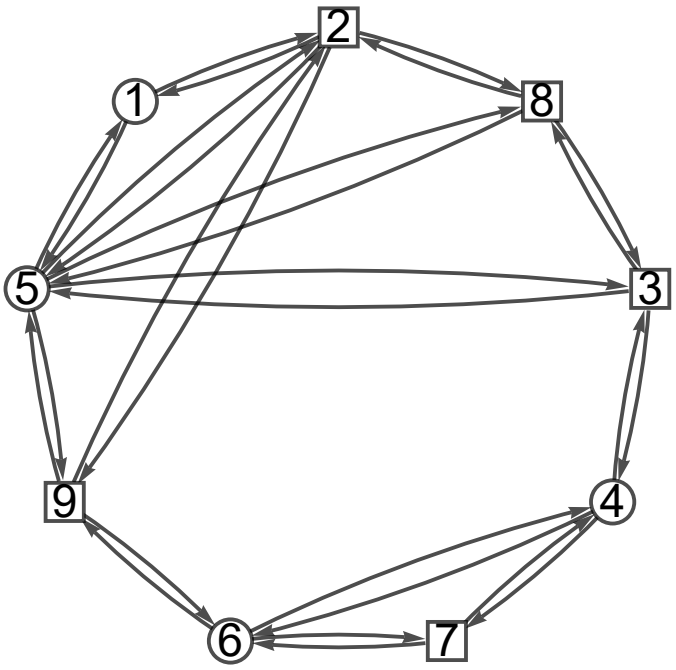
Листинг 2

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

In[ ]:= 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 → Placed["Name", Center],
            VertexStyle → Directive[White],
            VertexShapeFunction → {xx_ :> If[SameQ[b[[xx]], x], "Square", "Circle"]},
            VertexLabelStyle -> Directive[Black, 24], GraphLayout -> "CircularEmbedding"], b}]

In[ ]:= forma[ff_] := ((ff /. {ξ_u_↔v_ → ξu,v}) // TableForm)

In[ ]:=
        {g, b} = readGraph2["grDET0.txt", NotebookDirectory[]];
        GraphPlot[g, EdgeStyle → Directive[Black, Thick],
         VertexStyle → Directive[EdgeForm[Thick], White], MultiedgeStyle → .05]
```

Out[ ]=



In[ ]:=
```
balanceEqs = ((Total[x_# & /@ EdgeList[g, _ ↔ #]] - Total[x_# & /@ EdgeList[g, # ↔ _]])) ==
      MapIndexed[#1 /. x → x_#2[[1]] &, b][[#]] & /@ VertexList[g];
balanceEqs //
 forma
```

Out[ ]//TableForm=

$$-x_{1,2} - x_{1,5} + x_{2,1} + x_{5,1} == 0$$
$$x_{1,2} - x_{2,1} - x_{2,5} - x_{2,8} - x_{2,9} + x_{5,2} + x_{8,2} + x_{9,2} == x_2$$
$$x_{1,5} + x_{2,5} + x_{3,5} - x_{5,1} - x_{5,2} - x_{5,3} - x_{5,8} - x_{5,9} + x_{8,5} + x_{9,5} == 0$$
$$x_{2,8} + x_{3,8} + x_{5,8} - x_{8,2} - x_{8,3} - x_{8,5} == x_8$$
$$-x_{3,4} - x_{3,5} - x_{3,8} + x_{4,3} + x_{5,3} + x_{8,3} == x_3$$
$$x_{3,4} - x_{4,3} - x_{4,6} - x_{4,7} + x_{6,4} + x_{7,4} == 0$$
$$x_{4,7} + x_{6,7} - x_{7,4} - x_{7,6} == x_7$$
$$x_{4,6} - x_{6,4} - x_{6,7} - x_{6,9} + x_{7,6} + x_{9,6} == 0$$
$$x_{2,9} + x_{5,9} + x_{6,9} - x_{9,2} - x_{9,5} - x_{9,6} == x_9$$

In[ ]:=
```
M = {9};
Print["M = ", M];
```

M = {9}

In[ ]:=
```
(*Do[inclist=EdgeList[g,u↔_];
 Do[p_v=1/Length[inclist];,{v,inclist}];,{u,VertexList[g]}]*)
```

In[ ]:=
```
(*p_#&/@EdgeList[g]*)
```

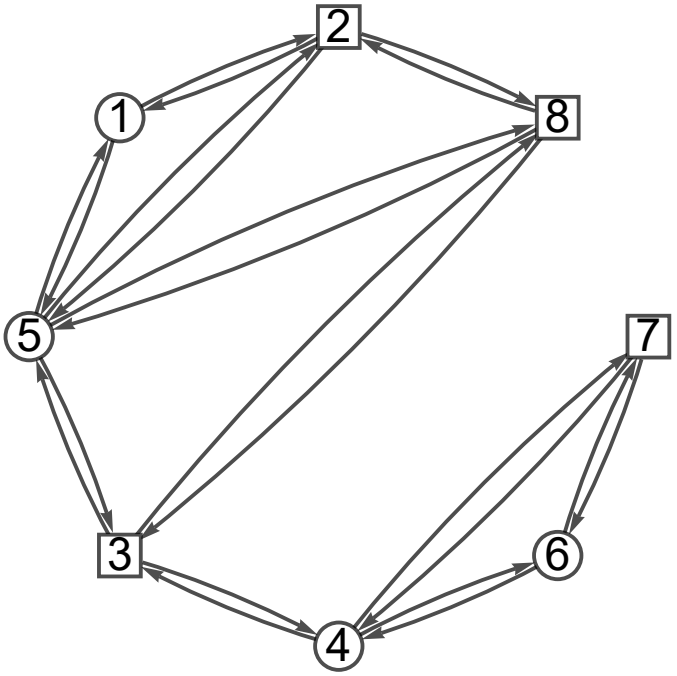
In[ ]:=
```
(*incL=
 DeleteCases[DeleteDuplicates[Cases[IncidenceList[g,#],i_↔j_:>{i,j}]//Flatten],
    v_/;v==#]&/@M*)
incL = (IncidenceList[g, #] & /@ M) // Flatten
```

Out[ ]= {9 ↔ 6, 6 ↔ 9, 9 ↔ 5, 5 ↔ 9, 9 ↔ 2, 2 ↔ 9}

In[ ]:=
```
(*Do[If[MemberQ[M,j[[1]]],b[[j[[2]]]]+=f_j,b[[j[[1]]]]-=f_j],{j,incL}]*)
b̄ = Fold[If[MemberQ[M, #2[[1]]], ReplacePart[#, #2[[2]] → #[[#2[[2]]]] - f_#2],
      ReplacePart[#, #2[[1]] → #[[#2[[1]]]] + f_#2]] &, b, incL];
b̄ = b̄[[Range[VertexCount[g]] ~Complement~ M]]
n̄ḡ = VertexDelete[g, M];
GraphPlot[n̄ḡ, EdgeStyle → Directive[Black, Thick],
 VertexStyle → Directive[EdgeForm[Thick], White], MultiedgeStyle → .05]
b̄
```

Out[ ]=
$$\{0,\ x + f_{2\to 9} - f_{9\to 2},\ x,\ 0,\ f_{5\to 9} - f_{9\to 5},\ f_{6\to 9} - f_{9\to 6},\ x,\ x\}$$

Out[ ]=



Out[ ]=
$$\{0,\ x + f_{2\to 9} - f_{9\to 2},\ x,\ 0,\ f_{5\to 9} - f_{9\to 5},\ f_{6\to 9} - f_{9\to 6},\ x,\ x\}$$

In[ ]:=
```
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[ ]:=
```
M⁺ = CC[g, M]
```

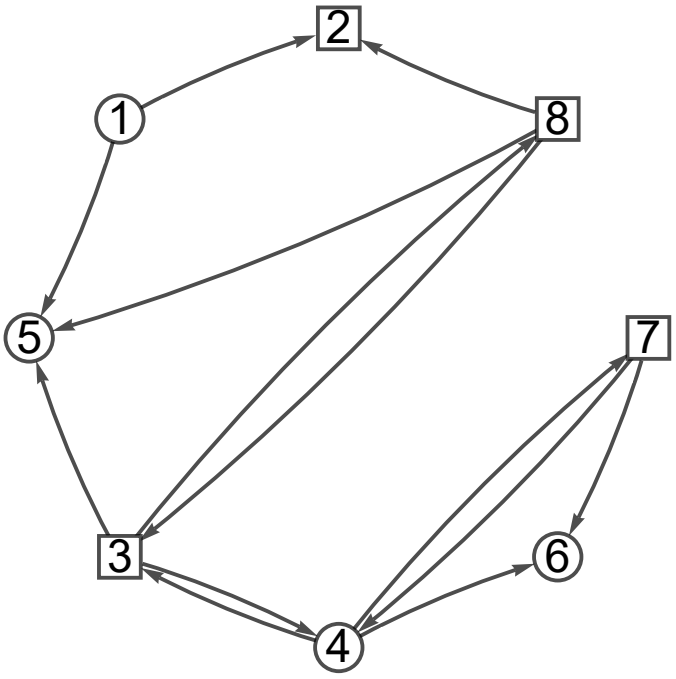
Out[ ]=
$$\{6 \leftrightarrow 9,\ 5 \leftrightarrow 9,\ 2 \leftrightarrow 9\}$$

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

Out[•]=
$$\left\{-\frac{f_{2\bullet\to 9}\, p_{2\bullet\to 1}}{p_{2\bullet\to 9}}-\frac{f_{5\bullet\to 9}\, p_{5\bullet\to 1}}{p_{5\bullet\to 9}},\right.$$
$$x+f_{2\bullet\to 9}-f_{9\bullet\to 2}+\frac{f_{2\bullet\to 9}\, p_{2\bullet\to 1}}{p_{2\bullet\to 9}}+\frac{f_{2\bullet\to 9}\, p_{2\bullet\to 5}}{p_{2\bullet\to 9}}+\frac{f_{2\bullet\to 9}\, p_{2\bullet\to 8}}{p_{2\bullet\to 9}}-\frac{f_{5\bullet\to 9}\, p_{5\bullet\to 2}}{p_{5\bullet\to 9}},\ x-\frac{f_{5\bullet\to 9}\, p_{5\bullet\to 3}}{p_{5\bullet\to 9}},$$
$$-\frac{f_{6\bullet\to 9}\, p_{6\bullet\to 4}}{p_{6\bullet\to 9}},\ f_{5\bullet\to 9}-f_{9\bullet\to 5}-\frac{f_{2\bullet\to 9}\, p_{2\bullet\to 5}}{p_{2\bullet\to 9}}+\frac{f_{5\bullet\to 9}\, p_{5\bullet\to 1}}{p_{5\bullet\to 9}}+\frac{f_{5\bullet\to 9}\, p_{5\bullet\to 2}}{p_{5\bullet\to 9}}+\frac{f_{5\bullet\to 9}\, p_{5\bullet\to 3}}{p_{5\bullet\to 9}}+\frac{f_{5\bullet\to 9}\, p_{5\bullet\to 8}}{p_{5\bullet\to 9}},$$
$$\left.f_{6\bullet\to 9}-f_{9\bullet\to 6}+\frac{f_{6\bullet\to 9}\, p_{6\bullet\to 4}}{p_{6\bullet\to 9}}+\frac{f_{6\bullet\to 9}\, p_{6\bullet\to 7}}{p_{6\bullet\to 9}},\ x-\frac{f_{6\bullet\to 9}\, p_{6\bullet\to 7}}{p_{6\bullet\to 9}},\ x-\frac{f_{2\bullet\to 9}\, p_{2\bullet\to 8}}{p_{2\bullet\to 9}}-\frac{f_{5\bullet\to 9}\, p_{5\bullet\to 8}}{p_{5\bullet\to 9}}\right\}$$

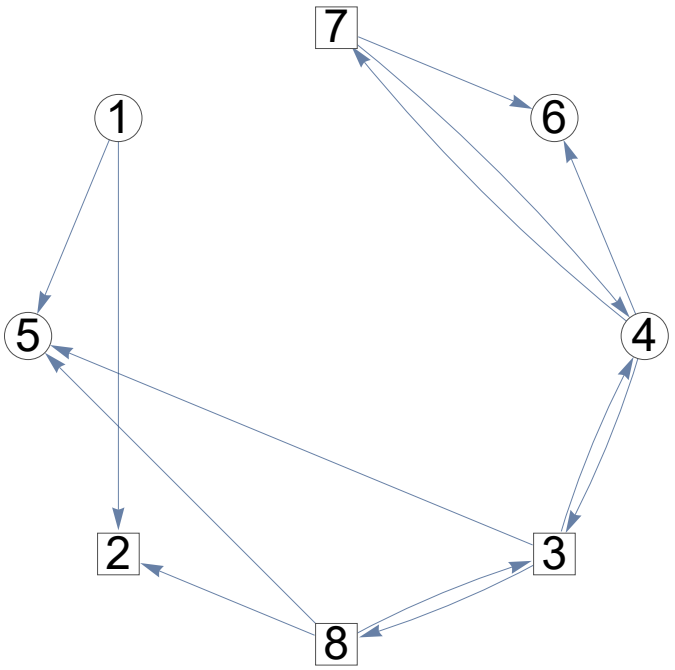
In[•]:=
```
GraphPlot[Fold[HighlightGraph[#1, u_ ↔ v_ /; u == #2, GraphHighlightStyle → "White"] &,
  ng, #[[1]] & /@ M^+], EdgeStyle → Directive[Black, Thick],
 VertexStyle → Directive[EdgeForm[Thick], White], MultiedgeStyle → .05]
```

Out[•]=



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

Out[•]=



In[•]:=
```
IIrem = VertexList[g1] ~Complement~ (M+[[All, 1]])
```

Out[•]=
```
{1, 3, 4, 7, 8}
```

In[•]:=
```
λ = SparseArray[
  Replace[(EdgeList[g1] /. # & /@ Flatten[Module[{i = #, jf, Icur},
      (Icur = ii↕[g1];
       jf = First[Icur];
       ({(i ↔ jf) → 1, (i ↔ #) → -p_{i↔#}/p_{i↔jf}} & /@ Icur[[2 ;;]])] & /@ IIrem, 1]),
   _ ↔ _ → 0, 2]]
```

Out[•]=
```
SparseArray[ <>  ]
```
Specified elements: 16
Dimensions: {8, 13}

In[•]:=
```
Grid[λ]
```

Out[•]=

1	$-\frac{p_{1\leftrightarrow5}}{p_{1\leftrightarrow2}}$	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	$-\frac{p_{3\leftrightarrow8}}{p_{3\leftrightarrow4}}$	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0	0	0	0	$-\frac{p_{3\leftrightarrow5}}{p_{3\leftrightarrow4}}$
0	0	0	0	1	0	0	$-\frac{p_{4\leftrightarrow7}}{p_{4\leftrightarrow3}}$	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0	0	$-\frac{p_{4\leftrightarrow6}}{p_{4\leftrightarrow3}}$	0
0	0	0	0	0	0	0	0	1	0	$-\frac{p_{7\leftrightarrow6}}{p_{7\leftrightarrow4}}$	0	0
0	0	1	0	0	0	$-\frac{p_{8\leftrightarrow3}}{p_{8\leftrightarrow2}}$	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0	$-\frac{p_{8\leftrightarrow5}}{p_{8\leftrightarrow2}}$	0	0	0

In[•]:=
```
g = g1;
b = b1;
```

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

Out[ ]=
```
{2, 3, 7, 8}
```

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

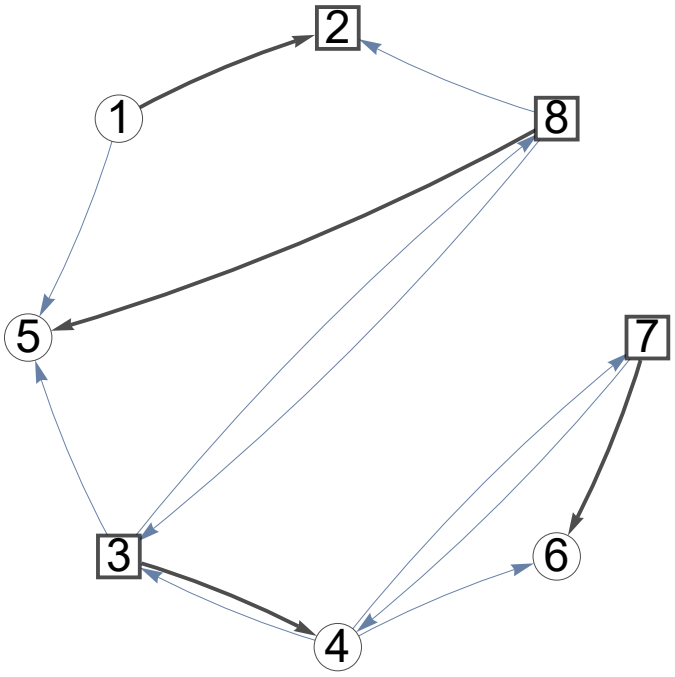
Out[ ]=
```
0.
```

Out[ ]//TableForm=

	1	2	3	4	5	6	7	8	9
pred	2	9	9	3	8	7	9	9	0
dir	−1	1	1	1	1	1	1	1	0
depth	2	1	1	2	2	2	1	1	0
d	8	1	4	7	3	9	6	5	2

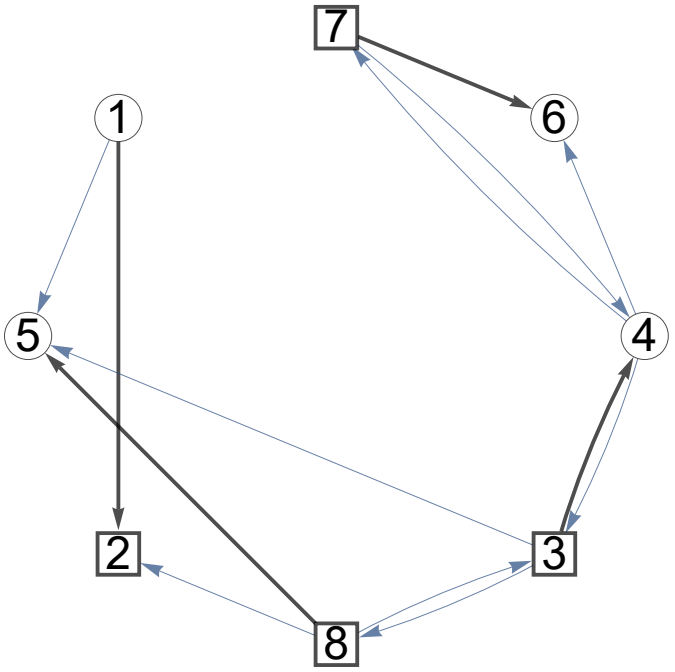
In[ ]:=
```
GraphPlot[HighlightGraph[
  Fold[HighlightGraph[#1, Style[u_ ↔ v_ /; u == #2, White]] &, ng, #[[1]] & /@ M+],
  {Style[u_ /; VertexQ[g, u] && pred[t][[u]] == root[t], EdgeForm[Thick]],
   Style[u_ ↔ v_ /; (pred[t][[u]] == v && dir[t][[u]] == -1) ||
      (pred[t][[v]] == u && dir[t][[v]] == 1), Directive[Black, Thick]]},
  GraphHighlightStyle → None], MultiedgeStyle → .05]
```

Out[ ]=



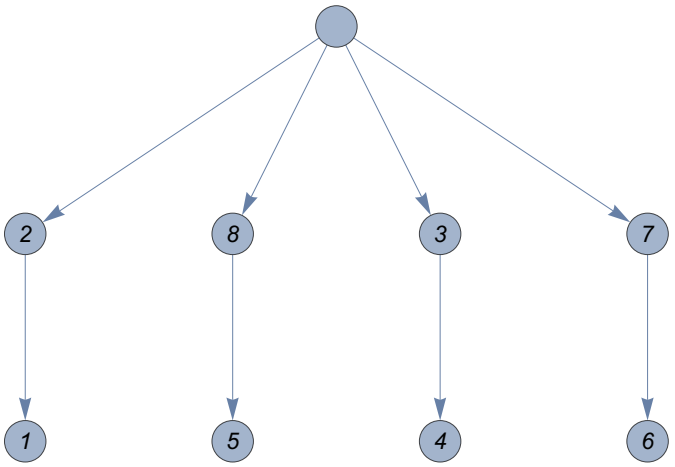
In[•]:=
```
GraphPlot[HighlightGraph[g1,
  {Style[u_ /; VertexQ[g, u] && pred[t][[u]] == root[t], EdgeForm[Thick]],
   Style[u_ ↔ v_ /; (pred[t][[u]] == v && dir[t][[u]] == -1) ||
       (pred[t][[v]] == u && dir[t][[v]] == 1), Directive[Black, Thick]]},
  GraphHighlightStyle → None], MultiedgeStyle → .05]
```

Out[•]=



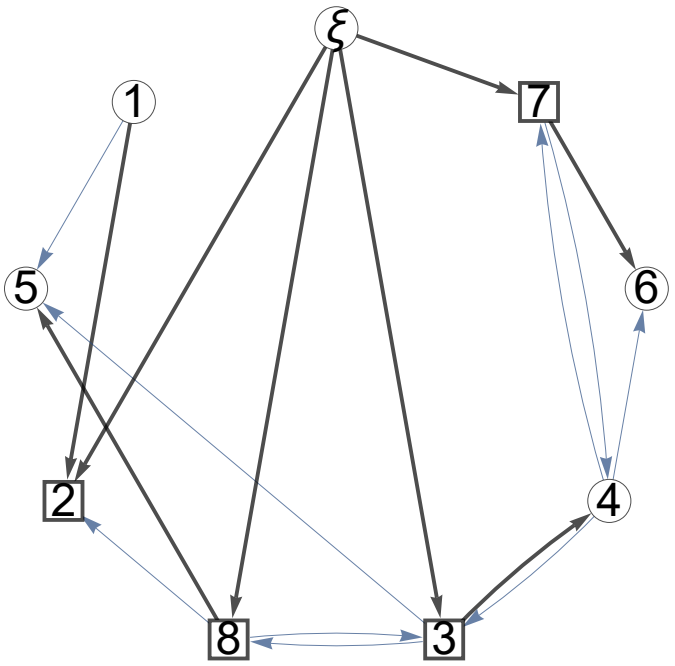
In[•]:=
```
t[[7]](*пометить на графе*)
```

Out[•]=



In[ ]:=
```
(*GraphPlot[g,MultiedgeStyle→.05]*)
GraphPlot[HighlightGraph[g,
  {Style[u_ /; VertexQ[g, u] && pred[t][[u]] == root[t], EdgeForm[Thick]],
   Style[u_ ↔ v_ /; (pred[t][[u]] == v && dir[t][[u]] == -1) ||
       (pred[t][[v]] == u && dir[t][[v]] == 1), Directive[Black, Thick]]},
  GraphHighlightStyle → None], MultiedgeStyle → .05]
```

Out[ ]=



In[ ]:=
```
AppendTo[b, -Total[b]];
b = Simplify[b /. x → 0]
```

Out[ ]=

$$\left\{-\frac{f_{2\bullet\to 9}\,p_{2\bullet\to 1}}{p_{2\bullet\to 9}}-\frac{f_{5\bullet\to 9}\,p_{5\bullet\to 1}}{p_{5\bullet\to 9}},\ -f_{9\bullet\to 2}+\frac{f_{2\bullet\to 9}\,(p_{2\bullet\to 1}+p_{2\bullet\to 5}+p_{2\bullet\to 8}+p_{2\bullet\to 9})}{p_{2\bullet\to 9}}-\frac{f_{5\bullet\to 9}\,p_{5\bullet\to 2}}{p_{5\bullet\to 9}},\right.$$
$$-\frac{f_{5\bullet\to 9}\,p_{5\bullet\to 3}}{p_{5\bullet\to 9}},\ -\frac{f_{6\bullet\to 9}\,p_{6\bullet\to 4}}{p_{6\bullet\to 9}},\ -f_{9\bullet\to 5}-\frac{f_{2\bullet\to 9}\,p_{2\bullet\to 5}}{p_{2\bullet\to 9}}+\frac{f_{5\bullet\to 9}\,(p_{5\bullet\to 1}+p_{5\bullet\to 2}+p_{5\bullet\to 3}+p_{5\bullet\to 8}+p_{5\bullet\to 9})}{p_{5\bullet\to 9}},$$
$$-f_{9\bullet\to 6}+\frac{f_{6\bullet\to 9}\,(p_{6\bullet\to 4}+p_{6\bullet\to 7}+p_{6\bullet\to 9})}{p_{6\bullet\to 9}},\ -\frac{f_{6\bullet\to 9}\,p_{6\bullet\to 7}}{p_{6\bullet\to 9}},$$
$$\left.-\frac{f_{2\bullet\to 9}\,p_{2\bullet\to 8}}{p_{2\bullet\to 9}}-\frac{f_{5\bullet\to 9}\,p_{5\bullet\to 8}}{p_{5\bullet\to 9}},\ -f_{2\bullet\to 9}-f_{5\bullet\to 9}-f_{6\bullet\to 9}+f_{9\bullet\to 2}+f_{9\bullet\to 5}+f_{9\bullet\to 6}\right\}$$

In[ ]:=
```
balanceEqs = ((Total[x_# & /@ EdgeList[g, _ ↔ #]] - Total[x_# & /@ EdgeList[g, # ↔ _]]) /.
        root[t] → ξ) == b[[#]] & /@ VertexList[g];
balanceEqs //
 forma
```

Out[ ]//TableForm=

$$-x_{1,2}-x_{1,5}==-\frac{f_{2,9}\,p_{2,1}}{p_{2,9}}-\frac{f_{5,9}\,p_{5,1}}{p_{5,9}}$$

$$x_{1,2}+x_{8,2}+x_{\xi,2}==-f_{9,2}+\frac{f_{2,9}\,(p_{2,1}+p_{2,5}+p_{2,8}+p_{2,9})}{p_{2,9}}-\frac{f_{5,9}\,p_{5,2}}{p_{5,9}}$$

$$x_{1,5}+x_{3,5}+x_{8,5}==-f_{9,5}-\frac{f_{2,9}\,p_{2,5}}{p_{2,9}}+\frac{f_{5,9}\,(p_{5,1}+p_{5,2}+p_{5,3}+p_{5,8}+p_{5,9})}{p_{5,9}}$$

$$x_{3,8}-x_{8,2}-x_{8,3}-x_{8,5}+x_{\xi,8}==-\frac{f_{2,9}\,p_{2,8}}{p_{2,9}}-\frac{f_{5,9}\,p_{5,8}}{p_{5,9}}$$

$$-x_{3,4}-x_{3,5}-x_{3,8}+x_{4,3}+x_{8,3}+x_{\xi,3}==-\frac{f_{5,9}\,p_{5,3}}{p_{5,9}}$$

$$x_{3,4}-x_{4,3}-x_{4,6}-x_{4,7}+x_{7,4}==-\frac{f_{6,9}\,p_{6,4}}{p_{6,9}}$$

$$x_{4,7}-x_{7,4}-x_{7,6}+x_{\xi,7}==-\frac{f_{6,9}\,p_{6,7}}{p_{6,9}}$$

$$x_{4,6}+x_{7,6}==-f_{9,6}+\frac{f_{6,9}\,(p_{6,4}+p_{6,7}+p_{6,9})}{p_{6,9}}$$

$$-x_{\xi,2}-x_{\xi,3}-x_{\xi,7}-x_{\xi,8}==-f_{2,9}-f_{5,9}-f_{6,9}+f_{9,2}+f_{9,5}+f_{9,6}$$

In[ ]:=
```
ps = partSolve[g, -b, t, x̃];
ps // forma
```

Out[ ]//TableForm=

$$\tilde{x}_{1,2}\to\frac{f_{2,9}\,p_{2,1}}{p_{2,9}}+\frac{f_{5,9}\,p_{5,1}}{p_{5,9}}$$

$$\tilde{x}_{1,5}\to 0$$

$$\tilde{x}_{3,4}\to-\frac{f_{6,9}\,p_{6,4}}{p_{6,9}}$$

$$\tilde{x}_{3,5}\to 0$$

$$\tilde{x}_{3,8}\to 0$$

$$\tilde{x}_{4,3}\to 0$$

$$\tilde{x}_{4,6}\to 0$$

$$\tilde{x}_{4,7}\to 0$$

$$\tilde{x}_{7,4}\to 0$$

$$\tilde{x}_{7,6}\to-f_{9,6}+\frac{f_{6,9}\,(p_{6,4}+p_{6,7}+p_{6,9})}{p_{6,9}}$$

$$\tilde{x}_{8,2}\to 0$$

$$\tilde{x}_{8,3}\to 0$$

$$\tilde{x}_{8,5}\to-f_{9,5}-\frac{f_{2,9}\,p_{2,5}}{p_{2,9}}+\frac{f_{5,9}\,(p_{5,1}+p_{5,2}+p_{5,3}+p_{5,8}+p_{5,9})}{p_{5,9}}$$

$$\tilde{x}_{9,2}\to-f_{9,2}-\frac{f_{2,9}\,p_{2,1}}{p_{2,9}}+\frac{f_{2,9}\,(p_{2,1}+p_{2,5}+p_{2,8}+p_{2,9})}{p_{2,9}}-\frac{f_{5,9}\,p_{5,1}}{p_{5,9}}-\frac{f_{5,9}\,p_{5,2}}{p_{5,9}}$$

$$\tilde{x}_{9,3}\to-\frac{f_{5,9}\,p_{5,3}}{p_{5,9}}-\frac{f_{6,9}\,p_{6,4}}{p_{6,9}}$$

$$\tilde{x}_{9,7}\to-f_{9,6}-\frac{f_{6,9}\,p_{6,7}}{p_{6,9}}+\frac{f_{6,9}\,(p_{6,4}+p_{6,7}+p_{6,9})}{p_{6,9}}$$

$$\tilde{x}_{9,8}\to-f_{9,5}-\frac{f_{2,9}\,p_{2,5}}{p_{2,9}}-\frac{f_{2,9}\,p_{2,8}}{p_{2,9}}-\frac{f_{5,9}\,p_{5,8}}{p_{5,9}}+\frac{f_{5,9}\,(p_{5,1}+p_{5,2}+p_{5,3}+p_{5,8}+p_{5,9})}{p_{5,9}}$$

In[ ]:=
```
Simplify[(balanceEqs /. {x → x̃, ξ → root[t]}) /. ps]
```

Out[ ]=
```
{True, True, True, True, True, True, True, True, True}
```

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

Out[ ]//TableForm=

	$\delta_{1,2}$	$\delta_{1,5}$	$\delta_{8,2}$	$\delta_{3,4}$	$\delta_{4,3}$	$\delta_{3,8}$	$\delta_{8,3}$	$\delta_{4,7}$	$\delta_{7,4}$	$\delta_{8,5}$	$\delta_{7,6}$
$1 \leftrightarrow 5$	-1	1	0	0	0	0	0	0	0	-1	0
$8 \leftrightarrow 2$	0	0	1	0	0	0	0	0	0	0	0
$4 \leftrightarrow 3$	0	0	0	1	1	0	0	0	0	0	0
$3 \leftrightarrow 8$	0	0	0	0	0	1	0	0	0	0	0
$8 \leftrightarrow 3$	0	0	0	0	0	0	1	0	0	0	0
$4 \leftrightarrow 7$	0	0	0	1	0	0	0	1	0	0	0
$7 \leftrightarrow 4$	0	0	0	-1	0	0	0	0	1	0	0
$4 \leftrightarrow 6$	0	0	0	1	0	0	0	0	0	0	-1
$3 \leftrightarrow 5$	0	0	0	0	0	0	0	0	0	-1	0

In[ ]:=
```
λ = SparseArray[λ, {Length[λ], Length[λ[[1]]] + Length[II*]}];
(*λ=λ[[;;-2]]*)
```

In[ ]:=
```
dopEq = # == 0 & /@ Flatten[λ.{x_# & /@ EdgeList[g]}^T];
dopEq // forma
```

Out[ ]//TableForm=

$$x_{1,2} - \frac{p_{1,5}\, x_{1,5}}{p_{1,2}} == 0$$
$$x_{3,4} - \frac{p_{3,8}\, x_{3,8}}{p_{3,4}} == 0$$
$$x_{3,4} - \frac{p_{3,5}\, x_{3,5}}{p_{3,4}} == 0$$
$$x_{4,3} - \frac{p_{4,7}\, x_{4,7}}{p_{4,3}} == 0$$
$$x_{4,3} - \frac{p_{4,6}\, x_{4,6}}{p_{4,3}} == 0$$
$$x_{7,4} - \frac{p_{7,6}\, x_{7,6}}{p_{7,4}} == 0$$
$$x_{8,2} - \frac{p_{8,3}\, x_{8,3}}{p_{8,2}} == 0$$
$$x_{8,2} - \frac{p_{8,5}\, x_{8,5}}{p_{8,2}} == 0$$

In[ ]:=
```
Λ = λ.(δMatr)^T;
"cicle det's:"
Λ // forma
```

Out[ ]= cicle det's:

Out[ ]//TableForm=

$$\begin{array}{cccccccc}
-1 - \frac{p_{1\leftrightarrow 5}}{p_{1\leftrightarrow 2}} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 1 & -\frac{p_{3\leftrightarrow 8}}{p_{3\leftrightarrow 4}} & 0 & 1 & -1 & 1 \\
0 & 0 & 1 & 0 & 0 & 1 & -1 & 1 \\
0 & 0 & 1 & 0 & 0 & -\frac{p_{4\leftrightarrow 7}}{p_{4\leftrightarrow 3}} & 0 & 0 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 & -\frac{p_{4\leftrightarrow 6}}{p_{4\leftrightarrow 3}} \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & \frac{p_{7\leftrightarrow 6}}{p_{7\leftrightarrow 4}} \\
0 & 1 & 0 & 0 & -\frac{p_{8\leftrightarrow 3}}{p_{8\leftrightarrow 2}} & 0 & 0 & 0 \\
\frac{p_{8\leftrightarrow 5}}{p_{8\leftrightarrow 2}} & 1 & 0 & 0 & 0 & 0 & 0 & 0
\end{array}
\qquad
\begin{array}{c}
0 \\ 0 \\ -\frac{p_{3\leftrightarrow 5}}{p_{3\leftrightarrow 4}} \\ 0 \\ 0 \\ 0 \\ 0 \\ \frac{p_{8\leftrightarrow 5}}{p_{8\leftrightarrow 2}}
\end{array}$$

In[ ]:=
```
MatrixRank[Λ]
```

Out[ ]= 8

In[•]:=
```
"Uc="
Uc = {1, 2, 3, 4, 5, 6, 7, 8}
"Unc="
Unc = {9}
```

Out[•]= $U_c =$

Out[•]= $\{1, 2, 3, 4, 5, 6, 7, 8\}$

Out[•]= $U_{nc} =$

Out[•]= $\{9\}$

In[•]:=
```
Λc = Λ[[All, Uc]];
Λnc = Λ[[All, Unc]];
"Λc="
Λc // MatrixForm
```

Out[•]= $\Lambda_c =$

Out[•]//MatrixForm=

$$\begin{pmatrix} -1 - \frac{p_{1\leftrightarrow 5}}{p_{1\leftrightarrow 2}} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & -\frac{p_{3\leftrightarrow 8}}{p_{3\leftrightarrow 4}} & 0 & 1 & -1 & 1 \\ 0 & 0 & 1 & 0 & 0 & 1 & -1 & 1 \\ 0 & 0 & 1 & 0 & 0 & -\frac{p_{4\leftrightarrow 7}}{p_{4\leftrightarrow 3}} & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & -\frac{p_{4\leftrightarrow 6}}{p_{4\leftrightarrow 3}} \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & \frac{p_{7\leftrightarrow 6}}{p_{7\leftrightarrow 4}} \\ 0 & 1 & 0 & 0 & -\frac{p_{8\leftrightarrow 3}}{p_{8\leftrightarrow 2}} & 0 & 0 & 0 \\ \frac{p_{8\leftrightarrow 5}}{p_{8\leftrightarrow 2}} & 1 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

In[•]:=
```
"det(Λc)="
Simplify[det = Det[Λc]] // forma
```

Out[•]= $\det(\Lambda_c) =$

Out[•]//TableForm=

$$\frac{(p_{1,2} + p_{1,5})\, p_{3,8}\, (p_{4,6}\, p_{4,7}\, p_{7,4} + p_{4,3}\, (p_{4,6}\, p_{7,4} + p_{4,7}\, (p_{7,4} + p_{7,6})))\, p_{8,3}}{p_{1,2}\, p_{3,4}\, p_{4,3}^2\, p_{7,4}\, p_{8,2}}$$

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

Out[•]= $U_T =$

Out[•]= $\{1 \leftrightarrow 2,\ 9 \leftrightarrow 2,\ 9 \leftrightarrow 3,\ 3 \leftrightarrow 4,\ 8 \leftrightarrow 5,\ 7 \leftrightarrow 6,\ 9 \leftrightarrow 7,\ 9 \leftrightarrow 8\}$

In[•]:=
```
"UNb="
UNb = uNb[g, t]
```

Out[•]= $U_{Nb} =$

Out[•]= $\{1 \leftrightarrow 5,\ 8 \leftrightarrow 2,\ 4 \leftrightarrow 3,\ 3 \leftrightarrow 8,\ 8 \leftrightarrow 3,\ 4 \leftrightarrow 7,\ 7 \leftrightarrow 4,\ 4 \leftrightarrow 6,\ 3 \leftrightarrow 5\}$

In[ ]:=
```
A = -λ.{x̃_# & /@ EdgeList[g]}^T /. ps;
"A="
A // MatrixForm
```

Out[ ]= A=

Out[ ]//MatrixForm=

$$\begin{pmatrix} -\frac{f_{2\to 9}\, p_{2\to 1}}{p_{2\to 9}} - \frac{f_{5\to 9}\, p_{5\to 1}}{p_{5\to 9}} \\ \frac{f_{6\to 9}\, p_{6\to 4}}{p_{6\to 9}} \\ \frac{f_{6\to 9}\, p_{6\to 4}}{p_{6\to 9}} \\ 0 \\ 0 \\ \frac{\left(-f_{9\to 6} + \frac{f_{6\to 9}\,(p_{6\to 4}+p_{6\to 7}+p_{6\to 9})}{p_{6\to 9}}\right) p_{7\to 6}}{p_{7\to 4}} \\ 0 \\ \frac{\left(-f_{9\to 5} - \frac{f_{2\to 9}\, p_{2\to 5}}{p_{2\to 9}} + \frac{f_{5\to 9}\,(p_{5\to 1}+p_{5\to 2}+p_{5\to 3}+p_{5\to 8}+p_{5\to 9})}{p_{5\to 9}}\right) p_{8\to 5}}{p_{8\to 2}} \end{pmatrix}$$

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

Out[ ]= β=

Out[ ]//TableForm=

$$-\frac{f_{2,9}\, p_{2,1}}{p_{2,9}} - \frac{f_{5,9}\, p_{5,1}}{p_{5,9}}$$

$$\frac{f_{6,9}\, p_{6,4}}{p_{6,9}}$$

$$\frac{f_{6,9}\, p_{6,4}}{p_{6,9}} + \frac{p_{3,5}\, x_{3,5}}{p_{3,4}}$$

$$0$$

$$0$$

$$\frac{\left(-f_{9,6} + \frac{f_{6,9}\,(p_{6,4}+p_{6,7}+p_{6,9})}{p_{6,9}}\right) p_{7,6}}{p_{7,4}}$$

$$0$$

$$\frac{\left(-f_{9,5} - \frac{f_{2,9}\, p_{2,5}}{p_{2,9}} + \frac{f_{5,9}\,(p_{5,1}+p_{5,2}+p_{5,3}+p_{5,8}+p_{5,9})}{p_{5,9}}\right) p_{8,5}}{p_{8,2}} - \frac{p_{8,5}\, x_{3,5}}{p_{8,2}}$$

In[ ]:=
```
"решаем уравнение Λcxc=β:"
xc = LinearSolve[Λc, β[[]]]
```

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

Out[ ]=
$$\left\{\left\{\frac{f_{5.\to 9}\, p_{1.\to 2}\, p_{2.\to 9}\, p_{5.\to 1} + f_{2.\to 9}\, p_{1.\to 2}\, p_{2.\to 1}\, p_{5.\to 9}}{(p_{1.\to 2} + p_{1.\to 5})\, p_{2.\to 9}\, p_{5.\to 9}}\right\},\right.$$

$$\left\{\frac{1}{(p_{1.\to 2} + p_{1.\to 5})\, p_{2.\to 9}\, p_{5.\to 9}\, p_{8.\to 2}}\left(f_{5.\to 9}\, p_{1.\to 5}\, p_{2.\to 9}\, p_{5.\to 1}\, p_{8.\to 5} + f_{5.\to 9}\, p_{1.\to 2}\, p_{2.\to 9}\, p_{5.\to 2}\, p_{8.\to 5} + f_{5.\to 9}\, p_{1.\to 5}\, p_{2.\to 9}\, p_{5.\to 2}\, p_{8.\to 5} + f_{5.\to 9}\, p_{1.\to 2}\, p_{2.\to 9}\, p_{5.\to 3}\, p_{8.\to 5} + f_{5.\to 9}\, p_{1.\to 5}\, p_{2.\to 9}\, p_{5.\to 3}\, p_{8.\to 5} + f_{5.\to 9}\, p_{1.\to 2}\, p_{2.\to 9}\, p_{5.\to 8}\, p_{8.\to 5} + f_{5.\to 9}\, p_{1.\to 5}\, p_{2.\to 9}\, p_{5.\to 8}\, p_{8.\to 5} - f_{2.\to 9}\, p_{1.\to 2}\, p_{2.\to 1}\, p_{5.\to 9}\, p_{8.\to 5} - f_{2.\to 9}\, p_{1.\to 2}\, p_{2.\to 5}\, p_{5.\to 9}\, p_{8.\to 5} - f_{2.\to 9}\, p_{1.\to 5}\, p_{2.\to 5}\, p_{5.\to 9}\, p_{8.\to 5} + f_{5.\to 9}\, p_{1.\to 2}\, p_{2.\to 9}\, p_{5.\to 9}\, p_{8.\to 5} - f_{9.\to 5}\, p_{1.\to 2}\, p_{2.\to 9}\, p_{5.\to 9}\, p_{8.\to 5} + f_{5.\to 9}\, p_{1.\to 5}\, p_{2.\to 9}\, p_{5.\to 9}\, p_{8.\to 5} - f_{9.\to 5}\, p_{1.\to 5}\, p_{2.\to 9}\, p_{5.\to 9}\, p_{8.\to 5} - p_{1.\to 2}\, p_{2.\to 9}\, p_{5.\to 9}\, p_{8.\to 5}\, x_{3.\to 5} - p_{1.\to 5}\, p_{2.\to 9}\, p_{5.\to 9}\, p_{8.\to 5}\, x_{3.\to 5}\right)\right\},$$

$$\left\{\left(p_{4.\to 6}\, p_{4.\to 7}\left(f_{6.\to 9}\, p_{3.\to 4}\, p_{6.\to 4}\, p_{7.\to 4} + f_{6.\to 9}\, p_{3.\to 4}\, p_{6.\to 4}\, p_{7.\to 6} + f_{6.\to 9}\, p_{3.\to 4}\, p_{6.\to 7}\, p_{7.\to 6} + f_{6.\to 9}\, p_{3.\to 4}\, p_{6.\to 9}\, p_{7.\to 6} - f_{9.\to 6}\, p_{3.\to 4}\, p_{6.\to 9}\, p_{7.\to 6} + p_{3.\to 5}\, p_{6.\to 9}\, p_{7.\to 4}\, x_{3.\to 5}\right)\right) \Big/ \left(p_{3.\to 4}\, p_{6.\to 9}\left(p_{4.\to 3}\, p_{4.\to 6}\, p_{7.\to 4} + p_{4.\to 3}\, p_{4.\to 7}\, p_{7.\to 4} + p_{4.\to 6}\, p_{4.\to 7}\, p_{7.\to 4} + p_{4.\to 3}\, p_{4.\to 7}\, p_{7.\to 6}\right)\right)\right\},$$

$$\left\{\frac{p_{3.\to 5}\, x_{3.\to 5}}{p_{3.\to 8}}\right\},$$

$$\left\{\frac{p_{8.\to 2}\left(\frac{\left(-\frac{f_{2.\to 9}\, p_{2.\to 1}}{p_{2.\to 9}} - \frac{f_{5.\to 9}\, p_{5.\to 1}}{p_{5.\to 9}}\right) p_{8.\to 5}}{p_{8.\to 2}} - \left(-1 - \frac{p_{1.\to 5}}{p_{1.\to 2}}\right)\left(\frac{\left(-f_{9.\to 5} - \frac{f_{2.\to 9}\, p_{2.\to 5}}{p_{2.\to 9}} + \frac{f_{5.\to 9}\,(p_{5.\to 1} + p_{5.\to 2} + p_{5.\to 3} + p_{5.\to 8} + p_{5.\to 9})}{p_{5.\to 9}}\right) p_{8.\to 5}}{p_{8.\to 2}} - \frac{p_{8.\to 5}\, x_{3.\to 5}}{p_{8.\to 2}}\right)\right)}{\left(1 + \frac{p_{1.\to 5}}{p_{1.\to 2}}\right) p_{8.\to 3}}\right\},$$

$$\left\{\left(p_{4.\to 3}\, p_{4.\to 6}\left(f_{6.\to 9}\, p_{3.\to 4}\, p_{6.\to 4}\, p_{7.\to 4} + f_{6.\to 9}\, p_{3.\to 4}\, p_{6.\to 4}\, p_{7.\to 6} + f_{6.\to 9}\, p_{3.\to 4}\, p_{6.\to 7}\, p_{7.\to 6} + f_{6.\to 9}\, p_{3.\to 4}\, p_{6.\to 9}\, p_{7.\to 6} - f_{9.\to 6}\, p_{3.\to 4}\, p_{6.\to 9}\, p_{7.\to 6} + p_{3.\to 5}\, p_{6.\to 9}\, p_{7.\to 4}\, x_{3.\to 5}\right)\right) \Big/ \left(p_{3.\to 4}\, p_{6.\to 9}\left(p_{4.\to 3}\, p_{4.\to 6}\, p_{7.\to 4} + p_{4.\to 3}\, p_{4.\to 7}\, p_{7.\to 4} + p_{4.\to 6}\, p_{4.\to 7}\, p_{7.\to 4} + p_{4.\to 3}\, p_{4.\to 7}\, p_{7.\to 6}\right)\right)\right\},$$

$$\left\{-\left(\left(p_{7.\to 6}\left(-f_{6.\to 9}\, p_{3.\to 4}\, p_{4.\to 3}\, p_{4.\to 6}\, p_{6.\to 4} - f_{6.\to 9}\, p_{3.\to 4}\, p_{4.\to 6}\, p_{4.\to 7}\, p_{6.\to 4} - f_{6.\to 9}\, p_{3.\to 4}\, p_{4.\to 3}\, p_{4.\to 6}\, p_{6.\to 7} - f_{6.\to 9}\, p_{3.\to 4}\, p_{4.\to 3}\, p_{4.\to 7}\, p_{6.\to 7} - f_{6.\to 9}\, p_{3.\to 4}\, p_{4.\to 6}\, p_{4.\to 7}\, p_{6.\to 7} - f_{6.\to 9}\, p_{3.\to 4}\, p_{4.\to 3}\, p_{4.\to 6}\, p_{6.\to 9} + f_{9.\to 6}\, p_{3.\to 4}\, p_{4.\to 3}\, p_{4.\to 6}\, p_{6.\to 9} - f_{6.\to 9}\, p_{3.\to 4}\, p_{4.\to 3}\, p_{4.\to 7}\, p_{6.\to 9} + f_{9.\to 6}\, p_{3.\to 4}\, p_{4.\to 3}\, p_{4.\to 7}\, p_{6.\to 9} - f_{6.\to 9}\, p_{3.\to 4}\, p_{4.\to 6}\, p_{4.\to 7}\, p_{6.\to 9} + f_{9.\to 6}\, p_{3.\to 4}\, p_{4.\to 6}\, p_{4.\to 7}\, p_{6.\to 9} + p_{3.\to 5}\, p_{4.\to 3}\, p_{4.\to 7}\, p_{6.\to 9}\, x_{3.\to 5}\right)\right) \Big/ \left(p_{3.\to 4}\, p_{6.\to 9}\left(p_{4.\to 3}\, p_{4.\to 6}\, p_{7.\to 4} + p_{4.\to 3}\, p_{4.\to 7}\, p_{7.\to 4} + p_{4.\to 6}\, p_{4.\to 7}\, p_{7.\to 4} + p_{4.\to 3}\, p_{4.\to 7}\, p_{7.\to 6}\right)\right)\right)\right\},$$

$$\left\{\frac{-\frac{p_{4.\to 7}\left(-f_{9.\to 6} + \frac{f_{6.\to 9}\,(p_{6.\to 4} + p_{6.\to 7} + p_{6.\to 9})}{p_{6.\to 9}}\right) p_{7.\to 6}}{p_{4.\to 3}\, p_{7.\to 4}} - \frac{p_{4.\to 7}\left(\frac{f_{6.\to 9}\, p_{6.\to 4}}{p_{6.\to 9}} + \frac{p_{3.\to 5}\, x_{3.\to 5}}{p_{3.\to 4}}\right)}{p_{4.\to 3}}}{-\frac{p_{4.\to 6}}{p_{4.\to 3}} - \frac{\left(1 + \frac{p_{4.\to 6}}{p_{4.\to 3}}\right) p_{4.\to 7}}{p_{4.\to 3}} - \frac{p_{4.\to 7}\, p_{7.\to 6}}{p_{4.\to 3}\, p_{7.\to 4}}}\right\}\right\}$$

In[ ]:=
```
xcp = MapThread[xₙ₁ → #2 &, {U_Nb[[Uc]], Flatten[xc]}];
xcp // TableForm
```

Out[ ]//TableForm=

$$x_{1.\to 5} \to \frac{f_{5.\to 9}\, p_{1.\to 2}\, p_{2.\to 9}\, p_{5.\to 1} + f_{2.\to 9}\, p_{1.\to 2}\, p_{2.\to 1}\, p_{5.\to 9}}{(p_{1.\to 2} + p_{1.\to 5})\, p_{2.\to 9}\, p_{5.\to 9}}$$

$$x_{8.\to 2} \to \frac{f_{5.\to 9}\, p_{1.\to 5}\, p_{2.\to 9}\, p_{5.\to 1}\, p_{8.\to 5} + f_{5.\to 9}\, p_{1.\to 2}\, p_{2.\to 9}\, p_{5.\to 2}\, p_{8.\to 5} + f_{5.\to 9}\, p_{1.\to 5}\, p_{2.\to 9}\, p_{5.\to 2}\, p_{8.\to 5} + f_{5.\to 9}\, p_{1.\to 2}\, p_{2.\to 9}\, p_{5.\to 3}\, p_{8.\to 5} + f_{5.\to 9}\, p_{1.\to 5}\, p_{2.\to 9}\, p_{5.\to 3}\, p_{8.\to 5} + f_{5.\to}}{}$$

$$x_{4.\to 3} \to \frac{p_{4.\to 6}\, p_{4.\to 7}\left(f_{6.\to 9}\, p_{3.\to 4}\, p_{6.\to 4}\, p_{7.\to 4} + f_{6.\to 9}\, p_{3.\to 4}\, p_{6.\to 4}\, p_{7.\to 6} + f_{6.\to 9}\, p_{3.\to 4}\, p_{6.\to 7}\, p_{7.\to 6} + f_{6.\to 9}\, p_{3.\to 4}\, p_{6.\to 9}\, p_{7.\to 6} - f_{9.\to 6}\, p_{3.\to 4}\, p_{6.\to 9}\, p_{7.\to 6} + p_{3.\to 5}\, p_{6.\to 9}\, p_{7.\to 4}\, x_{3.}\right.}{p_{3.\to 4}\, p_{6.\to 9}\left(p_{4.\to 3}\, p_{4.\to 6}\, p_{7.\to 4} + p_{4.\to 3}\, p_{4.\to 7}\, p_{7.\to 4} + p_{4.\to 6}\, p_{4.\to 7}\, p_{7.\to 4} + p_{4.\to 3}\, p_{4.\to 7}\, p_{7.\to 6}\right)}$$

$$x_{3.\to 8} \to \frac{p_{3.\to 5}\, x_{3.\to 5}}{p_{3.\to 8}}$$

$$x_{8.\to 3} \to \frac{p_{8.\to 2}\left(\frac{\left(-\frac{f_{2.\to 9}\, p_{2.\to 1}}{p_{2.\to 9}} - \frac{f_{5.\to 9}\, p_{5.\to 1}}{p_{5.\to 9}}\right) p_{8.\to 5}}{p_{8.\to 2}} - \left(-1 - \frac{p_{1.\to 5}}{p_{1.\to 2}}\right)\left(\frac{\left(-f_{9.\to 5} - \frac{f_{2.\to 9}\, p_{2.\to 5}}{p_{2.\to 9}} + \frac{f_{5.\to 9}\,(p_{5.\to 1} + p_{5.\to 2} + p_{5.\to 3} + p_{5.\to 8} + p_{5.\to 9})}{p_{5.\to 9}}\right) p_{8.\to 5}}{p_{8.\to 2}} - \frac{p_{8.\to 5}\, x_{3.\to 5}}{p_{8.\to 2}}\right)\right)}{\left(1 + \frac{p_{1.\to 5}}{p_{1.\to 2}}\right) p_{8.\to 3}}$$

$$x_{4.\to 7} \to \frac{p_{4.\to 3}\, p_{4.\to 6}\left(f_{6.\to 9}\, p_{3.\to 4}\, p_{6.\to 4}\, p_{7.\to 4} + f_{6.\to 9}\, p_{3.\to 4}\, p_{6.\to 4}\, p_{7.\to 6} + f_{6.\to 9}\, p_{3.\to 4}\, p_{6.\to 7}\, p_{7.\to 6} + f_{6.\to 9}\, p_{3.\to 4}\, p_{6.\to 9}\, p_{7.\to 6} - f_{9.\to 6}\, p_{3.\to 4}\, p_{6.\to 9}\, p_{7.\to 6} + p_{3.\to 5}\, p_{6.\to 9}\, p_{7.\to 4}\, x_{3.}\right.}{p_{3.\to 4}\, p_{6.\to 9}\left(p_{4.\to 3}\, p_{4.\to 6}\, p_{7.\to 4} + p_{4.\to 3}\, p_{4.\to 7}\, p_{7.\to 4} + p_{4.\to 6}\, p_{4.\to 7}\, p_{7.\to 4} + p_{4.\to 3}\, p_{4.\to 7}\, p_{7.\to 6}\right)}$$

$$x_{7.\to 4} \to -\frac{p_{7.\to 6}\left(-f_{6.\to 9}\, p_{3.\to 4}\, p_{4.\to 3}\, p_{4.\to 6}\, p_{6.\to 4} - f_{6.\to 9}\, p_{3.\to 4}\, p_{4.\to 6}\, p_{4.\to 7}\, p_{6.\to 4} - f_{6.\to 9}\, p_{3.\to 4}\, p_{4.\to 3}\, p_{4.\to 6}\, p_{6.\to 7} - f_{6.\to 9}\, p_{3.\to 4}\, p_{4.\to 3}\, p_{4.\to 7}\, p_{6.\to 7} - f_{6.\to 9}\, p_{3.\to 4}\, p_{4.\to 6}\, p_{4.\to 7}\right.}{p_{3.\to 4}\, p_{6.\to 9}}$$

$$x_{4.\to 6} \to \frac{-\frac{p_{4.\to 7}\left(-f_{9.\to 6} + \frac{f_{6.\to 9}\,(p_{6.\to 4} + p_{6.\to 7} + p_{6.\to 9})}{p_{6.\to 9}}\right) p_{7.\to 6}}{p_{4.\to 3}\, p_{7.\to 4}} - \frac{p_{4.\to 7}\left(\frac{f_{6.\to 9}\, p_{6.\to 4}}{p_{6.\to 9}} + \frac{p_{3.\to 5}\, x_{3.\to 5}}{p_{3.\to 4}}\right)}{p_{4.\to 3}}}{-\frac{p_{4.\to 6}}{p_{4.\to 3}} - \frac{\left(1 + \frac{p_{4.\to 6}}{p_{4.\to 3}}\right) p_{4.\to 7}}{p_{4.\to 3}} - \frac{p_{4.\to 7}\, p_{7.\to 6}}{p_{4.\to 3}\, p_{7.\to 4}}}$$

In[ ]:=
```
s = solveAll[g, t];
s // TableForm
```

Out[ ]//TableForm=

$$x_{1\bullet\to 2} \to \frac{f_{2\bullet\to 9}\, p_{2\bullet\to 1}}{p_{2\bullet\to 9}} + \frac{f_{5\bullet\to 9}\, p_{5\bullet\to 1}}{p_{5\bullet\to 9}} - x_{1\bullet\to 5}$$

$$x_{3\bullet\to 4} \to -\frac{f_{6\bullet\to 9}\, p_{6\bullet\to 4}}{p_{6\bullet\to 9}} + x_{4\bullet\to 3} + x_{4\bullet\to 6} + x_{4\bullet\to 7} - x_{7\bullet\to 4}$$

$$x_{8\bullet\to 5} \to -f_{9\bullet\to 5} - \frac{f_{2\bullet\to 9}\, p_{2\bullet\to 5}}{p_{2\bullet\to 9}} + \frac{f_{5\bullet\to 9}\,(p_{5\bullet\to 1}+p_{5\bullet\to 2}+p_{5\bullet\to 3}+p_{5\bullet\to 8}+p_{5\bullet\to 9})}{p_{5\bullet\to 9}} - x_{1\bullet\to 5} - x_{3\bullet\to 5}$$

$$x_{7\bullet\to 6} \to -f_{9\bullet\to 6} + \frac{f_{6\bullet\to 9}\,(p_{6\bullet\to 4}+p_{6\bullet\to 7}+p_{6\bullet\to 9})}{p_{6\bullet\to 9}} - x_{4\bullet\to 6}$$

$$x_{9\bullet\to 2} \to -f_{9\bullet\to 2} - \frac{f_{2\bullet\to 9}\, p_{2\bullet\to 1}}{p_{2\bullet\to 9}} + \frac{f_{2\bullet\to 9}\,(p_{2\bullet\to 1}+p_{2\bullet\to 5}+p_{2\bullet\to 8}+p_{2\bullet\to 9})}{p_{2\bullet\to 9}} - \frac{f_{5\bullet\to 9}\, p_{5\bullet\to 1}}{p_{5\bullet\to 9}} - \frac{f_{5\bullet\to 9}\, p_{5\bullet\to 2}}{p_{5\bullet\to 9}} + x_{1\bullet\to 5} - x_{8\bullet\to 2}$$

$$x_{9\bullet\to 3} \to -\frac{f_{5\bullet\to 9}\, p_{5\bullet\to 3}}{p_{5\bullet\to 9}} - \frac{f_{6\bullet\to 9}\, p_{6\bullet\to 4}}{p_{6\bullet\to 9}} + x_{3\bullet\to 5} + x_{3\bullet\to 8} + x_{4\bullet\to 6} + x_{4\bullet\to 7} - x_{7\bullet\to 4} - x_{8\bullet\to 3}$$

$$x_{9\bullet\to 7} \to -f_{9\bullet\to 6} - \frac{f_{6\bullet\to 9}\, p_{6\bullet\to 7}}{p_{6\bullet\to 9}} + \frac{f_{6\bullet\to 9}\,(p_{6\bullet\to 4}+p_{6\bullet\to 7}+p_{6\bullet\to 9})}{p_{6\bullet\to 9}} - x_{4\bullet\to 6} - x_{4\bullet\to 7} + x_{7\bullet\to 4}$$

$$x_{9\bullet\to 8} \to -f_{9\bullet\to 5} - \frac{f_{2\bullet\to 9}\, p_{2\bullet\to 5}}{p_{2\bullet\to 9}} - \frac{f_{2\bullet\to 9}\, p_{2\bullet\to 8}}{p_{2\bullet\to 9}} - \frac{f_{5\bullet\to 9}\, p_{5\bullet\to 8}}{p_{5\bullet\to 9}} + \frac{f_{5\bullet\to 9}\,(p_{5\bullet\to 1}+p_{5\bullet\to 2}+p_{5\bullet\to 3}+p_{5\bullet\to 8}+p_{5\bullet\to 9})}{p_{5\bullet\to 9}} - x_{1\bullet\to 5} - x_{3\bullet\to 5} - x_{3\bullet\to 8} + x_{8\bullet\to 2} + x_{8\bullet\to}$$

In[ ]:=
```
"общее решение:"
xsol = ((s /. xcp) ~Join~ xcp);
xsol /. {ξ_u_↔v_ → ξu,v} // TableForm
```

Out[ ]= общее решение:

Out[ ]//TableForm=

$$x_{1,2} \to \frac{f_{2,9}\,p_{2,1}}{p_{2,9}} + \frac{f_{5,9}\,p_{5,1}}{p_{5,9}} - \frac{f_{5,9}\,p_{1,2}\,p_{2,9}\,p_{5,1}+f_{2,9}\,p_{1,2}\,p_{2,1}\,p_{5,9}}{(p_{1,2}+p_{1,5})\,p_{2,9}\,p_{5,9}}$$

$$x_{3,4} \to -\frac{f_{6,9}\,p_{6,4}}{p_{6,9}} + \frac{p_{7,6}\,(-f_{6,9}\,p_{3,4}\,p_{4,3}\,p_{4,6}\,p_{6,4}-f_{6,9}\,p_{3,4}\,p_{4,6}\,p_{4,7}\,p_{6,4}-f_{6,9}\,p_{3,4}\,p_{4,3}\,p_{4,6}\,p_{6,7}-f_{6,9}\,p_{3,4}\,p_{4,3}\,p_{4,7}\,p_{6,7}-f_{6,9}\,p_{3,4}\,p_{4,6}\,p_{4,7}\,p_{6,7}-f$$
$$p_{3,4}\,p_{6,9}\,(p_{4,3}$$

$$x_{8,5} \to -f_{9,5} - \frac{f_{2,9}\,p_{2,5}}{p_{2,9}} + \frac{f_{5,9}\,(p_{5,1}+p_{5,2}+p_{5,3}+p_{5,8}+p_{5,9})}{p_{5,9}} - \frac{f_{5,9}\,p_{1,2}\,p_{2,9}\,p_{5,1}+f_{2,9}\,p_{1,2}\,p_{2,1}\,p_{5,9}}{(p_{1,2}+p_{1,5})\,p_{2,9}\,p_{5,9}} - x_{3,5}$$

$$x_{7,6} \to -f_{9,6} + \frac{f_{6,9}\,(p_{6,4}+p_{6,7}+p_{6,9})}{p_{6,9}} - \frac{-\frac{p_{4,7}\left(-f_{9,6}+\frac{f_{6,9}\,(p_{6,4}+p_{6,7}+p_{6,9})}{p_{6,9}}\right)p_{7,6}}{p_{4,3}\,p_{7,4}} - \frac{p_{4,7}\left(\frac{f_{6,9}\,p_{6,4}}{p_{6,9}}+\frac{p_{3,5}\,x_{3,5}}{p_{3,4}}\right)}{p_{4,3}}}{-\frac{p_{4,6}}{p_{4,3}} - \frac{\left(1+\frac{p_{4,6}}{p_{4,3}}\right)p_{4,7}}{p_{4,3}} - \frac{p_{4,7}\,p_{7,6}}{p_{4,3}\,p_{7,4}}}$$

$$x_{9,2} \to -f_{9,2} - \frac{f_{2,9}\,p_{2,1}}{p_{2,9}} + \frac{f_{2,9}\,(p_{2,1}+p_{2,5}+p_{2,8}+p_{2,9})}{p_{2,9}} - \frac{f_{5,9}\,p_{5,1}}{p_{5,9}} - \frac{f_{5,9}\,p_{5,2}}{p_{5,9}} + \frac{f_{5,9}\,p_{1,2}\,p_{2,9}\,p_{5,1}+f_{2,9}\,p_{1,2}\,p_{2,1}\,p_{5,9}}{(p_{1,2}+p_{1,5})\,p_{2,9}\,p_{5,9}} - \frac{f_{5,9}\,p_{1,5}\,p_{2,9}\,p_{5,1}}{}$$

$$x_{9,3} \to -\frac{f_{5,9}\,p_{5,3}}{p_{5,9}} - \frac{f_{6,9}\,p_{6,4}}{p_{6,9}} + x_{3,5} + \frac{p_{3,5}\,x_{3,5}}{p_{3,8}} + \frac{p_{7,6}\,(-f_{6,9}\,p_{3,4}\,p_{4,3}\,p_{4,6}\,p_{6,4}-f_{6,9}\,p_{3,4}\,p_{4,6}\,p_{4,7}\,p_{6,4}-f_{6,9}\,p_{3,4}\,p_{4,3}\,p_{4,6}\,p_{6,7}-f_{6,9}\,p_{3,4}\,p_{4,3}$$

$$x_{9,7} \to -f_{9,6} - \frac{f_{6,9}\,p_{6,7}}{p_{6,9}} + \frac{f_{6,9}\,(p_{6,4}+p_{6,7}+p_{6,9})}{p_{6,9}} - \frac{p_{7,6}\,(-f_{6,9}\,p_{3,4}\,p_{4,3}\,p_{4,6}\,p_{6,4}-f_{6,9}\,p_{3,4}\,p_{4,6}\,p_{4,7}\,p_{6,4}-f_{6,9}\,p_{3,4}\,p_{4,3}\,p_{4,6}\,p_{6,7}-f_{6,9}\,p_{3,4}\,p_{4,}$$

$$x_{9,8} \to -f_{9,5} - \frac{f_{2,9}\,p_{2,5}}{p_{2,9}} - \frac{f_{2,9}\,p_{2,8}}{p_{2,9}} - \frac{f_{5,9}\,p_{5,8}}{p_{5,9}} + \frac{f_{5,9}\,(p_{5,1}+p_{5,2}+p_{5,3}+p_{5,8}+p_{5,9})}{p_{5,9}} - \frac{f_{5,9}\,p_{1,2}\,p_{2,9}\,p_{5,1}+f_{2,9}\,p_{1,2}\,p_{2,1}\,p_{5,9}}{(p_{1,2}+p_{1,5})\,p_{2,9}\,p_{5,9}} - x_{3,5} - \frac{p_{3,5}}{p_{3}}$$

$$x_{1,5} \to \frac{f_{5,9}\,p_{1,2}\,p_{2,9}\,p_{5,1}+f_{2,9}\,p_{1,2}\,p_{2,1}\,p_{5,9}}{(p_{1,2}+p_{1,5})\,p_{2,9}\,p_{5,9}}$$

$$x_{8,2} \to \frac{f_{5,9}\,p_{1,5}\,p_{2,9}\,p_{5,1}\,p_{8,5}+f_{5,9}\,p_{1,2}\,p_{2,9}\,p_{5,2}\,p_{8,5}+f_{5,9}\,p_{1,5}\,p_{2,9}\,p_{5,2}\,p_{8,5}+f_{5,9}\,p_{1,2}\,p_{2,9}\,p_{5,3}\,p_{8,5}+f_{5,9}\,p_{1,5}\,p_{2,9}\,p_{5,3}\,p_{8,5}+f_{5,9}\,p_{1,2}\,p_{2,9}\,p_{5,8}\,p_{8,5}+}{}$$

$$x_{4,3} \to \frac{p_{4,6}\,p_{4,7}\,(f_{6,9}\,p_{3,4}\,p_{6,4}\,p_{7,4}+f_{6,9}\,p_{3,4}\,p_{6,4}\,p_{7,6}+f_{6,9}\,p_{3,4}\,p_{6,7}\,p_{7,6}+f_{6,9}\,p_{3,4}\,p_{6,9}\,p_{7,6}-f_{9,6}\,p_{3,4}\,p_{6,9}\,p_{7,6}+p_{3,5}\,p_{6,9}\,p_{7,4}\,x_{3,5})}{p_{3,4}\,p_{6,9}\,(p_{4,3}\,p_{4,6}\,p_{7,4}+p_{4,3}\,p_{4,7}\,p_{7,4}+p_{4,6}\,p_{4,7}\,p_{7,4}+p_{4,3}\,p_{4,7}\,p_{7,6})}$$

$$x_{3,8} \to \frac{p_{3,5}\,x_{3,5}}{p_{3,8}}$$

$$x_{8,3} \to \frac{p_{8,2}\left(\frac{\left(-\frac{f_{2,9}\,p_{2,1}}{p_{2,9}}-\frac{f_{5,9}\,p_{5,1}}{p_{5,9}}\right)p_{8,5}}{p_{8,2}} - \left(-1-\frac{p_{1,5}}{p_{1,2}}\right)\left(\frac{\left(-f_{9,5}-\frac{f_{2,9}\,p_{2,5}}{p_{2,9}}+\frac{f_{5,9}\,(p_{5,1}+p_{5,2}+p_{5,3}+p_{5,8}+p_{5,9})}{p_{5,9}}\right)p_{8,5}}{p_{8,2}} - \frac{p_{8,5}\,x_{3,5}}{p_{8,2}}\right)\right)}{\left(1+\frac{p_{1,5}}{p_{1,2}}\right)p_{8,3}}$$

$$x_{4,7} \to \frac{p_{4,3}\,p_{4,6}\,(f_{6,9}\,p_{3,4}\,p_{6,4}\,p_{7,4}+f_{6,9}\,p_{3,4}\,p_{6,4}\,p_{7,6}+f_{6,9}\,p_{3,4}\,p_{6,7}\,p_{7,6}+f_{6,9}\,p_{3,4}\,p_{6,9}\,p_{7,6}-f_{9,6}\,p_{3,4}\,p_{6,9}\,p_{7,6}+p_{3,5}\,p_{6,9}\,p_{7,4}\,x_{3,5})}{p_{3,4}\,p_{6,9}\,(p_{4,3}\,p_{4,6}\,p_{7,4}+p_{4,3}\,p_{4,7}\,p_{7,4}+p_{4,6}\,p_{4,7}\,p_{7,4}+p_{4,3}\,p_{4,7}\,p_{7,6})}$$

$$x_{7,4} \to -\frac{p_{7,6}\,(-f_{6,9}\,p_{3,4}\,p_{4,3}\,p_{4,6}\,p_{6,4}-f_{6,9}\,p_{3,4}\,p_{4,6}\,p_{4,7}\,p_{6,4}-f_{6,9}\,p_{3,4}\,p_{4,3}\,p_{4,6}\,p_{6,7}-f_{6,9}\,p_{3,4}\,p_{4,3}\,p_{4,7}\,p_{6,7}-f_{6,9}\,p_{3,4}\,p_{4,6}\,p_{4,7}\,p_{6,7}-f_{6,9}\,p_{3,4}\,p_{4,3}$$
$$p_{3,4}\,p_{6,9}\,(p_{4,3}\,p_{4,6}\,p_{7,4}+p_{4,}$$

$$x_{4,6} \to \frac{-\frac{p_{4,7}\left(-f_{9,6}+\frac{f_{6,9}\,(p_{6,4}+p_{6,7}+p_{6,9})}{p_{6,9}}\right)p_{7,6}}{p_{4,3}\,p_{7,4}} - \frac{p_{4,7}\left(\frac{f_{6,9}\,p_{6,4}}{p_{6,9}}+\frac{p_{3,5}\,x_{3,5}}{p_{3,4}}\right)}{p_{4,3}}}{-\frac{p_{4,6}}{p_{4,3}} - \frac{\left(1+\frac{p_{4,6}}{p_{4,3}}\right)p_{4,7}}{p_{4,3}} - \frac{p_{4,7}\,p_{7,6}}{p_{4,3}\,p_{7,4}}}$$

In[ ]:=
```
"eq test:"
Simplify[balanceEqs /. ξ → root[t] /. s /. xcp]
Simplify[(dopEq /. s) /. xcp]
```

Out[ ]= eq test:

Out[ ]= {True, True, True, True, True, True, True, True, True}

Out[ ]= {True, True, True, True, True, True, True, True}