Islamic University of Technology

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Student ID : 220021108

Section : A- 2

Department : Electrical & Electronic Engineering

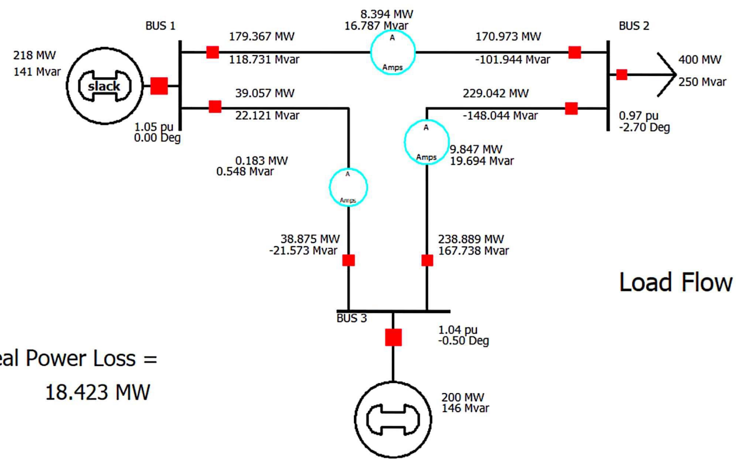
Course No : EEE 4402

Course Name :Power System II Lab

Experiment No : 04(part-02)

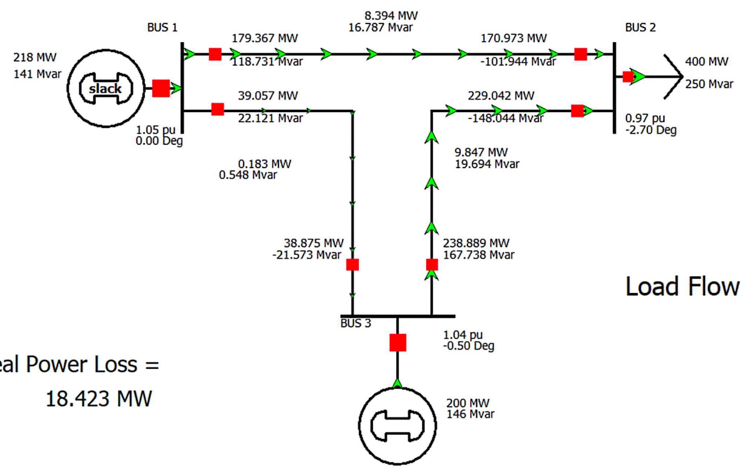
Experiment Name: Load Flow Study by Power World Simulator

Date of Submission : 31.08.2025



Load Flow Analysis for 3 BUS
Assingment - 01

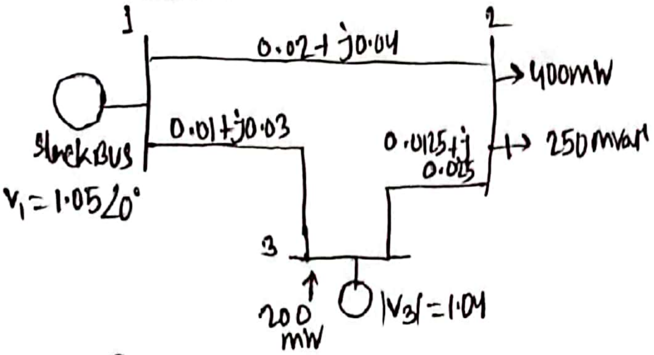
Total Real Power Loss =
18.423 MW



Load Flow Analysis for 3 BUS
Assingment - 01

Total Real Power Loss =
18.423 MW

Assignment-01:



$$Y = \begin{bmatrix} y_{12}+y_{13} & -y_{12} & -y_{13} \\ -y_{21} & y_{23}+y_{12} & -y_{23} \\ -y_{31} & -y_{32} & y_{13}+y_{23} \end{bmatrix}$$

where, $y_{12} = y_{21} = 10 - j20$

$y_{13} = y_{31} = 10 - j30$

$y_{23} = y_{32} = 16 - 32j$

$$S_2^{sch} = \frac{-(400 + j250)}{100} \text{ p.u}$$

$$= -4 - j2.5 \text{ p.u}$$

$\therefore P_2^{sch} = -4$ pu.

$Q_2^{sch} = -2.5$ p.u

[load bus]

Bus-1 is taken as the refence (slack bus)

$V_1 = 1.05\angle 0^\circ$

$P_3^{sch} = \frac{200}{100} = 2$ pu [generator bus]

Initial Assumption: $V_2^{(0)} = 1 + j0$; $V_3^{(0)} = 1.04 + j0$

$$V_2^{(1)} = \left[\frac{P_2^{sch} - jQ^{sch}}{V_2^{*}(0)} + y_{12}V_1 + y_{23}V_3^{(0)}\right]\frac{1}{y_{12}+y_{23}}$$

$$= \left[\frac{-4+2.5j}{1} + (10-j20)(1.05) + (16-j32)(1.04)\right]\frac{1}{26-j52}$$

$$= 0.97462 - j0.042307$$

$$Q_3^{(1)} = -\text{Imag}\left\{V_3^{*}(0)\left[V_3^{(0)}(y_{13}+y_{23}) - y_{13}V_1 - y_{23}V_2^{(1)}\right]\right\}$$

$$= -\text{Imag}\left\{(1.04 - j0)\left[1.04 \times (26-62j) - (10-j30)\,1.05 - (16-j32)(0.97462 - j0.042307)\right]\right\}$$

$$= 1.16$$

$$V_{c3}^{(1)} = \left[\frac{P_3^{sch} - jQ_3^{(1)}}{V_3^{*}(0)} + y_{13}V_1 + y_{23}V_2^{(1)}\right]\frac{1}{y_{13}+y_{23}}$$

$$= \frac{\frac{2-j1.16}{1.04} + (10-j30)(1.05) + (16-j32)(0.97462 - j0.042307)}{26-j62}$$

$$= 1.03783 - j0.00517$$

as; $|V_3|$ is constant at 1.04 pu; only retaining the imaginary part of $V_{c3}(1)$

$$\therefore e_3^{(1)} = \sqrt{(|V_3|)^2 - (f_e^{(1)})^2} = \sqrt{(1.04)^2 - (0.00517)^2}$$

$$= 1.039987$$

$$\therefore V_3^{(1)} = 1.039987 - j0.00517$$

2nd iteration;

$$V_2^{(2)} = \left[\frac{P_2^{sch} - jQ_2^{sch}}{V_2^{*}(1)} + y_{12}V_1 + y_{23}V_3^{(1)}\right]\frac{1}{y_{12}+y_{23}}$$

$$= \frac{\frac{-4+j2.5}{0.97462+j0.042307} + (10-j20)(1.05) + (16-j32)(1.039987 - j0.00517)}{26-52j}$$

$$= 0.971057 - j0.043432$$

$$Q_3^{(2)} = -\text{Imag}\left\{V_3^{*(1)}\left[V_3^{(1)}(y_{13}+y_{23}) - y_{13}V_1 - y_{23}V_2^{(2)}\right]\right\}$$

$$= -\text{Imag}\left\{(1.039987 + j0.005170)\left[(1.039987 - j0.005170)(26-j62) - (10-j30)(1.05+j0) - (16-j32)(0.971057 - j0.043432)\right]\right\}$$

$$= 1.38796$$

$$V_{c3}^{(2)} = \left[\frac{P_3^{sch} - jQ_3^{(2)}}{V_3^{*}(1)} + y_{13}V_1 + y_{23}V_2^{(2)}\right]\frac{1}{y_{13}+y_{23}}$$

$$= 1.030908 - j0.00730$$

$$e_3^{(1)} = \sqrt{(1.04)^2 - (0.0073)^2}$$

$$= 1.039974$$

$$\therefore V_3^{(1)} = 1.039974 - j0.0073$$

After two iterations:

$V_2 = 0.97 \angle -2.7^\circ$ pu ; $S_3 = 2 + j1.46$ pu.

$V_3 = 1.04 \angle -0.5^\circ$ pu ; $S_1 = 2.18 + j1.41$ pu

$$S_{12} = V_1 I_{12}^* = V_1 [y_{12}(V_1 - V_2)]^*$$

$$= 179.36 + j118.734$$

$$S_{21} = V_2 I_{21}^* = V_2 [y_{12}(V_2 - V_1)]^*$$

$$= -170.97 - j101.947$$

$$S_{13} = V_1 I_{13}^* = V_1 [y_{13}(V_1 - V_3)]^*$$

$$= 39.06 + j22.118$$

$$S_{31} = V_3 I_{31}^* = V_3 [y_{31}(V_3 - V_1)]^*$$

$$= -38.88 - j21.369$$

$$S_{23} = V_2 I_{23}^* = V_2 [y_{23} * (V_2 - V_3)]^*$$

$$= -229.03 - j148.05$$

$$S_{32} = V_3 I_{32}^* = V_3 [y_{23}(V_3 - V_2)]^*$$

$$= 238.88 + j167.746$$

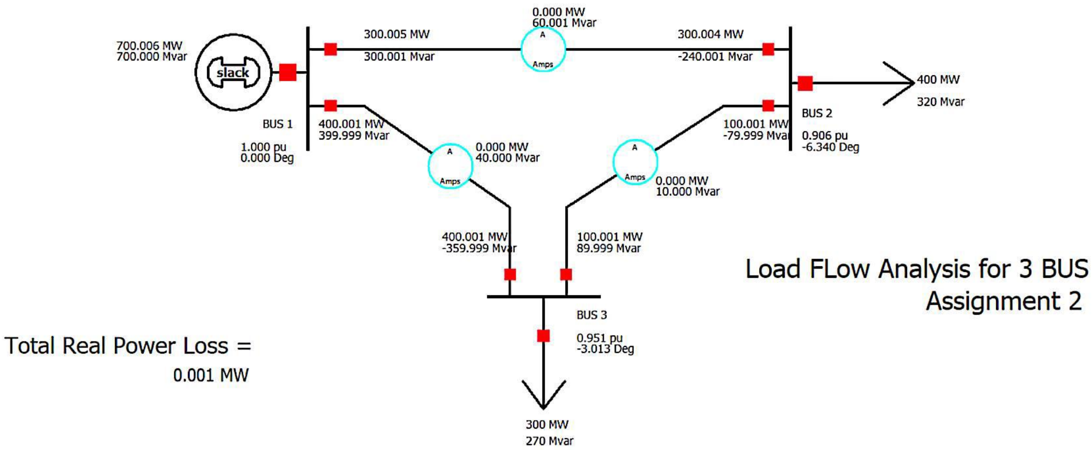
Line losses:

$$S_{L-12} = S_{12} + S_{21} = 8.39 + j16.79$$

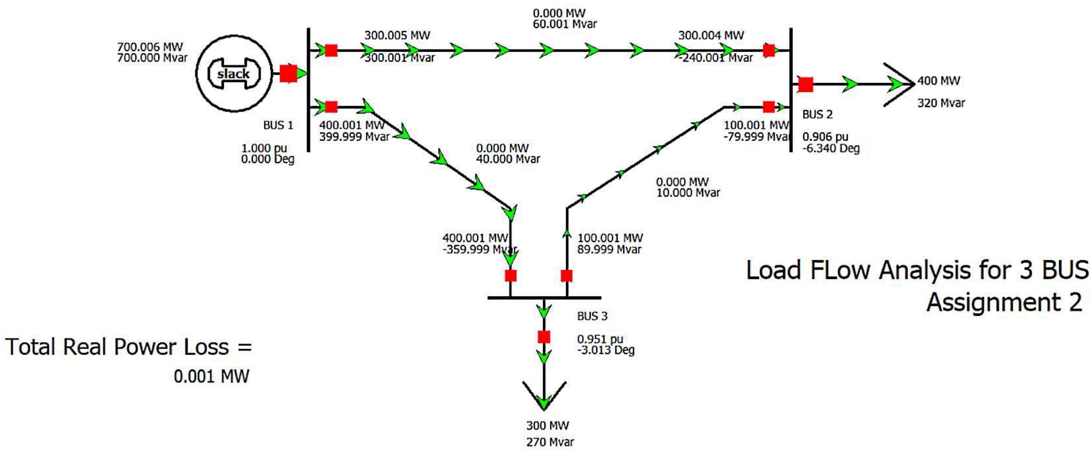
$$S_{L-13} = S_{13} + S_{31} = 0.18 + j0.548$$

$$S_{L-23} = S_{23} + S_{32} = 9.85 + j19.59$$

We can observe; the calculated results from theory are almost equal to the simulated results.



700.006 MW
700.000 Mvar
slack
BUS 1
1.000 pu
0.000 Deg
300.005 MW
300.001 Mvar
0.000 MW
60.001 Mvar
300.004 MW
-240.001 Mvar
400 MW
320 Mvar
BUS 2
0.906 pu
-6.340 Deg
400.001 MW
399.999 Mvar
0.000 MW
40.000 Mvar
100.001 MW
-79.999 Mvar
0.000 MW
10.000 Mvar
400.001 MW
-359.999 Mvar
100.001 MW
89.999 Mvar
BUS 3
0.951 pu
-3.013 Deg
300 MW
270 Mvar
Load FLow Analysis for 3 BUS
Assignment 2
Total Real Power Loss =
0.001 MW



700.006 MW
700.000 Mvar
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BUS 1
1.000 pu
0.000 Deg
300.005 MW
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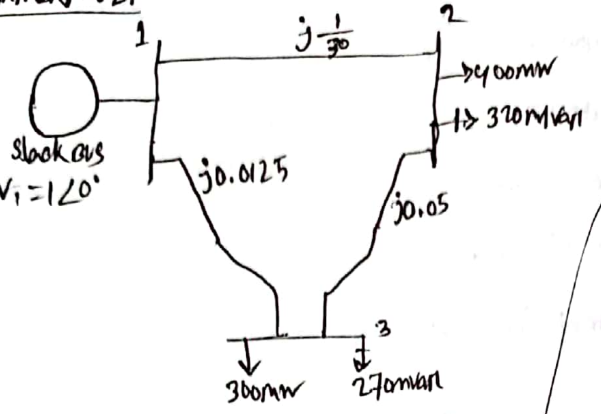
BUS 3
0.951 pu
-3.013 Deg
300 MW
270 Mvar
Load FLow Analysis for 3 BUS
Assignment 2
Total Real Power Loss =
0.001 MW

Assignment-02:



$$Y = \begin{bmatrix} y_{12}+y_{13} & -y_{12} & -y_{13} \\ -y_{21} & y_{23}+y_{12} & -y_{23} \\ -y_{31} & -y_{32} & y_{13}+y_{23} \end{bmatrix}$$

$y_{12} = y_{21} = -j30$

$y_{23} = y_{32} = -j820$

$y_{31} = y_{13} = -j80$

Load bus at 2;

$$S_2^{sch} = \frac{-(400+320j)}{100} = -4-j3.2$$

$\therefore P_2^{sch} = -4;\ Q_2^{sch} = -j3.2$

Load bus at 3;

$$S_2^{sch} = \frac{-(\cancel{400}+\cancel{320}j)}{100} = \cancel{-4-j3.2}\ -3-j2.7$$

$P_3^{sch} = -4;\ Q_2^{sch} = -j3.2$

~~Load bus at 3;~~

$$\cancel{S_3^{sch} = \frac{-(300+270j)}{100} = -3-j2.7}$$

Initial Assumption; $V_2^{(0)} = 1+j0;\ V_3^{(0)} = 1+j0$

$$V_2^{(1)} = \left[\frac{S_2^{sch*}}{V_2^{*(0)}} + y_{12}V_1 + y_{23}V_3^{(0)}\right]\frac{1}{y_{12}+y_{23}}$$

$$= \frac{\frac{-4+j3.2}{1} + (-j30)1 + (-j20)\times 1}{-j50}$$

$= 0.936-j0.08$

$$V_3^{(1)} = \left[\frac{S_3^{sch*}}{V_3^{*(0)}} + y_{13}V_1 + y_{23}V_2^{(1)}\right]\frac{1}{y_{13}+y_{23}}$$

$$= \frac{\frac{-3+j2.7}{1-j0} + (-j80)\times 1 + (-j20)\times(0.936-j0.08)}{-j100}$$

$= 0.9602-j0.046$

2nd iteration;

$V_2^{(1)} = 0.936-j0.08$

$$V_2^{(2)} = \left[\frac{S_2^{sch*}}{V_2^{*(1)}} + y_{12}V_1 + y_{23}V_3^{(1)}\right]\frac{1}{y_{13}+y_{23}}$$

$$= \frac{\frac{-4+j3.2}{0.936+j0.08} + (-j30)(1) + (-j20)(0.9602-j0.046)}{-j50}$$

$= 0.9089-j0.0974$

$$V_3^{(2)} = \left[\frac{S_3^{sch*}}{V_3^{*(1)}} + y_{13}V_1 + y_{23}V_2^{(2)}\right]\frac{1}{y_{13}+y_{23}}$$

$$= \frac{\frac{-3+j2.7}{0.9602+j0.048} + (-j80)1 + (-j20)(0.9089-j0.0974)}{-j100}$$

$= 0.9522-j0.0498$

From two iterations;

$V_2 = 0.91\angle -6.34°$ pu

$V_3 = 0.95\angle -3.01°$ pu

Slack bus power.

$$P_1 - jQ_1 = V_1^*\left[V_1(y_{12}+y_{13}) - y_{12}V_2 - y_{13}V_3\right]$$

$= 7 - j7$

$\therefore P_1 = 700MW$

$Q_1 = 700Mvar$

Line Currents;

$I_{12} = y_{12}(V_1-V_2) = 3-j3$

$I_{21} = -I_{12} = -3+j3$

$I_{13} = y_{13}(V_1-V_3) = 4-j4$

$I_{31} = y_{13}(V_3-V_1) = -4+j4$

$I_{23} = y_{23}(V_2-V_3) = -1+j$

$I_{32} = -I_{23} = 1-j$

$S_{12} = V_1 I_{12}^* = 3 + j3 = 300\,MW + j300\,MVar$

$S_{21} = V_2 I_{21}^* = -3 - j2.4 = -300\,MW - j240\,MVar$

$S_{13} = V_1 I_{13}^* = 4 + j4\,pu = 400\,MW + j400\,MVar$

$S_{31} = V_3 I_{31}^* = -4 - j3.6\,pu = -400\,MW - j360\,MVar$

$S_{32} = V_3 I_{32}^* = 1 + j0.9\,pu = 100\,MW + j90\,MVar$

$S_{23} = V_2 I_{23}^* = -1 - j0.8\,pu = -100\,MW - j80\,MVar$

Line losses;

$S_{L-12} = S_{12} + S_{21} = 0\,MW + j60\,MVar$

$S_{L-13} = S_{13} + S_{31} = 0\,MW + j40\,MVar$

$S_{L-23} = S_{23} + S_{32} = 0 + j10\,MVar$

The following values match exactly with the simulated results.

Discussion:

The experiment focused on load-flow analysis using power world Simulator software. Since non-linear equations are difficult and time-consuming to solve manually, the simulator provides an efficient and accurate way to analyze and simulate results. Minor deviations from theoretical calculations were observed, which can be attributed to numerical approximations such as the limited number of digits considered after the decimal point.