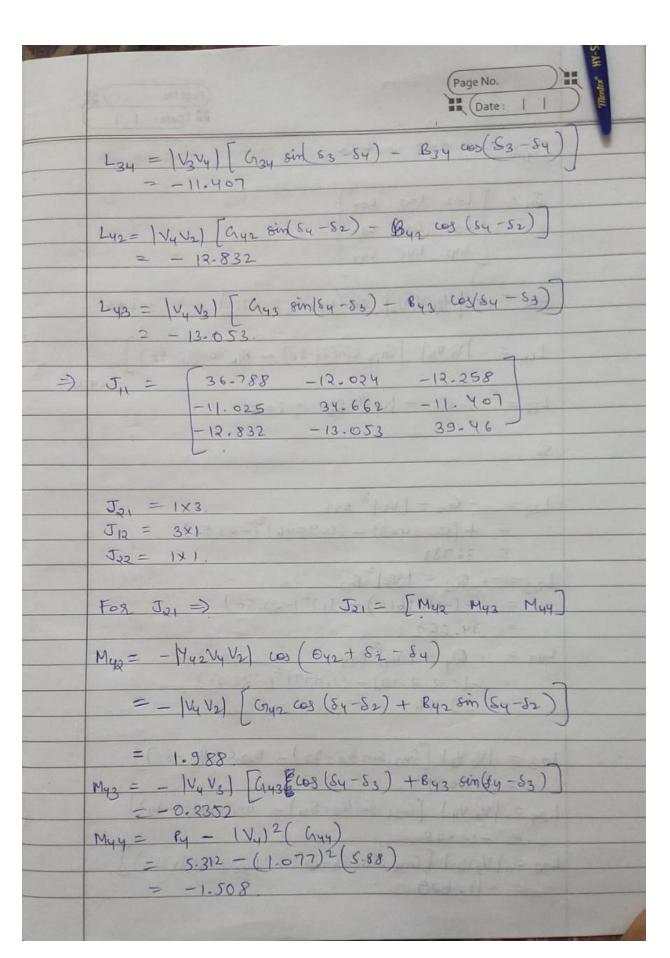
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|---|---|---|--|--|
| 3 | No of buses = 4 | | | |
| | Vmag = (1.04) delta = 0.9946 | 0.2630 | | |
| | Y-bus matrix is given. G7 = Re [Y]. 4XY matrix. B = Imp[Y]. 4XY matrix. | (diagonal elements) (non-diagonal elements) | | |
| | Bij = $\begin{cases} -23.50 \\ 11.76 \end{cases}$; $i = j$ (diagonal elements) Real power injected at ith bus, $P_i = \begin{cases} \frac{\pi}{2} & \text{Yik ViV}_k & \cos(\theta_{ik} + \delta_k - \delta_i) \end{cases}$ | | | |
| | $P_{i} = \begin{cases} Y_{ik} & \text{viv}_{k} \\ X = 1 \end{cases} $ $V_{ik} & \text{viv}_{k} \end{cases} cos (0 i k + 5 k $ | | | |







Ju= 2×3 matrix. L22 L23 L24 L32 L33 L34 Lyz Lyz Lyy Lik = - | Yik ViVK sin (Oik + 8x-Si) ; i+k. Lik = | Vi VK) [Gik sin(8i-SK) - Bik cos (8:-SK) · i + k Li = -Qi - |Vi|2 Bi ; i=K. Las = -Q2 - [V2] 2 822 $=+(13.5403)-(0.9946)^{2}(-73.50)$ = 36.788. 33 = - Q3 - \V3 |2 B33 $= -(-11.1616) - (1)^{2}(-23.50)$ 34.662 249 = - Qy - 1 Vy Byy $= -(-12.2019) - (1.077)^{2}(-23.50)$ = 39.46. Log = | V2 V3 | [C22 Sin (82-83) - B23 COS (85-83) = -12.024 L24 = 1 /2 /41 [G24 sin (82-84) - B24 cos (82-84) = -12.258.L32 = 1 V3 V2 1 [(n32 sin (83-52) - B32 808 (53-52) = = 11,025



| | Page No. | - |
|----------|---|---|
| | J12 = [-4.2842] | |
| | -6.3504 | |
| | 12-132 | |
| | - Later Cart and | |
| 7 | 522 3 [IXI] = [044] | |
| | $O_{44} = O_{44} - V_4 ^2 B_{44}$ $= (-12.2019) - (1.077)^2 (-23.50)$ | |
| | = 15.057. | |
| | | |
| | 10 A | 0 |
| 7 | Jacobian - matrix = J11 J12 | |
| | [J2, J22] | |
| | Torobine this = | |
| | Jubean mains | |
| 100 E. T | in Tell man and a contract of | |
| | 2/ 700 12-24 -12250 =4-2842 | |
| | 36-788 -12.024 -12.258 -4.2842 | |
| 40.3 | 36-788 -12.024 -12.258 -4.2842 -11.025 34.662 -11.407 -6.3504 | |
| 35.3 | 36.788 -12.024 -12.258 -4.2842 -11.025 34.662 -11.407 -6.3504 -12.832 -13.053 39.46, +12.132 | |
| 35.3 | 36-788 -12.024 -12.258 -4.2842 -11.025 34.662 -11.407 -6.3504 | |
| 30.3 | 36.788 - 12.024 - 12.258 - 4.2842 $-11.025 34.662 - 11.407 - 6.3504$ $-12.832 - 13.053 39.46 + 12.132$ $1988 - 0.2352 - 1.508 15.057$ | |

> No assumptions are made, only given data is used in all the questions.

Conclusion:

Newton-Raphson method is useful to calculate the voltages of all the buses in the power system after a certain number of iterations to converge the del(P) and del(Q) values to 0 or a very small number. Once knowing the bus voltages, we can have an overall idea of the load power flow in the system.