DC Power Flow

Poměrné hodnoty. Předpoklady:

$$u_i \approx u_j \approx 1 \qquad \sin\delta_{ij} \approx \delta_{ij} \qquad b_{ij} = -\frac{1}{x_{ij}}$$

$$P_{ij} = \frac{U_i U_j}{X_{ij}} \sin\delta_{ij}$$

$$p_{ij} \cdot S_v = \frac{u_i \cdot U_v \cdot u_j \cdot U_v}{x_{ij} \cdot Z_v} \sin\delta_{ij}$$

$$p_{ij} = \frac{u_i \cdot u_j}{x_{ij}} \sin\delta_{ij} \Rightarrow p_{ij} = \frac{\delta_{ij}}{x_{ij}} = \frac{\delta_i - \delta_j}{x_{ij}}$$

Maticově

$$p_i = \sum_{\substack{j=1 \\ j\neq i}}^{n} \frac{\delta_i - \delta_j}{x_{ij}} = \delta_i \sum_{\substack{j=1 \\ j\neq i}}^{n} \frac{1}{x_{ij}} - \sum_{\substack{j=1 \\ j\neq i}}^{n} \frac{\delta_j}{x_{ij}}$$

$$p_i = \delta_i b'_{(i,i)} + \sum_{\substack{j=1 \\ j\neq i}}^{n} \delta_j b'_{(i,j)}$$

$$(p) = (b')(\delta)$$

Jen podélné reaktance → **b´** singulární. 1 uzel jako referenční s $\delta = 0$ → matice **b´´** o řád menší.

(DC model nepočítá ztráty, tedy netřeba slack, ale reference úhlu ano.)

$$(\delta) = (b'')^{-1}(p)$$

$$(u) = (g)^{-1}(i)$$

Ustálený chod sítě

```
y12 = 1/(0.02 + 0.04 I)
y13 = 1/(0.01 + 0.03 I)
y23 = 1/(0.0125 + 0.025 I)
```

```
10. - 20. i
```

```
10. - 30. i
```

```
16. - 32. i
```

```
Sc = 100;
s2 = -(256.6 + 110.2 I)/Sc
s3 = -(138.6 + 45.2 I)/Sc
```

```
-2.566 - 1.102 i
```

```
-1.386 - 0.452 i
```

```
u1 = 1.05;
u20 = 1; u30 = 1;
```

DC power flow

```
b12 = 1 / Im[1 / y12] (* 1/0.04 *)
b13 = 1 / Im[1 / y13] (* 1/0.03 *)
b23 = 1 / Im[1 / y23] (* 1/0.025 *)
```

```
25.
```

```
33.3333
```

```
40.
```

```
bmat = {{b12 + b13, -b12, -b13}, {-b12, b12 + b23, -b23}, {-b13, -b23, b13 + b23}};
MatrixForm[bmat]
```

$$\begin{pmatrix} 58.3333 & -25. & -33.3333 \\ -25. & 65. & -40. \\ -33.3333 & -40. & 73.3333 \end{pmatrix}$$

```
bmat2 = bmat[[2 ;; 3, 2 ;; 3]]
```

```
{{65., -40.}, {-40., 73.3333}}
```

```
p = Re[{s2, s3}]
```

```
{-2.566, -1.386}
```

```
Inverse[bmat2]
```

```
{{0.0231579, 0.0126316}, {0.0126316, 0.0205263}}
```

```
delta = Insert[Inverse[bmat2].p, 0, 1]
% * 180 / Pi
```

```
{0, -0.0769305, -0.0608621}
```

```
{0, -4.40779, -3.48714}
```

```
p12 = (delta[[1]] - delta[[2]]) * b12
p13 = (delta[[1]] - delta[[3]]) * b13
p23 = (delta[[2]] - delta[[3]]) * b23
```

```
1.92326
```

```
2.02874
```

```
-0.642737
```

```
p12 + p13
p23 - p12
-p13 - p23
```

```
3.952
```

```
-2.566
```

```
-1.386
```

Výsledky Gauss (Newton)

Out[13]= 0.98 − 0.06 i

Out[14]= 1. − 0.05 i

In[15]:=
```
{Abs[u2], Arg[u2] * 180 / Pi}
{Abs[u3], Arg[u3] * 180 / Pi}
```

Out[15]= {0.981835, −3.50353}

Out[16]= {1.00125, −2.86241}

In[17]:=
```
s1v = u1 * Conjugate[y12 (u1 - u2) + y13 * (u1 - u3)]
s2v = u2 * Conjugate[y12 (u2 - u1) + y23 * (u2 - u3)]
s3v = u3 * Conjugate[y13 (u3 - u1) + y23 * (u3 - u2)]
```

Out[17]= 4.095 + 1.89 i

Out[18]= −2.566 − 1.102 i

Out[19]= −1.386 − 0.452 i

In[20]:=
```
i12 = y12 * (u1 - u2)
s12 = u1 * Conjugate[i12] * Sc
s21 = u2 * Conjugate[-i12] * Sc
```

Out[20]= 1.9 − 0.8 i

Out[21]= 199.5 + 84. i

Out[22]= −191. − 67. i

In[23]:=
```
ds12 = s12 + s21
```

Out[23]= 8.5 + 17. i

In[24]:=
```
i13 = y13 * (u1 - u3)
s13 = u1 * Conjugate[i13] * Sc
s31 = u3 * Conjugate[-i13] * Sc
```

Out[24]= 2. − 1. i

Out[25]= 210. + 105. i

Out[26]= −205. − 90. i

In[27]:=
```
ds13 = s13 + s31
```

Out[27]= 5. + 15. i

In[28]:=
```
i23 = y23 * (u2 - u3)
s23 = u2 * Conjugate[i23] * Sc
s32 = u3 * Conjugate[-i23] * Sc
```

Out[28]= −0.64 + 0.48 i

Out[29]= −65.6 − 43.2 i

Out[30]= 66.4 + 44.8 i

In[31]:=
```
ds23 = s23 + s32
```

Out[31]=
```
0.8 + 1.6 i
```

In[32]:=
```
ds12 + ds13 + ds23
(s1v + s2v + s3v) * Sc
```

Out[32]=
```
14.3 + 33.6 i
```

Out[33]=
```
14.3 + 33.6 i
```