Листинг 2

In[124]:=
```
ClearAll["Global`*"]
SetDirectory[NotebookDirectory[]];
Needs["FlowSolver`"]
```

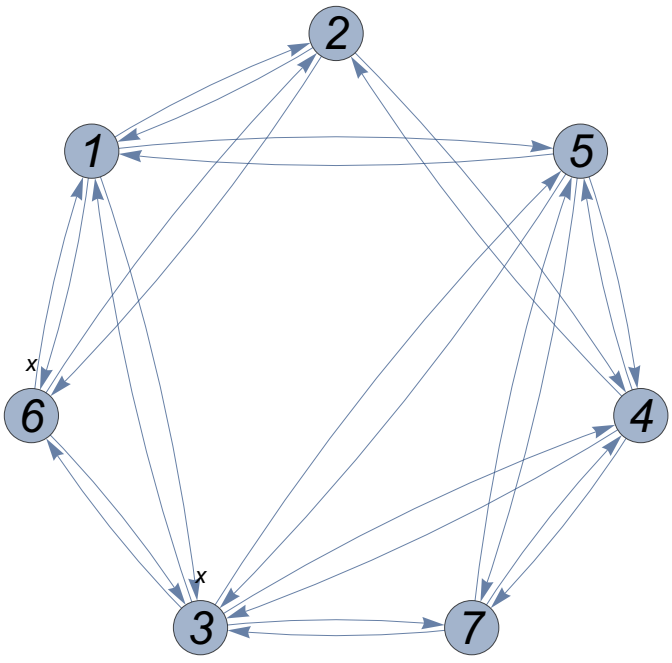
In[127]:=
```
readGraph2[file_, dir_] := Module[{
    fn = FileNameJoin[{dir, file}],
    stream, imod, umod, u, b
    },
    stream = OpenRead[fn];
    imod = Read[stream, {Word, Number}][[2]];
    umod = Read[stream, {Word, Number}][[2]];

  u = ({#[[1]] ↔ #[[2]], #[[2]] ↔ #[[1]]} & /@ ReadList[stream, Expression, umod]) // Flatten;
  b = ConstantArray[0, imod];
    (b[[Read[StringToStream[StringTake[#1, {5, -3}]], Number]]] = #2) &@@@
   ReadList[stream, {Word, Expression}, imod];
  {Graph[u, VertexSize -> Medium, VertexLabels -> {xx_ :> Placed[{xx, Style[{{
{x, SameQ[b[[xx]], x]}, {{
 {-b[[xx]]},
 {"↑"}
}, b[[xx]] < 0},
{{
 {b[[xx]]},
 {"↓"}
}, b[[xx]] > 0},
{"", True}
} // TableForm, Medium]}, {Center, Above}]}, VertexLabelStyle ->
     Directive[Black, Italic, 24], GraphLayout -> "CircularEmbedding"], b}

 ]
```

In[128]:=
```
{g, b} = readGraph2["gr.txt", NotebookDirectory[]];
GraphPlot[g, MultiedgeStyle → .05]
```

Out[129]=



In[130]:=
```
M = {7};
Print["M = ", M];
```

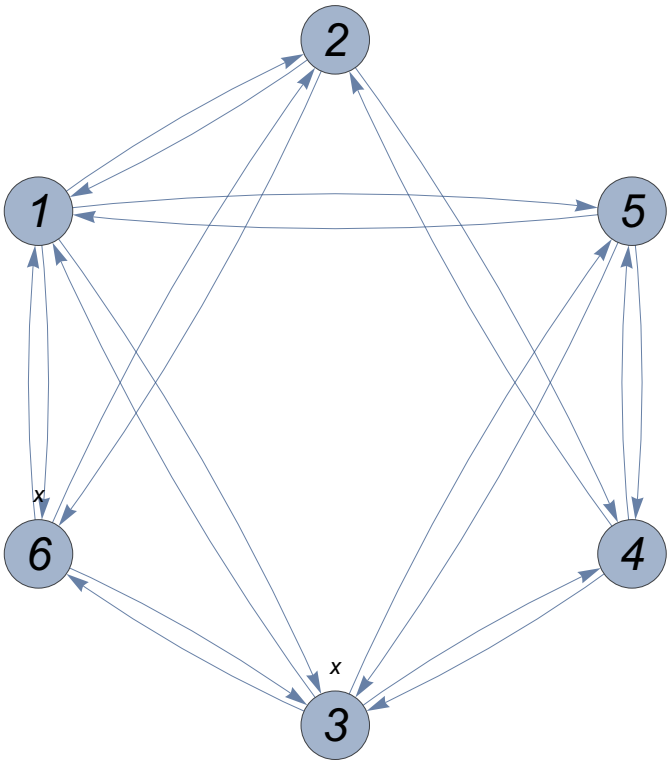
```
M = {7}
```

In[132]:=
```
(*incL=
 DeleteCases[DeleteDuplicates[Cases[IncidenceList[g,#],i_↔j_:>{i,j}]//Flatten],
    v_/;v==#]&/@M*)
incL = (IncidenceList[g, #] & /@ M) // Flatten
```

Out[132]= $\{3 \leftrightarrow 7, 7 \leftrightarrow 3, 7 \leftrightarrow 5, 5 \leftrightarrow 7, 7 \leftrightarrow 4, 4 \leftrightarrow 7\}$

In[133]:=
```
(*Do[If[MemberQ[M,j[[1]]],b[[j[[2]]]]+=f_j,b[[j[[1]]]]-=f_j],{j,incL}]*)
b = Fold[If[MemberQ[M, #2[[1]]], ReplacePart[#, #2[[2]] → #[[#2[[2]]]] + f_#2],
      ReplacePart[#, #2[[1]] → #[[#2[[1]]]] - f_#2]] &, b, incL];
Delete[b, #] & @@ M;
g = VertexDelete[g, M];
GraphPlot[g, MultiedgeStyle → .05]
b
```

Out[136]=



Out[137]= $\{0, 0, x - f_{3\leftrightarrow 7} + f_{7\leftrightarrow 3}, -f_{4\leftrightarrow 7} + f_{7\leftrightarrow 4}, -f_{5\leftrightarrow 7} + f_{7\leftrightarrow 5}, x, 0\}$

In[138]:=
```
CC[g_, M_] :=
  (DeleteDuplicates[Cases[IncidenceList[g, #], i_ ↔ j_ /; j == #]] & /@ M) // Flatten

ii_i_[g_] := Cases[IncidenceList[g, i], u_ ↔ v_ /; u == i :> v]
```

In[140]:=
```
M⁺ = CC[g, M]
```

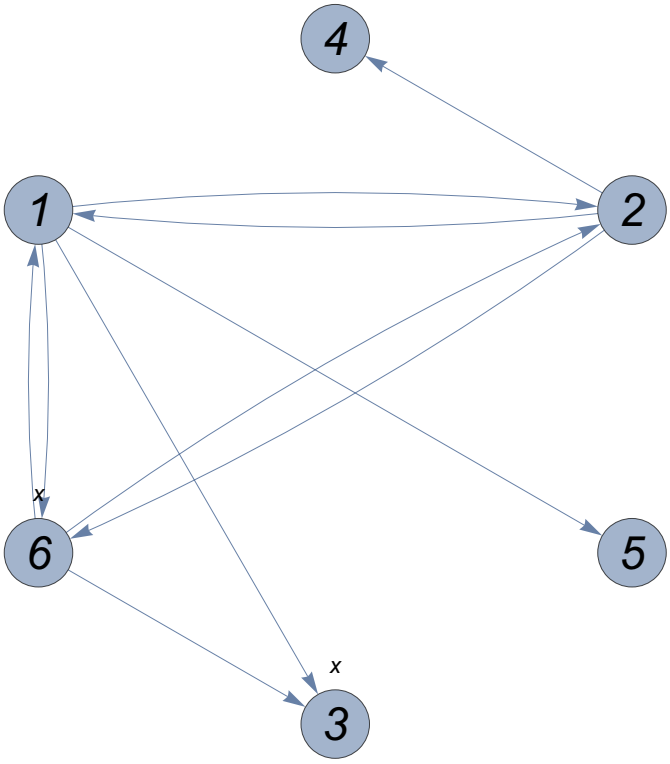
Out[140]= $\{3 \leftrightarrow 7, 5 \leftrightarrow 7, 4 \leftrightarrow 7\}$

In[141]:=
```
b1 = Fold[Module[{bb = #1, i = #2[[1]], k = #2[[2]]},
    (ReplacePart[bb, (({# → bb[[#]] + p_{i↔#}/p_{i↔k} f_{i↔k}, i → bb[[i]] - p_{i↔#}/p_{i↔k} f_{i↔k}}) &) /@ ii_i^‡[g]] //
     Flatten])] &, b, M^+]
```

Out[141]=
$$\left\{\frac{f_{3\bullet\to 7}\, p_{3\bullet\to 1}}{p_{3\bullet\to 7}}+\frac{f_{5\bullet\to 7}\, p_{5\bullet\to 1}}{p_{5\bullet\to 7}},\ \frac{f_{4\bullet\to 7}\, p_{4\bullet\to 2}}{p_{4\bullet\to 7}},\ x-f_{3\bullet\to 7}+f_{7\bullet\to 3}-\frac{f_{3\bullet\to 7}\, p_{3\bullet\to 1}}{p_{3\bullet\to 7}}+\frac{f_{4\bullet\to 7}\, p_{4\bullet\to 3}}{p_{4\bullet\to 7}}+\frac{f_{5\bullet\to 7}\, p_{5\bullet\to 3}}{p_{5\bullet\to 7}},\right.$$
$$-f_{4\bullet\to 7}+f_{7\bullet\to 4}+\frac{f_{3\bullet\to 7}\, p_{3\bullet\to 4}}{p_{3\bullet\to 7}}-\frac{f_{4\bullet\to 7}\, p_{4\bullet\to 2}}{p_{4\bullet\to 7}}+\frac{f_{5\bullet\to 7}\, p_{5\bullet\to 4}}{p_{5\bullet\to 7}},$$
$$\left.-f_{5\bullet\to 7}+f_{7\bullet\to 5}+\frac{f_{3\bullet\to 7}\, p_{3\bullet\to 5}}{p_{3\bullet\to 7}}+\frac{f_{4\bullet\to 7}\, p_{4\bullet\to 5}}{p_{4\bullet\to 7}}-\frac{f_{5\bullet\to 7}\, p_{5\bullet\to 1}}{p_{5\bullet\to 7}},\ x+\frac{f_{3\bullet\to 7}\, p_{3\bullet\to 6}}{p_{3\bullet\to 7}},\ 0\right\}$$

In[142]:=
```
g1 = Fold[EdgeDelete[#1, u_ ↔ v_ /; u == #2] &, g, #[[1]] & /@ M^+];
GraphPlot[g1, MultiedgeStyle → .05]
```

Out[143]=



In[144]:=
```
II_rem = VertexList[g1] ~Complement~ (M^+[[All, 1]])
```

Out[144]=
```
{1, 2, 6}
```

In[145]:=
```
λ = SparseArray[
  Replace[(EdgeList[g1] /. # & /@ Flatten[Module[{i = #, f, Icur},
      (Icur = ii_i^+[g1];
       jf = First[Icur];
       ({(i ↔ jf) → 1, (i ↔ #) → -p_{i↔#}/p_{i↔jf}} & /@ Icur[[2 ;;]])] & /@ II_rem, 1]),
   _ ↔ _ → 0, 2]]
```

Out[145]=
```
SparseArray[ <image> ]
```
Specified elements: 14
Dimensions: {7, 10}

In[160]:=
```
g = g1;
b = b1;
```

In[162]:=
```
II* = Cases[MapIndexed[{#1, #2} &, b], {el_, i_} /; MemberQ[el, x] :> i] // Flatten
```

Out[162]=
```
{3, 6}
```

In[163]:=
```
buildt = Timing[{t, g} = buildTree[g, II*];][[1]]
TableForm[t[[1 ;; 4]],
 TableHeadings → {{"pred", "dir", "depth", "d"}, t // pred // Length // Range}]
```

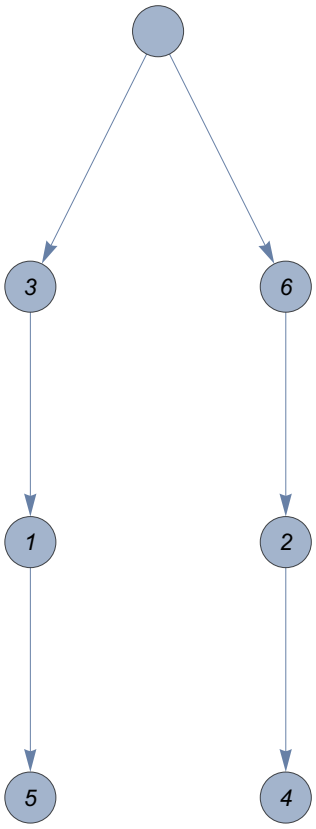
Out[163]=
```
0.015625
```

Out[164]//TableForm=

	1	2	3	4	5	6	7
pred	3	6	7	2	1	7	0
dir	-1	1	1	1	1	1	0
depth	2	2	1	3	3	1	0
d	5	4	1	7	6	2	3

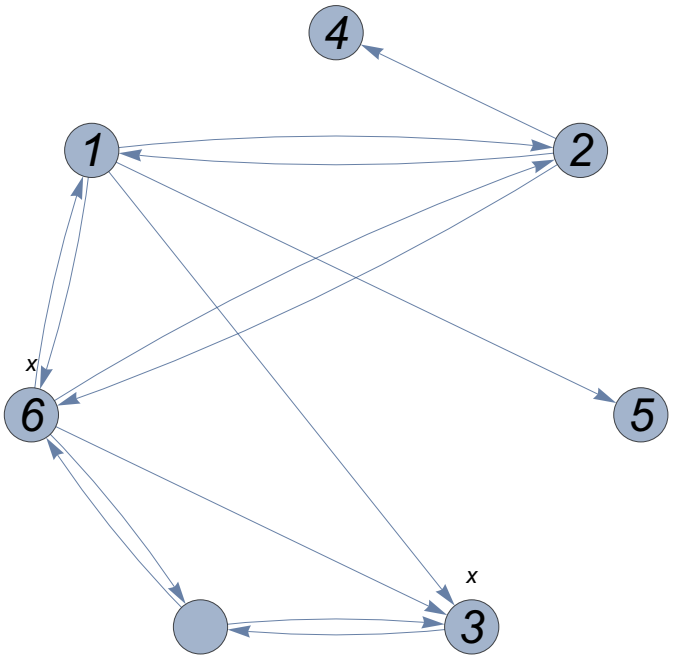
In[165]:=
```
t[[7]]
```

Out[165]=



In[166]:=
```
GraphPlot[g, MultiedgeStyle → .05]
```

Out[166]=



In[215]:=
```
matrt = Timing[δMatr = δ1[g, t]];
root = VertexCount[g];
TableForm[δMatr, TableHeadings → {uNb[g, t], δ[Switch[#[[2]], #[[1]] == root, #[[1]], #[[2]] == root, #, True, #] & /@ EdgeList[g]]}]
```

Out[217]//TableForm=

	$\delta_{1\bullet\leftrightarrow 2}$	$\delta_{2\bullet\leftrightarrow 1}$	$\delta_{1\bullet\leftrightarrow 5}$	$\delta_{2\bullet\leftrightarrow 4}$	$\delta_{1\bullet\leftrightarrow 3}$	$\delta_{6\bullet\leftrightarrow 3}$	$\delta_{6\bullet\leftrightarrow 1}$	$\delta_{1\bullet\leftrightarrow 6}$	$\delta_{6\bullet\leftrightarrow 2}$	$\delta_{2\bullet\leftrightarrow 6}$	δ
$1 \bullet\leftrightarrow 2$	1	0	0	0	−1	0	0	0	−1	0	1
$2 \bullet\leftrightarrow 1$	0	1	0	0	1	0	0	0	1	0	-
$6 \bullet\leftrightarrow 3$	0	0	0	0	0	1	0	0	0	0	-
$6 \bullet\leftrightarrow 1$	0	0	0	0	1	0	1	0	0	0	-
$1 \bullet\leftrightarrow 6$	0	0	0	0	−1	0	0	1	0	0	1

In[173]:=
```
dopEq = # == 0 & /@ Flatten[
    λ.{x_# & /@ EdgeList[g, u_ ↔ v_ /; u ≠ VertexCount[g] && v ≠ VertexCount[g]]}^T];
dopEq //
 TableForm
```

Out[174]//TableForm=

$$x_{1\bullet\leftrightarrow 2} - \frac{p_{1\bullet\leftrightarrow 5}\, x_{1\bullet\leftrightarrow 5}}{p_{1\bullet\leftrightarrow 2}} == 0$$

$$x_{1\bullet\leftrightarrow 2} - \frac{p_{1\bullet\leftrightarrow 3}\, x_{1\bullet\leftrightarrow 3}}{p_{1\bullet\leftrightarrow 2}} == 0$$

$$x_{1\bullet\leftrightarrow 2} - \frac{p_{1\bullet\leftrightarrow 6}\, x_{1\bullet\leftrightarrow 6}}{p_{1\bullet\leftrightarrow 2}} == 0$$

$$x_{2\bullet\leftrightarrow 1} - \frac{p_{2\bullet\leftrightarrow 4}\, x_{2\bullet\leftrightarrow 4}}{p_{2\bullet\leftrightarrow 1}} == 0$$

$$x_{2\bullet\leftrightarrow 1} - \frac{p_{2\bullet\leftrightarrow 6}\, x_{2\bullet\leftrightarrow 6}}{p_{2\bullet\leftrightarrow 1}} == 0$$

$$-\frac{p_{6\bullet\leftrightarrow 1}\, x_{6\bullet\leftrightarrow 1}}{p_{6\bullet\leftrightarrow 3}} + x_{6\bullet\leftrightarrow 3} == 0$$

$$-\frac{p_{6\bullet\leftrightarrow 2}\, x_{6\bullet\leftrightarrow 2}}{p_{6\bullet\leftrightarrow 3}} + x_{6\bullet\leftrightarrow 3} == 0$$

In[193]:=
```
Λ = λ.(δMatr[[All, 1 ;; -5]])^T;
"cicle det's:"
Grid[Λ, Frame → All]
```

Out[194]= cicle det's:

Out[195]=

1	0	0	0	0
$1+\frac{p_{1\leftrightarrow 3}}{p_{1\leftrightarrow 2}}$	$-\frac{p_{1\leftrightarrow 3}}{p_{1\leftrightarrow 2}}$	0	$-\frac{p_{1\leftrightarrow 3}}{p_{1\leftrightarrow 2}}$	$\frac{p_{1\leftrightarrow 3}}{p_{1\leftrightarrow 2}}$
1	0	0	0	$-\frac{p_{1\leftrightarrow 6}}{p_{1\leftrightarrow 2}}$
0	1	0	0	0
0	1	0	0	0
0	0	1	$-\frac{p_{6\leftrightarrow 1}}{p_{6\leftrightarrow 3}}$	0
$\frac{p_{6\leftrightarrow 2}}{p_{6\leftrightarrow 3}}$	$-\frac{p_{6\leftrightarrow 2}}{p_{6\leftrightarrow 3}}$	1	0	0

In[232]:=
```
"U_c="
U_c = {1, 2, 3, 4, 5}
"U_nc="
U_nc = {}
```

Out[232]= $U_c =$

Out[233]= $\{1, 2, 3, 4, 5\}$

Out[234]= $U_{nc} =$

Out[235]= $\{\}$

In[252]:=
```
Λc = Λ[[{1, 2, 3, 5, 6}, U_c]];
Λnc = Λ[[All, U_nc]];
"Λ_c="
Λc // MatrixForm
```

Out[254]= $\Lambda_c =$

Out[255]//MatrixForm=

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ 1+\frac{p_{1\leftrightarrow 3}}{p_{1\leftrightarrow 2}} & -\frac{p_{1\leftrightarrow 3}}{p_{1\leftrightarrow 2}} & 0 & -\frac{p_{1\leftrightarrow 3}}{p_{1\leftrightarrow 2}} & \frac{p_{1\leftrightarrow 3}}{p_{1\leftrightarrow 2}} \\ 1 & 0 & 0 & 0 & -\frac{p_{1\leftrightarrow 6}}{p_{1\leftrightarrow 2}} \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & -\frac{p_{6\leftrightarrow 1}}{p_{6\leftrightarrow 3}} & 0 \end{pmatrix}$$

In[256]:=
```
"det(Λ_c)="
Det[Λc]
```

Out[256]= $\det(\Lambda_c) =$

Out[257]= $$\frac{p_{1\leftrightarrow 3}\, p_{1\leftrightarrow 6}}{p_{1\leftrightarrow 2}^2}$$

In[258]:=
```
"U_T="
utind = Cases[t[[6]], ξ_ /; ξ ≠ 0];
U_T = EdgeList[g][[utind]]
```

Out[258]= $U_T =$

Out[260]= $\{1 \leftrightarrow 3,\ 6 \leftrightarrow 2,\ 7 \leftrightarrow 3,\ 2 \leftrightarrow 4,\ 1 \leftrightarrow 5,\ 7 \leftrightarrow 6\}$

In[261]:=
```
"U_Nb="
U_Nb = uNb[g, t]
```

Out[261]= $U_{Nb}=$

Out[262]= $\{1 \leftrightarrow 2,\ 2 \leftrightarrow 1,\ 6 \leftrightarrow 3,\ 6 \leftrightarrow 1,\ 1 \leftrightarrow 6\}$

In[263]:=
```
ps = x̃_# → x̃_# & /@ EdgeList[g]
```

Out[263]= $\left\{\tilde{x}_{1\leftrightarrow 2} \to \tilde{x}_{1\leftrightarrow 2},\ \tilde{x}_{2\leftrightarrow 1} \to \tilde{x}_{2\leftrightarrow 1},\ \tilde{x}_{1\leftrightarrow 5} \to \tilde{x}_{1\leftrightarrow 5},\ \tilde{x}_{2\leftrightarrow 4} \to \tilde{x}_{2\leftrightarrow 4},\ \tilde{x}_{1\leftrightarrow 3} \to \tilde{x}_{1\leftrightarrow 3},\ \tilde{x}_{6\leftrightarrow 3} \to \tilde{x}_{6\leftrightarrow 3},\ \tilde{x}_{6\leftrightarrow 1} \to \tilde{x}_{6\leftrightarrow 1},\ \tilde{x}_{1\leftrightarrow 6} \to \tilde{x}_{1\leftrightarrow 6},\ \tilde{x}_{6\leftrightarrow 2} \to \tilde{x}_{6\leftrightarrow 2},\ \tilde{x}_{2\leftrightarrow 6} \to \tilde{x}_{2\leftrightarrow 6},\ \tilde{x}_{7\leftrightarrow 3} \to \tilde{x}_{7\leftrightarrow 3},\ \tilde{x}_{7\leftrightarrow 6} \to \tilde{x}_{7\leftrightarrow 6},\ \tilde{x}_{3\leftrightarrow 7} \to \tilde{x}_{3\leftrightarrow 7},\ \tilde{x}_{6\leftrightarrow 7} \to \tilde{x}_{6\leftrightarrow 7}\right\}$

In[270]:=
```
A = -λ.{x̃_# & /@ EdgeList[g, u_ ↔ v_ /; u ≠ VertexCount[g] && v ≠ VertexCount[g]]}^T /. ps;
"A="
A // MatrixForm
```

Out[271]= $A=$

Out[272]//MatrixForm=

$$\begin{pmatrix} -\tilde{x}_{1\leftrightarrow 2} + \frac{p_{1\leftrightarrow 5}\,\tilde{x}_{1\leftrightarrow 5}}{p_{1\leftrightarrow 2}} \\ -\tilde{x}_{1\leftrightarrow 2} + \frac{p_{1\leftrightarrow 3}\,\tilde{x}_{1\leftrightarrow 3}}{p_{1\leftrightarrow 2}} \\ -\tilde{x}_{1\leftrightarrow 2} + \frac{p_{1\leftrightarrow 6}\,\tilde{x}_{1\leftrightarrow 6}}{p_{1\leftrightarrow 2}} \\ -\tilde{x}_{2\leftrightarrow 1} + \frac{p_{2\leftrightarrow 4}\,\tilde{x}_{2\leftrightarrow 4}}{p_{2\leftrightarrow 1}} \\ -\tilde{x}_{2\leftrightarrow 1} + \frac{p_{2\leftrightarrow 6}\,\tilde{x}_{2\leftrightarrow 6}}{p_{2\leftrightarrow 1}} \\ \frac{p_{6\leftrightarrow 1}\,\tilde{x}_{6\leftrightarrow 1}}{p_{6\leftrightarrow 3}} - \tilde{x}_{6\leftrightarrow 3} \\ \frac{p_{6\leftrightarrow 2}\,\tilde{x}_{6\leftrightarrow 2}}{p_{6\leftrightarrow 3}} - \tilde{x}_{6\leftrightarrow 3} \end{pmatrix}$$

In[273]:=
```
β = A - Δnc.{x_# & /@ U_Nb[[U_nc]]}^T;
"β="
β // TableForm
```

Out[274]= $\beta=$

Out[275]//TableForm=

$$-\tilde{x}_{1\leftrightarrow 2} + \frac{p_{1\leftrightarrow 5}\,\tilde{x}_{1\leftrightarrow 5}}{p_{1\leftrightarrow 2}}$$

$$-\tilde{x}_{1\leftrightarrow 2} + \frac{p_{1\leftrightarrow 3}\,\tilde{x}_{1\leftrightarrow 3}}{p_{1\leftrightarrow 2}}$$

$$-\tilde{x}_{1\leftrightarrow 2} + \frac{p_{1\leftrightarrow 6}\,\tilde{x}_{1\leftrightarrow 6}}{p_{1\leftrightarrow 2}}$$

$$-\tilde{x}_{2\leftrightarrow 1} + \frac{p_{2\leftrightarrow 4}\,\tilde{x}_{2\leftrightarrow 4}}{p_{2\leftrightarrow 1}}$$

$$-\tilde{x}_{2\leftrightarrow 1} + \frac{p_{2\leftrightarrow 6}\,\tilde{x}_{2\leftrightarrow 6}}{p_{2\leftrightarrow 1}}$$

$$\frac{p_{6\leftrightarrow 1}\,\tilde{x}_{6\leftrightarrow 1}}{p_{6\leftrightarrow 3}} - \tilde{x}_{6\leftrightarrow 3}$$

$$\frac{p_{6\leftrightarrow 2}\,\tilde{x}_{6\leftrightarrow 2}}{p_{6\leftrightarrow 3}} - \tilde{x}_{6\leftrightarrow 3}$$

In[279]:=
```
"решаем уравнение Λc xc=β:"
xc = LinearSolve[Λc, β[[{1, 2, 3, 5, 6}]]]
```

Out[279]= решаем уравнение $\Lambda_c x_c = \beta$:

Out[280]=
$$\left\{\left\{-\tilde{x}_{1\to 2}+\frac{p_{1\to 5}\,\tilde{x}_{1\to 5}}{p_{1\to 2}}\right\},\ \left\{-\tilde{x}_{2\to 1}+\frac{p_{2\to 6}\,\tilde{x}_{2\to 6}}{p_{2\to 1}}\right\},\right.$$
$$\left\{\frac{1}{p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 3}}\left(-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 1}\,\tilde{x}_{1\to 2}-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 1}\,\tilde{x}_{1\to 3}+\right.\right.$$
$$p_{1\to 2}\,p_{1\to 3}\,p_{1\to 5}\,p_{2\to 1}\,p_{6\to 1}\,\tilde{x}_{1\to 5}+p_{1\to 2}\,p_{1\to 5}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 1}\,\tilde{x}_{1\to 5}+p_{1\to 3}\,p_{1\to 5}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 1}\,\tilde{x}_{1\to 5}-$$
$$p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 1}\,\tilde{x}_{1\to 6}+p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 1}\,\tilde{x}_{2\to 1}-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 6}\,p_{6\to 1}\,\tilde{x}_{2\to 6}+$$
$$\left.p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 1}\,\tilde{x}_{6\to 1}-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 3}\,\tilde{x}_{6\to 3}\right)\Big\},\ \left\{\frac{1}{p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}}\right.$$
$$\left(-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,\tilde{x}_{1\to 2}-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,\tilde{x}_{1\to 3}+p_{1\to 2}\,p_{1\to 3}\,p_{1\to 5}\,p_{2\to 1}\,\tilde{x}_{1\to 5}+\right.$$
$$p_{1\to 2}\,p_{1\to 5}\,p_{1\to 6}\,p_{2\to 1}\,\tilde{x}_{1\to 5}+p_{1\to 3}\,p_{1\to 5}\,p_{1\to 6}\,p_{2\to 1}\,\tilde{x}_{1\to 5}-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,\tilde{x}_{1\to 6}+$$
$$\left.\left.p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,\tilde{x}_{2\to 1}-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 6}\,\tilde{x}_{2\to 6}\right)\Big\},\ \left\{\frac{p_{1\to 5}\,\tilde{x}_{1\to 5}-p_{1\to 6}\,\tilde{x}_{1\to 6}}{p_{1\to 6}}\right\}\right\}$$

In[281]:=
```
xcp = MapThread[x#1 → #2 &, {UNb[[Uc]], Flatten[xc]}]
```

Out[281]=
$$\left\{x_{1\to 2}\to -\tilde{x}_{1\to 2}+\frac{p_{1\to 5}\,\tilde{x}_{1\to 5}}{p_{1\to 2}},\ x_{2\to 1}\to -\tilde{x}_{2\to 1}+\frac{p_{2\to 6}\,\tilde{x}_{2\to 6}}{p_{2\to 1}},\right.$$
$$x_{6\to 3}\to\frac{1}{p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 3}}\left(-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 1}\,\tilde{x}_{1\to 2}-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 1}\,\tilde{x}_{1\to 3}+\right.$$
$$p_{1\to 2}\,p_{1\to 3}\,p_{1\to 5}\,p_{2\to 1}\,p_{6\to 1}\,\tilde{x}_{1\to 5}+p_{1\to 2}\,p_{1\to 5}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 1}\,\tilde{x}_{1\to 5}+p_{1\to 3}\,p_{1\to 5}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 1}\,\tilde{x}_{1\to 5}-$$
$$p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 1}\,\tilde{x}_{1\to 6}+p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 1}\,\tilde{x}_{2\to 1}-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 6}\,p_{6\to 1}\,\tilde{x}_{2\to 6}+$$
$$\left.p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 1}\,\tilde{x}_{6\to 1}-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 3}\,\tilde{x}_{6\to 3}\right),\ x_{6\to 1}\to\frac{1}{p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}}$$
$$\left(-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,\tilde{x}_{1\to 2}-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,\tilde{x}_{1\to 3}+p_{1\to 2}\,p_{1\to 3}\,p_{1\to 5}\,p_{2\to 1}\,\tilde{x}_{1\to 5}+\right.$$
$$p_{1\to 2}\,p_{1\to 5}\,p_{1\to 6}\,p_{2\to 1}\,\tilde{x}_{1\to 5}+p_{1\to 3}\,p_{1\to 5}\,p_{1\to 6}\,p_{2\to 1}\,\tilde{x}_{1\to 5}-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,\tilde{x}_{1\to 6}+$$
$$\left.\left.p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,\tilde{x}_{2\to 1}-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 6}\,\tilde{x}_{2\to 6}\right),\ x_{1\to 6}\to\frac{p_{1\to 5}\,\tilde{x}_{1\to 5}-p_{1\to 6}\,\tilde{x}_{1\to 6}}{p_{1\to 6}}\right\}$$

In[282]:=
```
"общее решение:"
xsol = ((s /. xcp) ~Join~ xcp);
xsol // TableForm
```

Out[282]= общее решение:

Out[284]//TableForm=

$$\text{Join}\left[s,\ \left\{x_{1\to 2}\to -\tilde{x}_{1\to 2}+\frac{p_{1\to 5}\,\tilde{x}_{1\to 5}}{p_{1\to 2}},\ x_{2\to 1}\to -\tilde{x}_{2\to 1}+\frac{p_{2\to 6}\,\tilde{x}_{2\to 6}}{p_{2\to 1}},\right.\right.$$
$$x_{6\to 3}\to\frac{1}{p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 3}}\left(-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 1}\,\tilde{x}_{1\to 2}-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 1}\,\tilde{x}_{1\to 3}+\right.$$
$$p_{1\to 2}\,p_{1\to 3}\,p_{1\to 5}\,p_{2\to 1}\,p_{6\to 1}\,\tilde{x}_{1\to 5}+p_{1\to 2}\,p_{1\to 5}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 1}\,\tilde{x}_{1\to 5}+$$
$$p_{1\to 3}\,p_{1\to 5}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 1}\,\tilde{x}_{1\to 5}-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 1}\,\tilde{x}_{1\to 6}+$$
$$p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 1}\,\tilde{x}_{2\to 1}-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 6}\,p_{6\to 1}\,\tilde{x}_{2\to 6}+$$
$$\left.p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 1}\,\tilde{x}_{6\to 1}-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,p_{6\to 3}\,\tilde{x}_{6\to 3}\right),\ x_{6\to 1}\to\frac{1}{p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}}$$
$$\left(-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,\tilde{x}_{1\to 2}-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,\tilde{x}_{1\to 3}+p_{1\to 2}\,p_{1\to 3}\,p_{1\to 5}\,p_{2\to 1}\,\tilde{x}_{1\to 5}+\right.$$
$$p_{1\to 2}\,p_{1\to 5}\,p_{1\to 6}\,p_{2\to 1}\,\tilde{x}_{1\to 5}+p_{1\to 3}\,p_{1\to 5}\,p_{1\to 6}\,p_{2\to 1}\,\tilde{x}_{1\to 5}-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,\tilde{x}_{1\to 6}+$$
$$\left.\left.\left.p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 1}\,\tilde{x}_{2\to 1}-p_{1\to 2}\,p_{1\to 3}\,p_{1\to 6}\,p_{2\to 6}\,\tilde{x}_{2\to 6}\right),\ x_{1\to 6}\to\frac{p_{1\to 5}\,\tilde{x}_{1\to 5}-p_{1\to 6}\,\tilde{x}_{1\to 6}}{p_{1\to 6}}\right\}\right]$$

In[287]:=
```
"eq test:"
Simplify[dopEq /. s /. xcp]
```

Out[287]= eq test:

Out[288]=

$$\left\{\frac{p_{1\bullet\to5}\left(-x_{1\bullet\to5}+\tilde{x}_{1\bullet\to5}\right)}{p_{1\bullet\to2}}==\tilde{x}_{1\bullet\to2},\ \frac{p_{1\bullet\to3}\,x_{1\bullet\to3}+p_{1\bullet\to2}\,\tilde{x}_{1\bullet\to2}-p_{1\bullet\to5}\,\tilde{x}_{1\bullet\to5}}{p_{1\bullet\to2}}==0,\right.$$
$$\tilde{x}_{1\bullet\to2}==\frac{p_{1\bullet\to6}\,\tilde{x}_{1\bullet\to6}}{p_{1\bullet\to2}},\ \frac{p_{2\bullet\to4}\,x_{2\bullet\to4}+p_{2\bullet\to1}\,\tilde{x}_{2\bullet\to1}-p_{2\bullet\to6}\,\tilde{x}_{2\bullet\to6}}{p_{2\bullet\to1}}==0,\ \frac{p_{2\bullet\to6}\left(-x_{2\bullet\to6}+\tilde{x}_{2\bullet\to6}\right)}{p_{2\bullet\to1}}==\tilde{x}_{2\bullet\to1},$$
$$\frac{p_{6\bullet\to1}\,\tilde{x}_{6\bullet\to1}}{p_{6\bullet\to3}}==\tilde{x}_{6\bullet\to3},\ \frac{1}{p_{6\bullet\to3}}\left(p_{6\bullet\to2}\,x_{6\bullet\to2}+p_{6\bullet\to1}\left(\tilde{x}_{1\bullet\to2}+\tilde{x}_{1\bullet\to3}-\frac{p_{1\bullet\to5}\,\tilde{x}_{1\bullet\to5}}{p_{1\bullet\to2}}-\frac{p_{1\bullet\to5}\,\tilde{x}_{1\bullet\to5}}{p_{1\bullet\to3}}-\right.\right.$$
$$\left.\left.\frac{p_{1\bullet\to5}\,\tilde{x}_{1\bullet\to5}}{p_{1\bullet\to6}}+\tilde{x}_{1\bullet\to6}-\tilde{x}_{2\bullet\to1}+\frac{p_{2\bullet\to6}\,\tilde{x}_{2\bullet\to6}}{p_{2\bullet\to1}}-\tilde{x}_{6\bullet\to1}\right)+p_{6\bullet\to3}\,\tilde{x}_{6\bullet\to3}\right)==0\Big\}\ /.\ s$$