Листинг 2

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

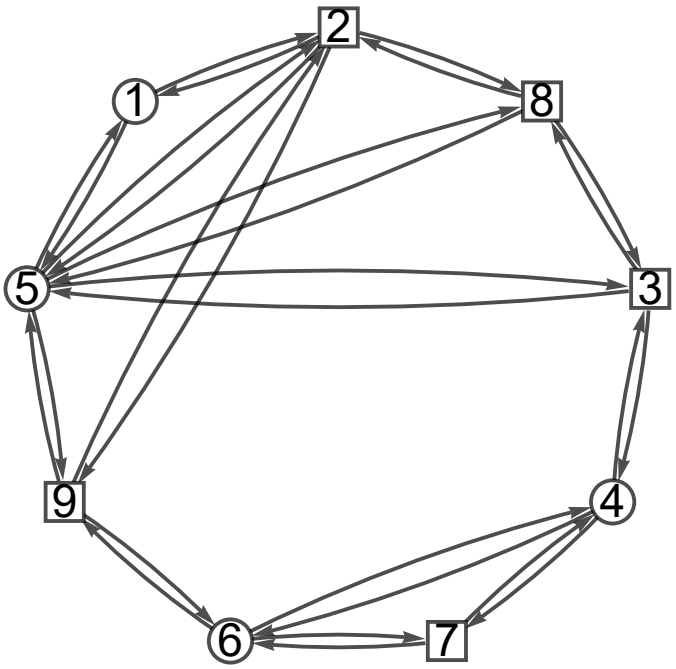
In[ ]:=
```
readGraph2[file_, dir_] := Module[{
    fn = FileNameJoin[{dir, file}],
    stream, imod, umod, u, b
    },
    stream = OpenRead[fn];
    imod = Read[stream, {Word, Number}][[2]];
    umod = Read[stream, {Word, Number}][[2]];

  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)
```

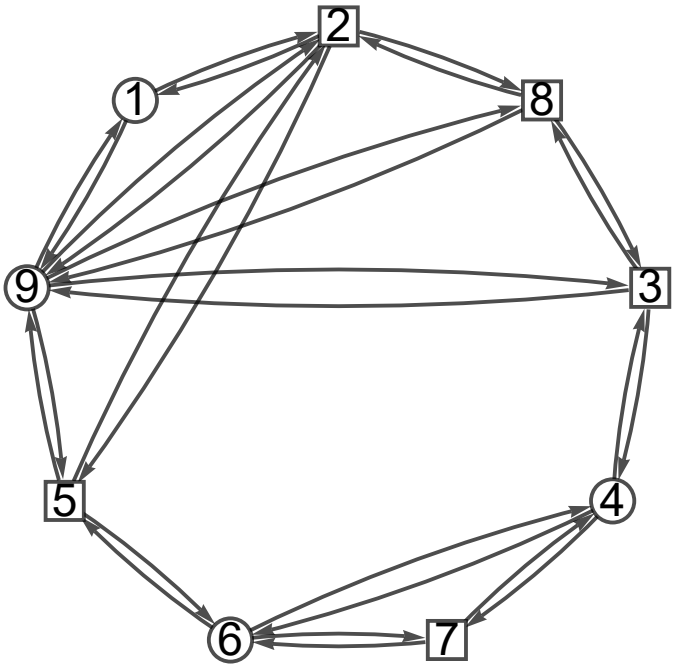
In[ ]:=
```
{g, b} = readGraph2["grDET0.txt", NotebookDirectory[]];
GraphPlot[g, EdgeStyle → Directive[Black, Thick],
 VertexStyle → Directive[EdgeForm[Thick], White], MultiedgeStyle → .05]
```

Out[ ]=



In[ ]:=
```
g = VertexReplace[g, {5 → 9, 9 → 5}];
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=

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

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]}]*)
```

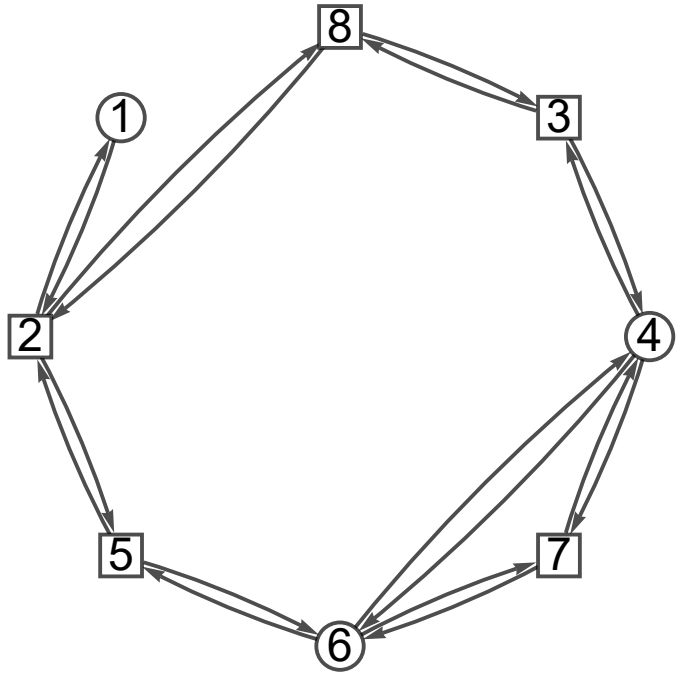
In[ ]:=
```
(*p_#&/@EdgeList[g]*)
```

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

Out[ ]=
```
{1 ↔ 9, 9 ↔ 1, 8 ↔ 9, 9 ↔ 8, 2 ↔ 9, 9 ↔ 2, 5 ↔ 9, 9 ↔ 5, 3 ↔ 9, 9 ↔ 3}
```

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[g // VertexCount] ~Complement~ M]];
n̄ḡ = VertexDelete[g, M];
GraphPlot[n̄ḡ, EdgeStyle → Directive[Black, Thick],
 VertexStyle → Directive[EdgeForm[Thick], White], MultiedgeStyle → .05]
b̄
```

Out[ ]=



Out[ ]= $\{f_{1\to 9} - f_{9\to 1},\ x + f_{2\to 9} - f_{9\to 2},\ x + f_{3\to 9} - f_{9\to 3},\ 0,\ f_{5\to 9} - f_{9\to 5},\ 0,\ x,\ x + f_{8\to 9} - f_{9\to 8}\}$

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]
```

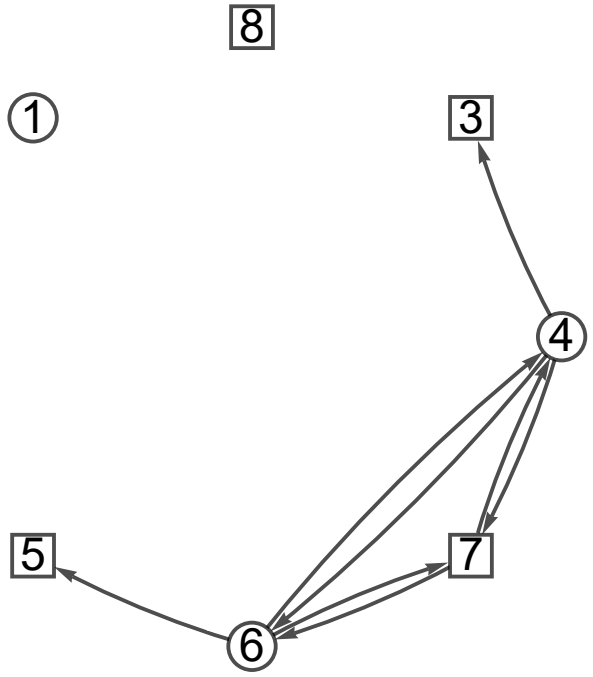
Out[ ]= $\{1 \leftrightarrow 9,\ 8 \leftrightarrow 9,\ 2 \leftrightarrow 9,\ 5 \leftrightarrow 9,\ 3 \leftrightarrow 9\}$

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

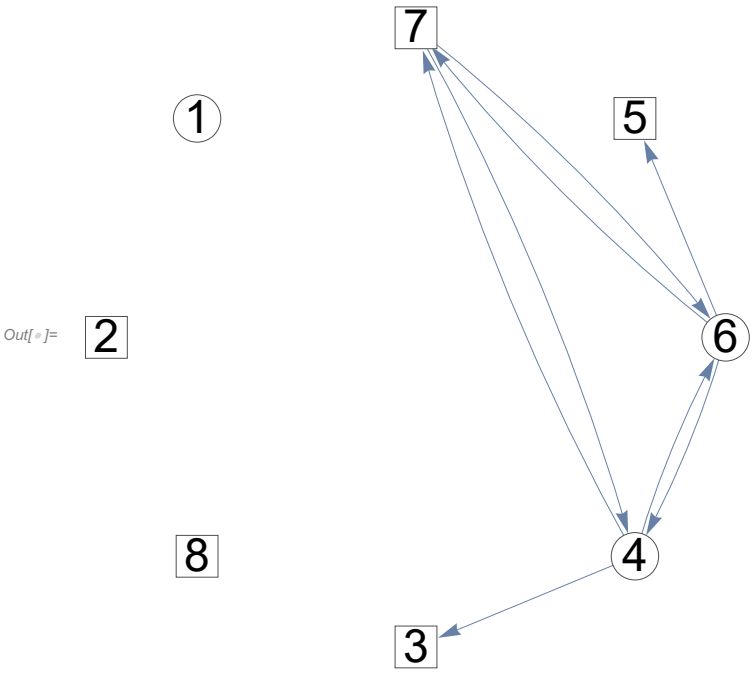
In[•]:=
```
GraphPlot[Fold[HighlightGraph[#1, u_ ↔ v_ /; u == #2, GraphHighlightStyle → "White"] &,
  ng, #[[1]] & /@ M^+], EdgeStyle → Directive[Black, Thick],
 VertexStyle → Directive[EdgeForm[Thick], White], MultiedgeStyle → .05]
```

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[ ]=
```
{4, 6, 7}
```

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: 10
Dimensions: {5, 8}

In[ ]:=
```
Grid[λ]
```

Out[ ]=

1	$-\frac{p_{4\to 7}}{p_{4\to 3}}$	0	0	0	0	0	0
1	0	0	0	0	0	$-\frac{p_{4\to 6}}{p_{4\to 3}}$	0
0	0	0	0	1	$-\frac{p_{6\to 4}}{p_{6\to 7}}$	0	0
0	0	0	0	1	0	0	$-\frac{p_{6\to 5}}{p_{6\to 7}}$
0	0	1	$-\frac{p_{7\to 6}}{p_{7\to 4}}$	0	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}]
```

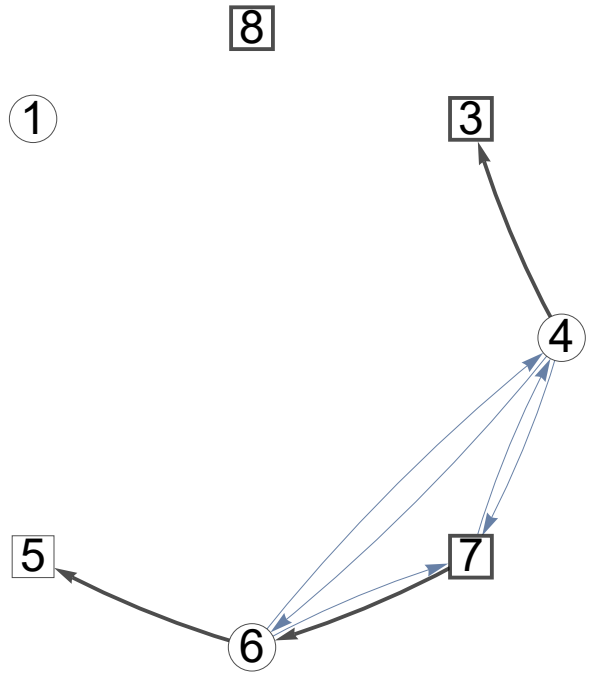
Out[ ]= 0.

Out[ ]//TableForm=

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

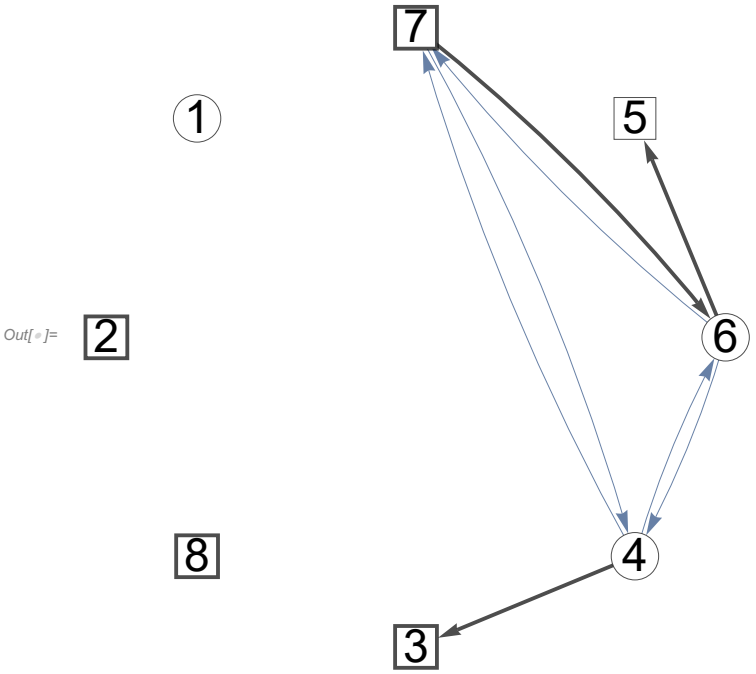
In[ ]:=
```
GraphPlot[HighlightGraph[
  Fold[HighlightGraph[#1, Style[u_ ↔ v_ /; u == #2, White]] &, ng, #[[1]] & /@ M+],
  {Style[u_ /; VertexQ[g, u] && pred[t][[u]] == root[t], EdgeForm[Thick]],
   Style[u_ ↔ v_ /; (pred[t][[u]] == v && dir[t][[u]] == -1) ||
       (pred[t][[v]] == u && dir[t][[v]]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

Out[ ]=



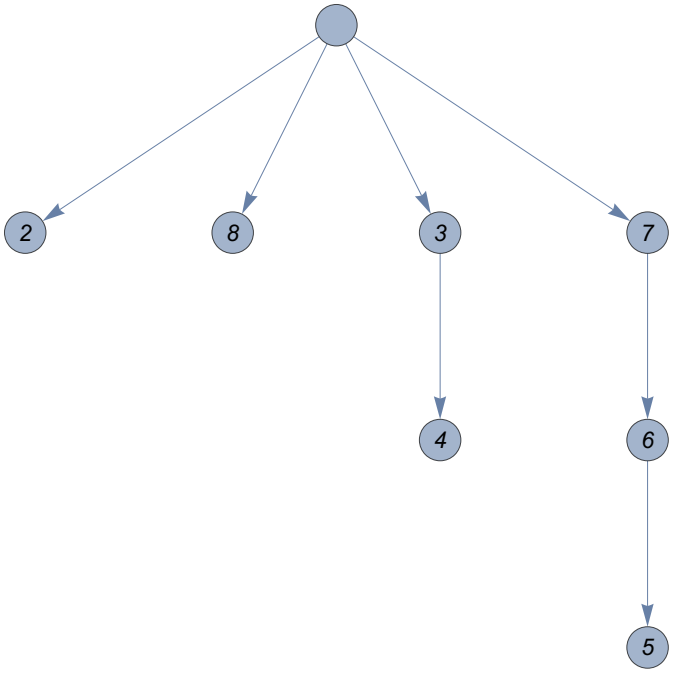
In[•]:=
```
GraphPlot[HighlightGraph[g1,
  {Style[u_ /; VertexQ[g, u] && pred[t][[u]] == root[t], EdgeForm[Thick]],
   Style[u_ ↔ v_ /; (pred[t][[u]] == v && dir[t][[u]] == -1) ||
       (pred[t][[v]] == u && dir[t][[v]] == 1), Directive[Black, Thick]]},
  GraphHighlightStyle → None], MultiedgeStyle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

Out[•]=



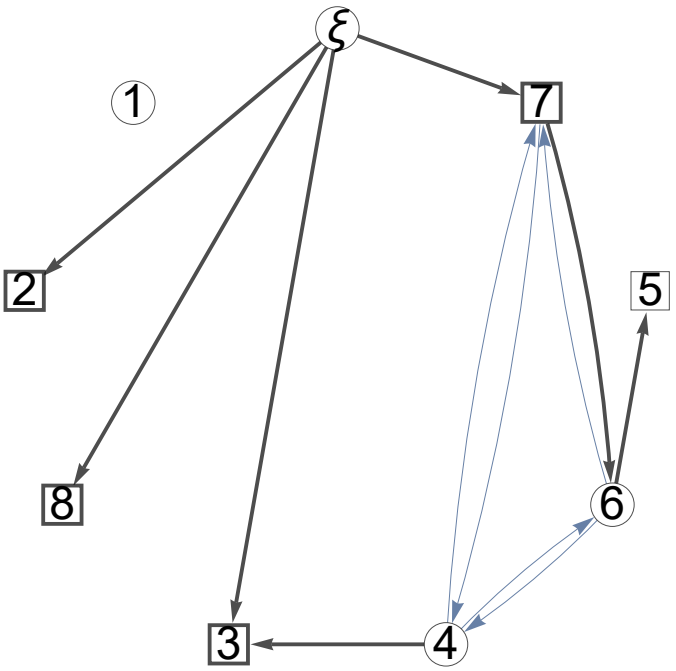
In[•]:=
```
t[[7]](*пометить на графе*)
```

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[ ]=

$$\left\{-f_{9\bullet\to 1}+f_{1\bullet\to 9}\left(1+\frac{p_{1\bullet\to 2}}{p_{1\bullet\to 9}}\right)-\frac{f_{2\bullet\to 9}\,p_{2\bullet\to 1}}{p_{2\bullet\to 9}},\right.$$

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

$$-f_{9\bullet\to 3}+\frac{f_{3\bullet\to 9}\,(p_{3\bullet\to 4}+p_{3\bullet\to 8}+p_{3\bullet\to 9})}{p_{3\bullet\to 9}}-\frac{f_{8\bullet\to 9}\,p_{8\bullet\to 3}}{p_{8\bullet\to 9}},-\frac{f_{3\bullet\to 9}\,p_{3\bullet\to 4}}{p_{3\bullet\to 9}},$$

$$-f_{9\bullet\to 5}-\frac{f_{2\bullet\to 9}\,p_{2\bullet\to 5}}{p_{2\bullet\to 9}}+\frac{f_{5\bullet\to 9}\,(p_{5\bullet\to 2}+p_{5\bullet\to 6}+p_{5\bullet\to 9})}{p_{5\bullet\to 9}},-\frac{f_{5\bullet\to 9}\,p_{5\bullet\to 6}}{p_{5\bullet\to 9}},$$

$$0,-f_{9\bullet\to 8}-\frac{f_{2\bullet\to 9}\,p_{2\bullet\to 8}}{p_{2\bullet\to 9}}-\frac{f_{3\bullet\to 9}\,p_{3\bullet\to 8}}{p_{3\bullet\to 9}}+\frac{f_{8\bullet\to 9}\,(p_{8\bullet\to 2}+p_{8\bullet\to 3}+p_{8\bullet\to 9})}{p_{8\bullet\to 9}},$$

$$\left.-f_{1\bullet\to 9}-f_{2\bullet\to 9}-f_{3\bullet\to 9}-f_{5\bullet\to 9}-f_{8\bullet\to 9}+f_{9\bullet\to 1}+f_{9\bullet\to 2}+f_{9\bullet\to 3}+f_{9\bullet\to 5}+f_{9\bullet\to 8}\right\}$$

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

Out[ ]//TableForm=

$$0 == -f_{9,1} + f_{1,9}\left(1 + \frac{p_{1,2}}{p_{1,9}}\right) - \frac{f_{2,9}\,p_{2,1}}{p_{2,9}}$$

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

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

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

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

$$x_{4,7} + x_{6,7} - x_{7,4} - x_{7,6} + x_{\xi,7} == 0$$

$$x_{4,6} - x_{6,4} - x_{6,5} - x_{6,7} + x_{7,6} == -\frac{f_{5,9}\,p_{5,6}}{p_{5,9}}$$

$$x_{6,5} == -f_{9,5} - \frac{f_{2,9}\,p_{2,5}}{p_{2,9}} + \frac{f_{5,9}\,(p_{5,2}+p_{5,6}+p_{5,9})}{p_{5,9}}$$

$$-x_{\xi,2} - x_{\xi,3} - x_{\xi,7} - x_{\xi,8} == -f_{1,9} - f_{2,9} - f_{3,9} - f_{5,9} - f_{8,9} + f_{9,1} + f_{9,2} + f_{9,3} + f_{9,5} + f_{9,8}$$

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

Out[ ]//TableForm=

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

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

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

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

$$\tilde{x}_{6,5} \to -f_{9,5} - \frac{f_{2,9}\,p_{2,5}}{p_{2,9}} + \frac{f_{5,9}\,(p_{5,2}+p_{5,6}+p_{5,9})}{p_{5,9}}$$

$$\tilde{x}_{6,7} \to 0$$

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

$$\tilde{x}_{7,6} \to -f_{9,5} - \frac{f_{2,9}\,p_{2,5}}{p_{2,9}} - \frac{f_{5,9}\,p_{5,6}}{p_{5,9}} + \frac{f_{5,9}\,(p_{5,2}+p_{5,6}+p_{5,9})}{p_{5,9}}$$

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

$$\tilde{x}_{9,3} \to -f_{9,3} - \frac{f_{3,9}\,p_{3,4}}{p_{3,9}} + \frac{f_{3,9}\,(p_{3,4}+p_{3,8}+p_{3,9})}{p_{3,9}} - \frac{f_{8,9}\,p_{8,3}}{p_{8,9}}$$

$$\tilde{x}_{9,7} \to -f_{9,5} - \frac{f_{2,9}\,p_{2,5}}{p_{2,9}} - \frac{f_{5,9}\,p_{5,6}}{p_{5,9}} + \frac{f_{5,9}\,(p_{5,2}+p_{5,6}+p_{5,9})}{p_{5,9}}$$

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

$$\tilde{x}_{1\bullet\!\leftrightarrow\!\bullet 0} \to 0$$

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

Out[ ]=

$$\left\{f_{9\bullet\!\leftrightarrow\!1} + \frac{f_{2\bullet\!\leftrightarrow\!9}\,p_{2\bullet\!\leftrightarrow\!1}}{p_{2\bullet\!\leftrightarrow\!9}} == f_{1\bullet\!\leftrightarrow\!9}\left(1 + \frac{p_{1\bullet\!\leftrightarrow\!2}}{p_{1\bullet\!\leftrightarrow\!9}}\right),\ \text{True},\ \text{True},\ \text{True},\right.$$

$$\left.\text{True},\ \text{True},\ \text{True},\ \text{True},\ f_{9\bullet\!\leftrightarrow\!1} + f_{1\bullet\!\leftrightarrow\!9}\left(-1 - \frac{p_{1\bullet\!\leftrightarrow\!2}}{p_{1\bullet\!\leftrightarrow\!9}}\right) + \frac{f_{2\bullet\!\leftrightarrow\!9}\,p_{2\bullet\!\leftrightarrow\!1}}{p_{2\bullet\!\leftrightarrow\!9}} == 0\right\}$$

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

Out[ ]//TableForm=

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

$$x_{4,3} - \frac{p_{4,7}\, x_{4,7}}{p_{4,3}} == 0$$

$$x_{4,3} - \frac{p_{4,6}\, x_{4,6}}{p_{4,3}} == 0$$

$$-\frac{p_{6,4}\, x_{6,4}}{p_{6,7}} + x_{6,7} == 0$$

$$-\frac{p_{6,5}\, x_{6,5}}{p_{6,7}} + x_{6,7} == 0$$

$$x_{7,4} - \frac{p_{7,6}\, x_{7,6}}{p_{7,4}} == 0$$

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

Out[]= cicle det's:

Out[]//TableForm=

$$\begin{array}{ccccc} -1-\frac{p_{4,\to 7}}{p_{4,\to 3}} & 1 & 0 & 1 & -1 \\ -1 & 1 & 0 & 1 & -1-\frac{p_{4,\to 6}}{p_{4,\to 3}} \\ 0 & 0 & 1 & -\frac{p_{6,\to 4}}{p_{6,\to 7}} & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & -\frac{p_{7,\to 6}}{p_{7,\to 4}} & -\frac{p_{7,\to 6}}{p_{7,\to 4}} & \frac{p_{7,\to 6}}{p_{7,\to 4}} \end{array}$$

In[]:=
```
rank = MatrixRank[Λ]
```

Out[]= 5

In[]:=
```
"U_c="
U_c = Range[rank]
"U_nc="
U_nc = Range[Length[Λ[[1]]]] ~Complement~ U_c
```

Out[]= $U_c =$

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

Out[]= $U_{nc} =$

Out[]= { }

In[]:=
```
Λc = Λ[[All, U_c]];
Λnc = Λ[[All, U_nc]];
"Λ_c="
Λc // MatrixForm
```

Out[]= $\Lambda_c =$

Out[]//MatrixForm=

$$\begin{pmatrix} -1-\frac{p_{4,\to 7}}{p_{4,\to 3}} & 1 & 0 & 1 & -1 \\ -1 & 1 & 0 & 1 & -1-\frac{p_{4,\to 6}}{p_{4,\to 3}} \\ 0 & 0 & 1 & -\frac{p_{6,\to 4}}{p_{6,\to 7}} & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & -\frac{p_{7,\to 6}}{p_{7,\to 4}} & -\frac{p_{7,\to 6}}{p_{7,\to 4}} & \frac{p_{7,\to 6}}{p_{7,\to 4}} \end{pmatrix}$$

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

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

Out[ ]//TableForm=

$$-\frac{p_{6,4}\left(p_{4,6}\,p_{4,7}\,p_{7,4}+p_{4,3}\left(p_{4,6}\,p_{7,4}+p_{4,7}\left(p_{7,4}+p_{7,6}\right)\right)\right)}{p_{4,3}^2\,p_{6,7}\,p_{7,4}}$$

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

Out[ ]= $U_T =$

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

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

Out[ ]= $U_{Nb} =$

Out[ ]= $\{4 \leftrightarrow 7,\ 7 \leftrightarrow 4,\ 6 \leftrightarrow 7,\ 6 \leftrightarrow 4,\ 4 \leftrightarrow 6\}$

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

Out[ ]= $A =$

Out[ ]//MatrixForm=

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

In[ ]:=
```
β = A(*-Λnc.{x#&/@UNb[[Unc]]}^T*);
"β="
β // forma
```

Out[ ]= $\beta =$

Out[ ]//TableForm=

$$-\frac{f_{3,9}\,p_{3,4}}{p_{3,9}}$$
$$-\frac{f_{3,9}\,p_{3,4}}{p_{3,9}}$$
$$0$$
$$\frac{\left(-f_{9,5}-\frac{f_{2,9}\,p_{2,5}}{p_{2,9}}+\frac{f_{5,9}\left(p_{5,2}+p_{5,6}+p_{5,9}\right)}{p_{5,9}}\right)p_{6,5}}{p_{6,7}}$$
$$\frac{\left(-f_{9,5}-\frac{f_{2,9}\,p_{2,5}}{p_{2,9}}-\frac{f_{5,9}\,p_{5,6}}{p_{5,9}}+\frac{f_{5,9}\left(p_{5,2}+p_{5,6}+p_{5,9}\right)}{p_{5,9}}\right)p_{7,6}}{p_{7,4}}$$

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

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

Out[•]=

$$\Big\{\Big\{\Big(f_{3\to 9}\,p_{2\to 9}\,p_{3\to 4}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 7}\,p_{7\to 4}+f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 2}\,p_{6\to 5}\,p_{6\to 7}\,p_{7\to 4}+f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 6}\,p_{6\to 5}\,p_{6\to 7}\,p_{7\to 4}-f_{2\to 9}\,p_{2\to 5}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 9}\,p_{6\to 5}\,p_{6\to 7}\,p_{7\to 4}+f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 9}\,p_{6\to 5}\,p_{6\to 7}\,p_{7\to 4}-f_{9\to 5}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 9}\,p_{6\to 5}\,p_{6\to 7}\,p_{7\to 4}+f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 2}\,p_{6\to 4}\,p_{6\to 5}\,p_{7\to 6}+f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 6}\,p_{6\to 4}\,p_{6\to 5}\,p_{7\to 6}-f_{2\to 9}\,p_{2\to 5}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 5}\,p_{7\to 6}+f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 5}\,p_{7\to 6}-f_{9\to 5}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 5}\,p_{7\to 6}+f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 2}\,p_{6\to 4}\,p_{6\to 7}\,p_{7\to 6}-f_{2\to 9}\,p_{2\to 5}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 7}\,p_{7\to 6}+f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 7}\,p_{7\to 6}-f_{9\to 5}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 7}\,p_{7\to 6}+f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 2}\,p_{6\to 5}\,p_{6\to 7}\,p_{7\to 6}+f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 6}\,p_{6\to 5}\,p_{6\to 7}\,p_{7\to 6}-f_{2\to 9}\,p_{2\to 5}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 9}\,p_{6\to 5}\,p_{6\to 7}\,p_{7\to 6}+f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 9}\,p_{6\to 5}\,p_{6\to 7}\,p_{7\to 6}-f_{9\to 5}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 9}\,p_{6\to 5}\,p_{6\to 7}\,p_{7\to 6}\Big)\Big/\big(p_{2\to 9}\,p_{3\to 9}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 7}\,(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})\big)\Big\},$$

$$\Big\{-\Big(\Big(\Big(-f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 2}\,p_{6\to 4}\,p_{6\to 5}-f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 7}\,p_{5\to 2}\,p_{6\to 4}\,p_{6\to 5}-f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 6}\,p_{4\to 7}\,p_{5\to 2}\,p_{6\to 4}\,p_{6\to 5}-f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 6}\,p_{6\to 4}\,p_{6\to 5}-f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 7}\,p_{5\to 6}\,p_{6\to 4}\,p_{6\to 5}-f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 6}\,p_{4\to 7}\,p_{5\to 6}\,p_{6\to 4}\,p_{6\to 5}+f_{2\to 9}\,p_{2\to 5}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 5}-f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 5}+f_{9\to 5}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 5}+f_{2\to 9}\,p_{2\to 5}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 7}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 5}-f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 7}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 5}+f_{9\to 5}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 7}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 5}+f_{2\to 9}\,p_{2\to 5}\,p_{3\to 9}\,p_{4\to 6}\,p_{4\to 7}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 5}-f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 6}\,p_{4\to 7}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 5}+f_{9\to 5}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 6}\,p_{4\to 7}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 5}-f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 2}\,p_{6\to 4}\,p_{6\to 7}-f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 7}\,p_{5\to 2}\,p_{6\to 4}\,p_{6\to 7}-f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 6}\,p_{4\to 7}\,p_{5\to 2}\,p_{6\to 4}\,p_{6\to 7}+f_{2\to 9}\,p_{2\to 5}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 7}-f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 7}+f_{9\to 5}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 7}+f_{3\to 9}\,p_{2\to 9}\,p_{3\to 4}\,p_{4\to 3}\,p_{4\to 7}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 7}+f_{2\to 9}\,p_{2\to 5}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 7}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 7}-f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 7}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 7}+f_{9\to 5}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 7}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 7}-f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 6}\,p_{4\to 7}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 7}+f_{9\to 5}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 6}\,p_{4\to 7}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 7}-f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 2}\,p_{6\to 5}\,p_{6\to 7}-f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 6}\,p_{6\to 5}\,p_{6\to 7}+f_{2\to 9}\,p_{2\to 5}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 9}\,p_{6\to 5}\,p_{6\to 7}-f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 9}\,p_{6\to 5}\,p_{6\to 7}+f_{9\to 5}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 3}\,p_{4\to 6}\,p_{5\to 9}\,p_{6\to 5}\,p_{6\to 7}-f_{5\to 9}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 6}\,p_{4\to 7}\,p_{5\to 9}\,p_{6\to 5}\,p_{6\to 7}+f_{9\to 5}\,p_{2\to 9}\,p_{3\to 9}\,p_{4\to 6}\,p_{4\to 7}\,p_{5\to 9}\,p_{6\to 5}\,p_{6\to 7}\Big)\,p_{7\to 6}\Big)\Big/\big(p_{2\to 9}\,p_{3\to 9}\,p_{5\to 9}\,p_{6\to 4}\,p_{6\to 7}\,(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})\big)\Big)\Big\},$$

$$\left\{\frac{\left(-f_{9\to 5}-\frac{f_{2\to 9}\,p_{2\to 5}}{p_{2\to 9}}+\frac{f_{5\to 9}\,(p_{5\to 2}+p_{5\to 6}+p_{5\to 9})}{p_{5\to 9}}\right)p_{6\to 5}}{p_{6\to 7}}\right\},$$

$$\left\{\frac{\left(-f_{9\to 5}-\frac{f_{2\to 9}\,p_{2\to 5}}{p_{2\to 9}}+\frac{f_{5\to 9}\,(p_{5\to 2}+p_{5\to 6}+p_{5\to 9})}{p_{5\to 9}}\right)p_{6\to 5}}{p_{6\to 4}}\right\},$$

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

In[ ]:=
```
xcp = MapThread[x_#1 → #2 &, {U_Nb[[U_c]], Flatten[xc]}];
xcp // TableForm
```

Out[ ]//TableForm=

$$x_{4,\to 7} \to \frac{f_{3,\to 9}\, p_{2,\to 9}\, p_{3,\to 4}\, p_{4,\to 3}\, p_{4,\to 6}\, p_{5,\to 9}\, p_{6,\to 4}\, p_{6,\to 7}\, p_{7,\to 4} + f_{5,\to 9}\, p_{2,\to 9}\, p_{3,\to 9}\, p_{4,\to 3}\, p_{4,\to 6}\, p_{5,\to 2}\, p_{6,\to 5}\, p_{6,\to 7}\, p_{7,\to 4} + f_{5,\to 9}\, p_{2,\to 9}\, p_{3,\to 9}\, p_{4,\to 3}\, p_{4,\to 6}\, p_{5,\to 6}\, p_{6,\to 5}\, p_{6,\to 7}\, p$$

$$x_{7,\to 4} \to -\frac{(-f_{5,\to 9}\, p_{2,\to 9}\, p_{3,\to 9}\, p_{4,\to 3}\, p_{4,\to 6}\, p_{5,\to 2}\, p_{6,\to 4}\, p_{6,\to 5} - f_{5,\to 9}\, p_{2,\to 9}\, p_{3,\to 9}\, p_{4,\to 3}\, p_{4,\to 7}\, p_{5,\to 2}\, p_{6,\to 4}\, p_{6,\to 5} - f_{5,\to 9}\, p_{2,\to 9}\, p_{3,\to 9}\, p_{4,\to 6}\, p_{4,\to 7}\, p_{5,\to 2}\, p_{6,\to 4}\, p_{6,\to 5} - f_{5,\to 9}\, p$$

$$x_{6,\to 7} \to \frac{\left(-f_{9,\to 5} - \frac{f_{2,\to 9}\, p_{2,\to 5}}{p_{2,\to 9}} + \frac{f_{5,\to 9}\,(p_{5,\to 2} + p_{5,\to 6} + p_{5,\to 9})}{p_{5,\to 9}}\right) p_{6,\to 5}}{p_{6,\to 7}}$$

$$x_{6,\to 4} \to \frac{\left(-f_{9,\to 5} - \frac{f_{2,\to 9}\, p_{2,\to 5}}{p_{2,\to 9}} + \frac{f_{5,\to 9}\,(p_{5,\to 2} + p_{5,\to 6} + p_{5,\to 9})}{p_{5,\to 9}}\right) p_{6,\to 5}}{p_{6,\to 4}}$$

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

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

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

Out[ ]//TableForm=

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

$$x_{7,\to 6} \to -f_{9,\to 5} - \frac{f_{2,\to 9}\, p_{2,\to 5}}{p_{2,\to 9}} - \frac{f_{5,\to 9}\, p_{5,\to 6}}{p_{5,\to 9}} + \frac{f_{5,\to 9}\,(p_{5,\to 2} + p_{5,\to 6} + p_{5,\to 9})}{p_{5,\to 9}} - x_{4,\to 6} + x_{6,\to 4} + x_{6,\to 7}$$

$$x_{6,\to 5} \to -f_{9,\to 5} - \frac{f_{2,\to 9}\, p_{2,\to 5}}{p_{2,\to 9}} + \frac{f_{5,\to 9}\,(p_{5,\to 2} + p_{5,\to 6} + p_{5,\to 9})}{p_{5,\to 9}}$$

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

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

$$x_{9,\to 7} \to -f_{9,\to 5} - \frac{f_{2,\to 9}\, p_{2,\to 5}}{p_{2,\to 9}} - \frac{f_{5,\to 9}\, p_{5,\to 6}}{p_{5,\to 9}} + \frac{f_{5,\to 9}\,(p_{5,\to 2} + p_{5,\to 6} + p_{5,\to 9})}{p_{5,\to 9}} - x_{4,\to 6} - x_{4,\to 7} + x_{6,\to 4} + x_{7,\to 4}$$

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

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

Out[ ]= общее решение:

Out[ ]//TableForm=

$$x_{4,3} \to \frac{p_{4,6}\, p_{4,7}\,(f_{3,9}\, p_{2,9}\, p_{3,4}\, p_{5,9}\, p_{6,4}\, p_{6,7}\, p_{7,4} + p_{3,9}\,(-(f_{2,9}\, p_{2,5} + f_{9,5}\, p_{2,9})\, p_{5,9}\,(p_{6,4}\, p_{6,7}\, p_{7,6} + p_{6,5}\,(p_{6,4}\, p_{7,6} + p_{6,7}\,(p_{7,4} + p_{7,6}))) + f_{5,9}\, p_{2,9}\,(p}{p_{2,9}\, p_{3,9}\, p_{5,9}\, p_{6,4}\, p_{6,7}\,(p_{4,6}\, p}$$

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

$$x_{6,5} \to -f_{9,5} - \frac{f_{2,9}\, p_{2,5}}{p_{2,9}} + \frac{f_{5,9}\,(p_{5,2} + p_{5,6} + p_{5,9})}{p_{5,9}}$$

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

$$x_{9,3} \to \frac{f_{3,9}\, p_{2,9}\, p_{5,9}\, p_{6,4}\, p_{6,7}\,(p_{3,4}\, p_{4,3}\,(p_{4,6}\, p_{7,4} + p_{4,7}\,(p_{7,4} + p_{7,6})) + (p_{3,8} + p_{3,9})\,(p_{4,6}\, p_{4,7}\, p_{7,4} + p_{4,3}\,(p_{4,6}\, p_{7,4} + p_{4,7}\,(p_{7,4} + p_{7,6}))))) - p_{3,9}\,(f_{9,3}$$

$$x_{9,7} \to \frac{-p_{5,9}\,(f_{3,9}\, p_{2,9}\, p_{3,4}\, p_{4,3}\, p_{6,4}\, p_{6,7}\,(p_{4,6}\, p_{7,4} + p_{4,7}\,(p_{7,4} + p_{7,6})) + (f_{2,9}\, p_{2,5} + f_{9,5}\, p_{2,9})\, p_{3,9}\,(p_{4,3}\, p_{6,4}\, p_{6,7}\,(p_{4,6}\, p_{7,4} + p_{4,7}\,(p_{7,4} + p_{7,6})) + p_{4,6}$$

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

$$x_{4,7} \to \frac{p_{4,3}\, p_{4,6}\,(f_{3,9}\, p_{2,9}\, p_{3,4}\, p_{5,9}\, p_{6,4}\, p_{6,7}\, p_{7,4} + p_{3,9}\,(-(f_{2,9}\, p_{2,5} + f_{9,5}\, p_{2,9})\, p_{5,9}\,(p_{6,4}\, p_{6,7}\, p_{7,6} + p_{6,5}\,(p_{6,4}\, p_{7,6} + p_{6,7}\,(p_{7,4} + p_{7,6}))) + f_{5,9}\, p_{2,9}\,(p}{p_{2,9}\, p_{3,9}\, p_{5,9}\, p_{6,4}\, p_{6,7}\,(p_{4,6}\, p$$

$$x_{7,4} \to \frac{(f_{5,9}\, p_{2,9}\, p_{3,9}\,(p_{4,6}\, p_{4,7}\,(p_{5,6}\, p_{6,5}\,(p_{6,4} + p_{6,7}) + p_{5,2}\,(p_{6,5}\, p_{6,7} + p_{6,4}\,(p_{6,5} + p_{6,7}))) + p_{5,9}\,(p_{6,5}\, p_{6,7} + p_{6,4}\,(p_{6,5} + p_{6,7})))) + p_{4,3}\,(p_{4,7}\, p_{6,4}\,(p_{5,}$$

$$x_{6,7} \to \frac{\left(-f_{9,5} - \frac{f_{2,9}\, p_{2,5}}{p_{2,9}} + \frac{f_{5,9}\,(p_{5,2} + p_{5,6} + p_{5,9})}{p_{5,9}}\right) p_{6,5}}{p_{6,7}}$$

$$x_{6,4} \to \frac{\left(-f_{9,5} - \frac{f_{2,9}\, p_{2,5}}{p_{2,9}} + \frac{f_{5,9}\,(p_{5,2} + p_{5,6} + p_{5,9})}{p_{5,9}}\right) p_{6,5}}{p_{6,4}}$$

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

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

Out[ ]= eq test:

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

$\left.\text{True},\ \text{True},\ \text{True},\ \text{True},\ f_{9\bullet\to 1}+f_{1\bullet\to 9}\left(-1-\frac{p_{1\bullet\to 2}}{p_{1\bullet\to 9}}\right)+\frac{f_{2\bullet\to 9}\,p_{2\bullet\to 1}}{p_{2\bullet\to 9}}==0\right\}$

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