Листинг 2

In[1]:=
```
ClearAll["Global`*"]
SetDirectory[NotebookDirectory[]];
Needs["FlowSolver`"]
```

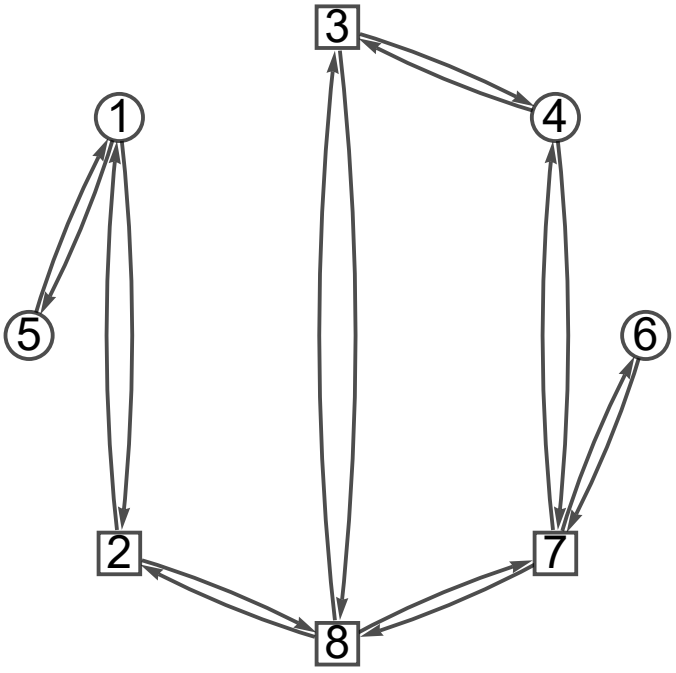
In[4]:=
```
readGraph2[file_, dir_] := Module[{
    fn = FileNameJoin[{dir, file}],
    stream, imod, umod, u, b
    },
    stream = OpenRead[fn];
    imod = Read[stream, {Word, Number}][[2]];
    umod = Read[stream, {Word, Number}][[2]];

  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[5]:=
```
forma[ff_] := ((ff /. {ξ_u_↔v_ → ξu,v}) // TableForm)
```

In[8]:=
```
{g, b} = readGraph2["gr3.txt", NotebookDirectory[]];
GraphPlot[g, EdgeStyle → Directive[Black, Thick],
 VertexStyle → Directive[EdgeForm[Thick], White], MultiedgeStyle → .05]
```

Out[9]=



In[10]:=
```
balanceEqs = ((Total[x_# & /@ EdgeList[g, _ ↔ #]] - Total[x_# & /@ EdgeList[g, # ↔ _]])) ==
      MapIndexed[#1 /. x → x_#2[[1]] &, b][[#]] & /@ VertexList[g];
balanceEqs //
 forma
```

Out[11]//TableForm=

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

In[14]:=
```
M = {8};
Print["M = ", M];
```

M = {8}

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

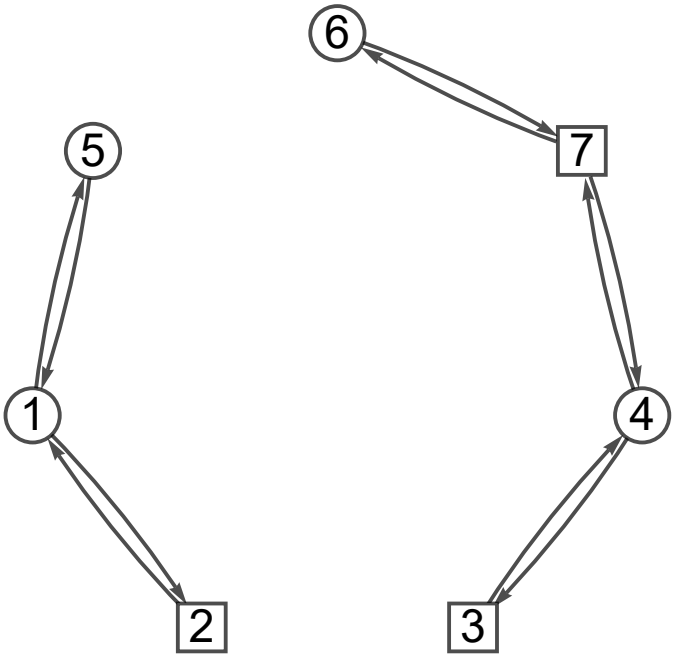
In[ ]:=
```
(*p_#&/@EdgeList[g]*)
```

In[16]:=
```
(*incL=
 DeleteCases[DeleteDuplicates[Cases[IncidenceList[g,#],i_↔j_:>{i,j}]//Flatten],
    v_/;v==#]&/@M*)
incL = (IncidenceList[g, #] & /@ M) // Flatten
```

Out[16]= {2 ↔ 8, 8 ↔ 2, 3 ↔ 8, 8 ↔ 3, 7 ↔ 8, 8 ↔ 7}

In[17]:=
```
(*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[20]=



Out[21]= $\{0,\ x + f_{2\leftrightarrow 8} - f_{8\leftrightarrow 2},\ x + f_{3\leftrightarrow 8} - f_{8\leftrightarrow 3},\ 0,\ 0,\ 0,\ x + f_{7\leftrightarrow 8} - f_{8\leftrightarrow 7}\}$

In[22]:=
```
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[24]:=
```
M⁺ = CC[g, M]
```

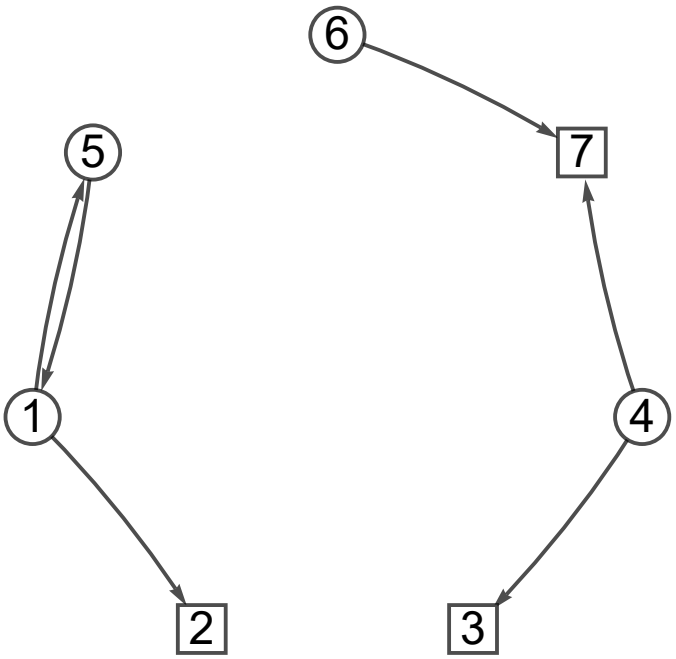
Out[24]= $\{2 \leftrightarrow 8,\ 3 \leftrightarrow 8,\ 7 \leftrightarrow 8\}$

In[25]:=
```
b1̄ = 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^+[n̄ḡ]])] &, b̄, M⁺]
```

Out[25]= $\left\{-\frac{f_{2\leftrightarrow 8}\, p_{2\leftrightarrow 1}}{p_{2\leftrightarrow 8}},\ x + f_{2\leftrightarrow 8} - f_{8\leftrightarrow 2} + \frac{f_{2\leftrightarrow 8}\, p_{2\leftrightarrow 1}}{p_{2\leftrightarrow 8}},\ x + f_{3\leftrightarrow 8} - f_{8\leftrightarrow 3} + \frac{f_{3\leftrightarrow 8}\, p_{3\leftrightarrow 4}}{p_{3\leftrightarrow 8}},\right.$
$\left. -\frac{f_{3\leftrightarrow 8}\, p_{3\leftrightarrow 4}}{p_{3\leftrightarrow 8}} - \frac{f_{7\leftrightarrow 8}\, p_{7\leftrightarrow 4}}{p_{7\leftrightarrow 8}},\ 0,\ -\frac{f_{7\leftrightarrow 8}\, p_{7\leftrightarrow 6}}{p_{7\leftrightarrow 8}},\ x + f_{7\leftrightarrow 8} - f_{8\leftrightarrow 7} + \frac{f_{7\leftrightarrow 8}\, p_{7\leftrightarrow 4}}{p_{7\leftrightarrow 8}} + \frac{f_{7\leftrightarrow 8}\, p_{7\leftrightarrow 6}}{p_{7\leftrightarrow 8}}\right\}$

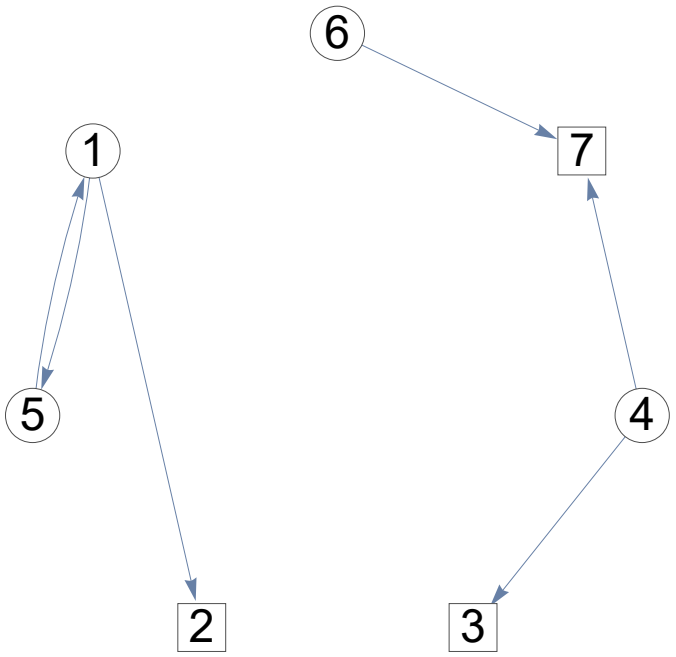
In[26]:=
```
GraphPlot[Fold[HighlightGraph[#1, u_ ⟷ v_ /; u == #2, GraphHighlightStyle → "White"] &,
  ng̅, #[[1]] & /@ M⁺], EdgeStyle → Directive[Black, Thick],
 VertexStyle → Directive[EdgeForm[Thick], White], MultiedgeStyle → .05]
```

Out[26]=



In[27]:=
```
g1̅ = Fold[EdgeDelete[#1, u_ ⟷ v_ /; u == #2] &, ng̅, #[[1]] & /@ M⁺];
GraphPlot[g1̅, MultiedgeStyle → .05]
```

Out[28]=



In[29]:=
```
II_rem = VertexList[g1̅] ~Complement~ (M⁺[[All, 1]])
```

Out[29]= {1, 4, 5, 6}

In[30]:=
```
λ = SparseArray[
  Replace[(EdgeList[g1] /. # & /@ Flatten[Module[{i = #, jf, 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[30]=
```
SparseArray[ ]
```
Specified elements: 4
Dimensions: {2, 6}

In[31]:=
```
Grid[λ]
```

Out[31]=
$$\begin{array}{cccccc} 1 & -\frac{p_{1\leftrightarrow 5}}{p_{1\leftrightarrow 2}} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & -\frac{p_{4\leftrightarrow 7}}{p_{4\leftrightarrow 3}} & 0 \end{array}$$

In[32]:=
```
g = g1;
b = b1;
```

In[34]:=
```
II* = Cases[MapIndexed[{#1, #2} &, b],
    {el_, i_} /; MemberQ[el, x] || SameQ[el, x] :> i] // Flatten
```

Out[34]=
```
{2, 3, 7}
```

In[35]:=
```
buildt = Timing[{t, g} = buildTree[g, II*];][[1]]
TableForm[t[[1 ;; 4]],
 TableHeadings → {{"pred", "dir", "depth", "d"}, t // pred // Length // Range}]
```

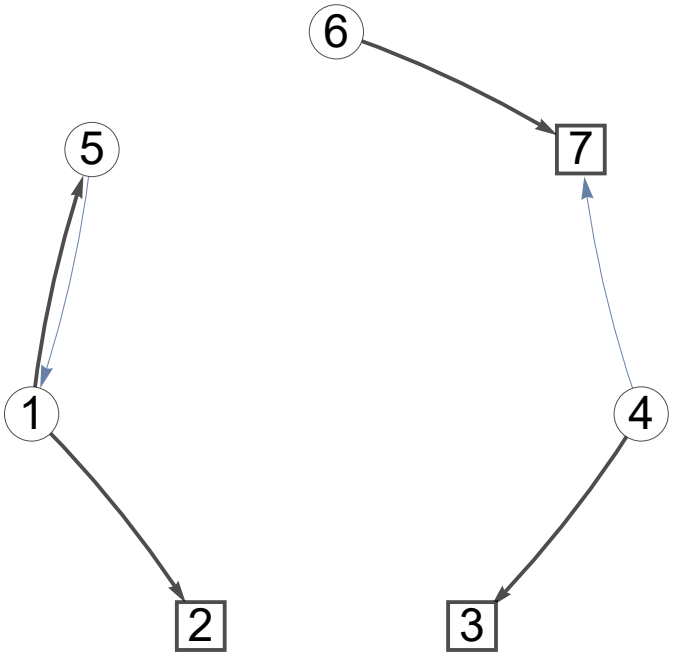
Out[35]=
```
0.015625
```

Out[36]//TableForm=

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

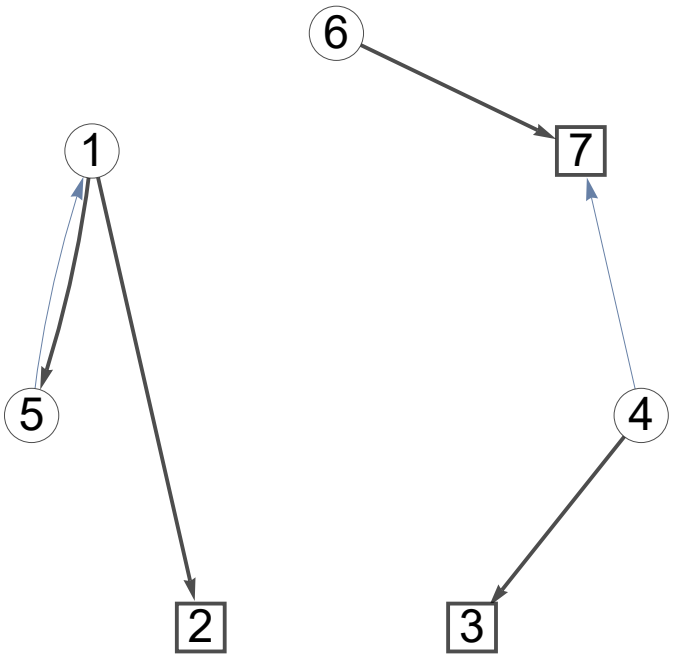
In[37]:=
```
GraphPlot[HighlightGraph[
  Fold[HighlightGraph[#1, Style[u_ ↔ v_ /; u == #2, White]] &, ng, #[[1]] & /@ M^+],
  {Style[u_ /; VertexQ[g, u] && pred[t][[u]] == root[t], EdgeForm[Thick]],
   Style[u_ ↔ v_ /; (pred[t][[u]] == v && dir[t][[u]] == -1) ||
      (pred[t][[v]] == u && dir[t][[v]] == 1), Directive[Black, Thick]]},
  GraphHighlightStyle → None], MultiedgeStyle → .05]
```

Out[37]=

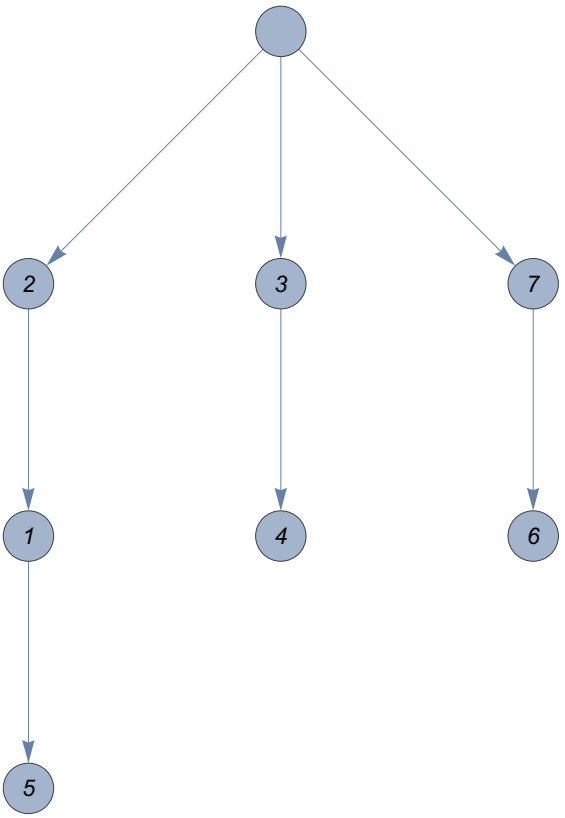


In[38]:=
```
GraphPlot[HighlightGraph[g1,
  {Style[u_ /; VertexQ[g, u] && pred[t][[u]] == root[t], EdgeForm[Thick]],
   Style[u_ ↔ v_ /; (pred[t][[u]] == v && dir[t][[u]] == -1) ||
      (pred[t][[v]] == u && dir[t][[v]] == 1), Directive[Black, Thick]]},
  GraphHighlightStyle → None], MultiedgeStyle → .05]
```

Out[38]=

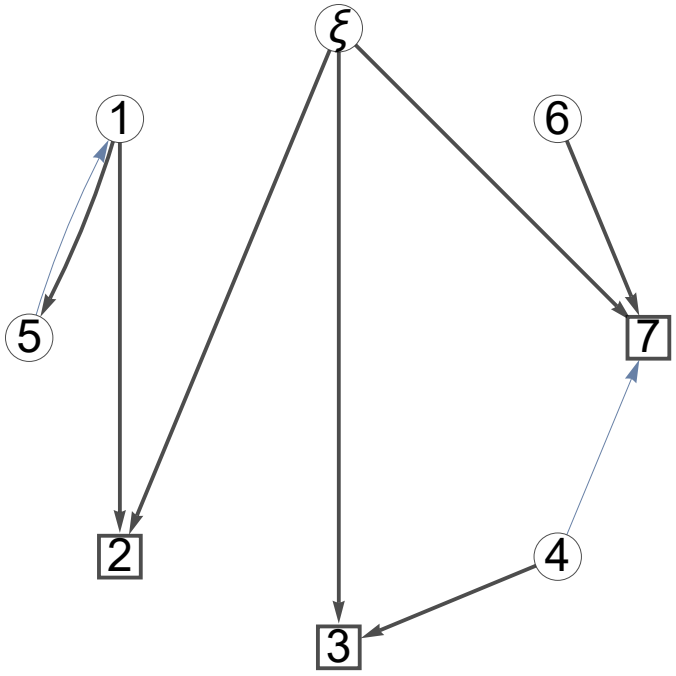


In[39]:=
```
t[[7]](*пометить на графе*)
```



Out[39]=

In[40]:=
```
(*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[40]=

In[41]:=
```
AppendTo[b, -Total[b]];
b = Simplify[b /. x → 0]
```

Out[42]=
$$\left\{-\frac{f_{2\bullet\to 8}\, p_{2\bullet\to 1}}{p_{2\bullet\to 8}},\ -f_{8\bullet\to 2}+f_{2\bullet\to 8}\left(1+\frac{p_{2\bullet\to 1}}{p_{2\bullet\to 8}}\right),\ -f_{8\bullet\to 3}+f_{3\bullet\to 8}\left(1+\frac{p_{3\bullet\to 4}}{p_{3\bullet\to 8}}\right),\ -\frac{f_{3\bullet\to 8}\, p_{3\bullet\to 4}}{p_{3\bullet\to 8}}-\frac{f_{7\bullet\to 8}\, p_{7\bullet\to 4}}{p_{7\bullet\to 8}},\ 0,\right.$$
$$\left.-\frac{f_{7\bullet\to 8}\, p_{7\bullet\to 6}}{p_{7\bullet\to 8}},\ -f_{8\bullet\to 7}+\frac{f_{7\bullet\to 8}\,(p_{7\bullet\to 4}+p_{7\bullet\to 6}+p_{7\bullet\to 8})}{p_{7\bullet\to 8}},\ -f_{2\bullet\to 8}-f_{3\bullet\to 8}-f_{7\bullet\to 8}+f_{8\bullet\to 2}+f_{8\bullet\to 3}+f_{8\bullet\to 7}\right\}$$

In[43]:=
```
balanceEqs = ((Total[x_# & /@ EdgeList[g, _ ↔ #]] - Total[x_# & /@ EdgeList[g, # ↔ _]]) /.
      root[t] → ξ) == b[[#]] & /@ VertexList[g];
balanceEqs //
 forma
```

Out[44]//TableForm=
$$-x_{1,2}-x_{1,5}+x_{5,1}==-\frac{f_{2,8}\, p_{2,1}}{p_{2,8}}$$
$$x_{1,2}+x_{\xi,2}==-f_{8,2}+f_{2,8}\left(1+\frac{p_{2,1}}{p_{2,8}}\right)$$
$$x_{1,5}-x_{5,1}==0$$
$$x_{4,3}+x_{\xi,3}==-f_{8,3}+f_{3,8}\left(1+\frac{p_{3,4}}{p_{3,8}}\right)$$
$$-x_{4,3}-x_{4,7}==-\frac{f_{3,8}\, p_{3,4}}{p_{3,8}}-\frac{f_{7,8}\, p_{7,4}}{p_{7,8}}$$
$$x_{4,7}+x_{6,7}+x_{\xi,7}==-f_{8,7}+\frac{f_{7,8}\,(p_{7,4}+p_{7,6}+p_{7,8})}{p_{7,8}}$$
$$-x_{6,7}==-\frac{f_{7,8}\, p_{7,6}}{p_{7,8}}$$
$$-x_{\xi,2}-x_{\xi,3}-x_{\xi,7}==-f_{2,8}-f_{3,8}-f_{7,8}+f_{8,2}+f_{8,3}+f_{8,7}$$

In[45]:=
```
ps = partSolve[g, -b, t, x̃];
ps // forma
```

Out[46]//TableForm=
$$\tilde{x}_{1,2}\to\frac{f_{2,8}\, p_{2,1}}{p_{2,8}}$$
$$\tilde{x}_{1,5}\to 0$$
$$\tilde{x}_{4,3}\to\frac{f_{3,8}\, p_{3,4}}{p_{3,8}}+\frac{f_{7,8}\, p_{7,4}}{p_{7,8}}$$
$$\tilde{x}_{4,7}\to 0$$
$$\tilde{x}_{5,1}\to 0$$
$$\tilde{x}_{6,7}\to\frac{f_{7,8}\, p_{7,6}}{p_{7,8}}$$
$$\tilde{x}_{8,2}\to -f_{8,2}+f_{2,8}\left(1+\frac{p_{2,1}}{p_{2,8}}\right)-\frac{f_{2,8}\, p_{2,1}}{p_{2,8}}$$
$$\tilde{x}_{8,3}\to -f_{8,3}+f_{3,8}\left(1+\frac{p_{3,4}}{p_{3,8}}\right)-\frac{f_{3,8}\, p_{3,4}}{p_{3,8}}-\frac{f_{7,8}\, p_{7,4}}{p_{7,8}}$$
$$\tilde{x}_{8,7}\to -f_{8,7}-\frac{f_{7,8}\, p_{7,6}}{p_{7,8}}+\frac{f_{7,8}\,(p_{7,4}+p_{7,6}+p_{7,8})}{p_{7,8}}$$

In[47]:=
```
Simplify[(balanceEqs /. {x → x̃, ξ → root[t]}) /. ps]
```

Out[47]=
```
{True, True, True, True, True, True, True, True}
```

In[48]:=
```
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 &], #}][True]}]] // forma
```

Out[50]//TableForm=

	$\delta_{1,2}$	$\delta_{1,5}$	$\delta_{5,1}$	$\delta_{4,3}$	$\delta_{4,7}$	$\delta_{6,7}$	δ_2	δ_3	δ_7
$5\bullet\!\!-\!\!\bullet 1$	0	1	1	0	0	0	0	0	0
$4\bullet\!\!-\!\!\bullet 7$	0	0	0	−1	1	0	0	1	−1

In[51]:=
```
λ = SparseArray[λ, {Length[λ], Length[λ[[1]]] + Length[II*]}];
(*λ=λ[[;;-2]]*)
```

In[52]:=
```
dopEq = # == 0 & /@ Flatten[λ.{x# & /@ EdgeList[g]}^T];
dopEq // forma
```

Out[53]//TableForm=

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

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

In[54]:=
```
Λ = λ.(δMatr)^T;
"cicle det's:"
Λ // forma
```

Out[55]= cicle det's:

Out[56]//TableForm=

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

In[57]:=
```
MatrixRank[Λ]
```

Out[57]= 2

In[62]:=
```
"U_c="
U_c = {1, 2}
"U_nc="
U_nc = {}
```

Out[62]= $U_c =$

Out[63]= $\{1, 2\}$

Out[64]= $U_{nc} =$

Out[65]= $\{\}$

In[70]:=
```
Λc = Λ[[All, U_c]];
Λnc = Λ[[All, U_nc]];
"Λ_c="
Λc // MatrixForm
```

Out[72]= $\Lambda_c =$

Out[73]//MatrixForm=

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

In[74]:=
```
"det(Λ_c)="
Simplify[det = Det[Λc]] // forma
```

Out[74]= $\det(\Lambda_c) =$

Out[75]//TableForm=

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

In[76]:=
```
"U_T="
utind = Cases[t[[6]], ξ_ /; ξ ≠ 0];
U_T = EdgeList[g][[utind]]
```

Out[76]= $U_T =$

Out[78]= $\{1 \bullet\!\!\rightarrow 2,\ 8 \bullet\!\!\rightarrow 2,\ 8 \bullet\!\!\rightarrow 3,\ 4 \bullet\!\!\rightarrow 3,\ 1 \bullet\!\!\rightarrow 5,\ 6 \bullet\!\!\rightarrow 7,\ 8 \bullet\!\!\rightarrow 7\}$

In[79]:=
```
"U_Nb="
U_Nb = uNb[g, t]
```

Out[79]= $U_{Nb}=$

Out[80]= $\{5 \bullet\!\!\rightarrow 1,\ 4 \bullet\!\!\rightarrow 7\}$

In[81]:=
```
A = -λ.{x̃_# & /@ EdgeList[g]}^T /. ps;
"A="
A // MatrixForm
```

Out[82]= $A=$

Out[83]//MatrixForm=

$$\begin{pmatrix} -\frac{f_{2\bullet\!\!\rightarrow 8}\, p_{2\bullet\!\!\rightarrow 1}}{p_{2\bullet\!\!\rightarrow 8}} \\ -\frac{f_{3\bullet\!\!\rightarrow 8}\, p_{3\bullet\!\!\rightarrow 4}}{p_{3\bullet\!\!\rightarrow 8}} \quad -\frac{f_{7\bullet\!\!\rightarrow 8}\, p_{7\bullet\!\!\rightarrow 4}}{p_{7\bullet\!\!\rightarrow 8}} \end{pmatrix}$$

In[84]:=
```
β = A - Λnc.{x_# & /@ U_Nb[[U_nc]]}^T;
"β="
β // forma
```

Out[85]= $\beta=$

Out[86]//TableForm=

$$-\frac{f_{2,8}\, p_{2,1}}{p_{2,8}}$$
$$-\frac{f_{3,8}\, p_{3,4}}{p_{3,8}} \quad -\frac{f_{7,8}\, p_{7,4}}{p_{7,8}}$$

In[89]:=
```
"решаем уравнение Λ_c x_c=β:"
xc = LinearSolve[Λc, β[[]]]
```

Out[89]= решаем уравнение $\Lambda_c x_c=\beta$:

Out[90]= $$\left\{\left\{\frac{f_{2\bullet\!\!\rightarrow 8}\, p_{1\bullet\!\!\rightarrow 2}\, p_{2\bullet\!\!\rightarrow 1}}{p_{1\bullet\!\!\rightarrow 5}\, p_{2\bullet\!\!\rightarrow 8}}\right\},\ \left\{\frac{p_{4\bullet\!\!\rightarrow 3}\left(f_{7\bullet\!\!\rightarrow 8}\, p_{3\bullet\!\!\rightarrow 8}\, p_{7\bullet\!\!\rightarrow 4} + f_{3\bullet\!\!\rightarrow 8}\, p_{3\bullet\!\!\rightarrow 4}\, p_{7\bullet\!\!\rightarrow 8}\right)}{p_{3\bullet\!\!\rightarrow 8}\left(p_{4\bullet\!\!\rightarrow 3} + p_{4\bullet\!\!\rightarrow 7}\right) p_{7\bullet\!\!\rightarrow 8}}\right\}\right\}$$

In[91]:=
```
xcp = MapThread[x_#1 → #2 &, {U_Nb[[U_c]], Flatten[xc]}];
xcp // TableForm
```

Out[92]//TableForm=

$$x_{5\bullet\!\!\rightarrow 1} \to \frac{f_{2\bullet\!\!\rightarrow 8}\, p_{1\bullet\!\!\rightarrow 2}\, p_{2\bullet\!\!\rightarrow 1}}{p_{1\bullet\!\!\rightarrow 5}\, p_{2\bullet\!\!\rightarrow 8}}$$
$$x_{4\bullet\!\!\rightarrow 7} \to \frac{p_{4\bullet\!\!\rightarrow 3}\left(f_{7\bullet\!\!\rightarrow 8}\, p_{3\bullet\!\!\rightarrow 8}\, p_{7\bullet\!\!\rightarrow 4}+f_{3\bullet\!\!\rightarrow 8}\, p_{3\bullet\!\!\rightarrow 4}\, p_{7\bullet\!\!\rightarrow 8}\right)}{p_{3\bullet\!\!\rightarrow 8}\left(p_{4\bullet\!\!\rightarrow 3}+p_{4\bullet\!\!\rightarrow 7}\right) p_{7\bullet\!\!\rightarrow 8}}$$

In[93]:=
```
s = solveAll[g, t];
s // TableForm
```

Out[94]//TableForm=

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

In[95]:=
```
"общее решение:"
xsol = ((s /. xcp) ~Join~ xcp);
xsol /. {ξ_u_↔v_ → ξu,v} // Simplify // TableForm
```

Out[95]= общее решение:

Out[97]//TableForm=

$$x_{1,2} \to \frac{f_{2,8}\, p_{2,1}}{p_{2,8}}$$

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

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

$$x_{6,7} \to \frac{f_{7,8}\, p_{7,6}}{p_{7,8}}$$

$$x_{8,2} \to f_{2,8} - f_{8,2}$$

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

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

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

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

In[98]:=
```
"eq test:"
Simplify[balanceEqs /. ξ → root[t] /. s /. xcp]
Simplify[(dopEq /. s) /. xcp]
```

Out[98]= eq test:

Out[99]= {True, True, True, True, True, True, True, True}

Out[100]= {True, True}