Листинг 1.

```
BeginPackage["FlowSolver`"]
```

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

```
buildTree::usage="build a tree based on graph g with a specified root"

getDepth[x_,depth_]:={{
 {depth[[x]], x>0},
 {-1, True}
}
```

```
edge::usage="ret edge from i to j with specified direction"
edge[i_,j_,dir_]:={{
 {i•→j, dir<0},
 {j•→i, dir>0},
 {i•-•j, dir==0}
}
```

```
buildTree[g_?GraphQ,root_]:=Module[{
    rt={},
    pred=ConstantArray[0,VertexCount[g]],
    dir=ConstantArray[0,VertexCount[g]],
    depth=ConstantArray[0,VertexCount[g]],
    d=ConstantArray[root,VertexCount[g]],
    curD=0,lastVis=root,edgeN=ConstantArray[0,VertexCount[g]]
    },
    DepthFirstScan[UndirectedGraph[g],root,{
    "PrevisitVertex"-> ((depth[[#]]=getDepth[pred[[#]],depth]+1;d[[lastVis]]=#;
    lastVis=#)&),"FrontierEdge"-> ((pred[[Last[#]]]=First[#];
    dir[[Last[#]]]={{
 {1, MemberQ[EdgeList[g],First[#]\[DirectedEdge]Last[#]]},
 {-1, True}
};
edgeN[[Last[#]]]=Position[EdgeList[g],
edge[First[#],Last[#],-dir[[Last[#]]]]][[1,1]];
)&)}];
    {pred,dir,depth,d,root,edgeN}
]
```

```
treeQ::usage="tests if the structure t is a tree"
treeQ[t_List]:=Length[t]==6&&Length[t[[1]]]==Length[t[[2]]]&&Length[t[[1]]]==Lengt
```

```
pred[t_?treeQ]:=t[[1]]
dir[t_?treeQ]:=t[[2]]
depth[t_?treeQ]:=t[[3]]
getDepth[v_,t_?treeQ]:=getDepth[v,depth[t]]
d[t_?treeQ]:=t[[4]]
root[t_?treeQ]:=t[[5]]
reverceD[t_?treeQ]:=Module[{
rd=ConstantArray[0,t//dir//Length]
},rd[[t//root]]=NestWhile[(rd[[d[t][[#]]]]=#;d[t][[#]])&,
t//root,(d[t][[#]]!=(t//root))&];rd]
tableForm[t_]:=TableForm[t[[1;;4]],
TableHeadings->{{"pred","dir","depth","d"},t//pred//Length//Range}]
uNb[g_?GraphQ,t_?treeQ]:=EdgeList[g,\[Tau]_\[DirectedEdge]\[Rho]_/;pred[t][[\[Tau]]]!=\[Rho]&&pred[t][[\[Rho]]]!=\[Tau]]
```

```
path[t_?treeQ,v_]:=NestList[pred[t][[#]]&,v,getDepth[v,t]]
alignDepth=Compile[{{vert1,_Integer},
{vert2,_Integer},{pred,_Integer,1},{depth,_Integer,1}},
NestWhile[pred[[#]]&,vert1,getDepth[#,depth]>getDepth[vert2,depth]&]
];
```

```
lcmHelper=Compile[{{vert1,_Integer},{vert2,_Integer},{pred,_Integer,1},{depth,_Inte
Module[{v1=vert1,v2=vert2},
v1=alignDepth[v1,v2,pred,depth];
v2=alignDepth[v2,v1,pred,depth];

NestWhile[{pred[[#[[1]]]],pred[[#[[2]]]]}&,List[v1,v2],#[[1]]!=#[[2]]&][[1]]
],{{alignDepth[_,_,_,_],_Integer}}
];
lcm[t_?treeQ,vert1_,vert2_]:=lcmHelper[vert1,vert2,pred[t],depth[t]]
pathLen[t_?treeQ,v1_,v2_]:=getDepth[v1,t]+getDepth[v2,t]-2*getDepth[lcm[v1,v2],t]
subTree[t_?treeQ,v_]:=NestWhileList[d[t][[#]]&,v,getDepth[d[[#]],t]>getDepth[v,t]&
getLeafs[t_?treeQ]:=Cases[Range[pred[t]//Length],x_/;getDepth[x,t]>=getDepth[d[t][[
```

```
partSolve::usage=
"ret list of rules with part solve for graph g
with outside flow b and base tree, left part symbols are x"
partSolve[g_?GraphQ,b_List,tree_?treeQ,x_]:=Module[{xed,t=tree,rd,last=0},
rd=reverceD[t];
xed=ConstantArray[0,g//VertexCount];
last=NestWhile[(xed[[#]]+=-dir[t][[#]]×b[[#]];
xed[[pred[t][[#]]]]+=dir[t][[pred[t][[#]]]]×dir[t][[#]]×xed[[#]];
rd[[#]])&,rd[[t//root]],(pred[t][[#]]!=(t//root))&];
(xed[[#]]+=-dir[t][[#]]×b[[#]])&[last];
Print[rd];
((Subscript[x, #]-> 0)&/@(uNb[g,t]))∪((Subscript[x, edge[#,pred[t][[#]],
dir[t][[#]]]]->xed[[#]])&/@((g//VertexList)~Complement~{t//root}))]
partSolve[g_?GraphQ,b_List,rootV_,x_]:=partSolve[g,b,buildTree[g,rootV],x]
```

```
Subscript[δ, τ_↔ρ_][g_?GraphQ,t_?treeQ]:=Module[
{λ=lcm[t,τ,ρ],δ=ConstantArray[0,g//VertexCount]},
NestWhile[(δ[[#]]=dir[t][[#]];pred[t][[#]])&,τ,#!= λ&];
NestWhile[(δ[[#]]=-dir[t][[#]];pred[t][[#]])&,ρ,#!= λ&];
((Subscript[x, edge[#,pred[t][[#]],dir[t][[#]]]]->δ[[#]])&
/@(g//VertexList))~Join~{Subscript[x, τ↔ρ]-> 1,Subscript[x, _]->0}
]
```

```
δ2h=Compile[{{l,_Integer,1},{pr,_Integer,1},{dep,_Integer,1},
{direct,_Integer,1},{nums,_Integer,1},{n,_Integer}},
Module[{λ,δ=SparseArray[{},n],τ=l[[1]],ρ=l[[2]],j=l[[3]]},
λ=lcmHelper[τ,ρ,pr,dep];
NestWhile[(δ[[nums[[#]]]]=direct[[#]];pr[[#]])&,τ,#!= λ&];
NestWhile[(δ[[nums[[#]]]]=-direct[[#]];pr[[#]])&,ρ,#!= λ&];
δ[[j]]=1;
δ],Parallelization->False,  RuntimeAttributes -> {Listable}
]
```

```
δ2[{τ_,ρ_,j_},t_,n_]:=Module[{λ,δ=SparseArray[{},n]},
λ=lcm[t,τ,ρ];
NestWhile[(δ[[t[[6,#]]]]=dir[t][[#]];pred[t][[#]])&,τ,#!= λ&];
NestWhile[(δ[[t[[6,#]]]]=-dir[t][[#]];pred[t][[#]])&,ρ,#!= λ&];
δ[[j]]=1;
δ]
```

```
alignJ=Compile[{{j,_Integer},{l,_Integer,2},{ed,_Integer,1}},
NestWhile[(#+1)&,j,(l[[#]]!=ed)&]];
δ1[g_?GraphQ,t_?treeQ]:=Module[
{λ,unb=uNb[g,t],unb1,tmp,δ,τ,ρ,ed,j=1},
δ=SparseArray[{},{unb//Length,g//EdgeCount}];
tmp={#[[1]],#[[2]]}&/@EdgeList[g];
unb1=Map[(ed=#;j=alignJ[j,tmp,{ed[[1]],ed[[2]]}];{#[[1]],#[[2]],j})&,unb];
δ2[#,t,g//EdgeCount]&/@unb1//SparseArray]
```

```
eqSystem[g_?GraphQ]:=Fold[ReplacePart[#1,{(#2//First)->#1[[#2//First]]-
Subscript[x, #2],(#2//Last)->#1[[#2//Last]]+Subscript[x, #2]}]&,
ConstantArray[0,g//VertexCount],g//EdgeList]
```

```
solveAll[g_?GraphQ,t_?treeQ]:=Module[{xs=Subscript[x, #]&/@(g//EdgeList)},
    Cases[(MapThread[#1->#2&,{xs,Parallelize[ParallelMap[Subscript[x, #]&,
    uNb[g,t]].δMatr]+(ParallelMap[Subscript[x̃, #]&,(g//EdgeList)]/.ps)}]),
    Except[x_->x_]]]
```

```
setPred[t_?treeQ,i_,val_]:=ReplacePart[t,{1,i}->val];
setDir[t_?treeQ,i_,val_]:=ReplacePart[t,{2,i}->val];
setDepth[t_?treeQ,i_,val_]:=ReplacePart[t,{3,i}->val];
setD[t_?treeQ,i_,val_]:=ReplacePart[t,{4,i}->val];
```

```
EndPackage[]
```

Листинг 2

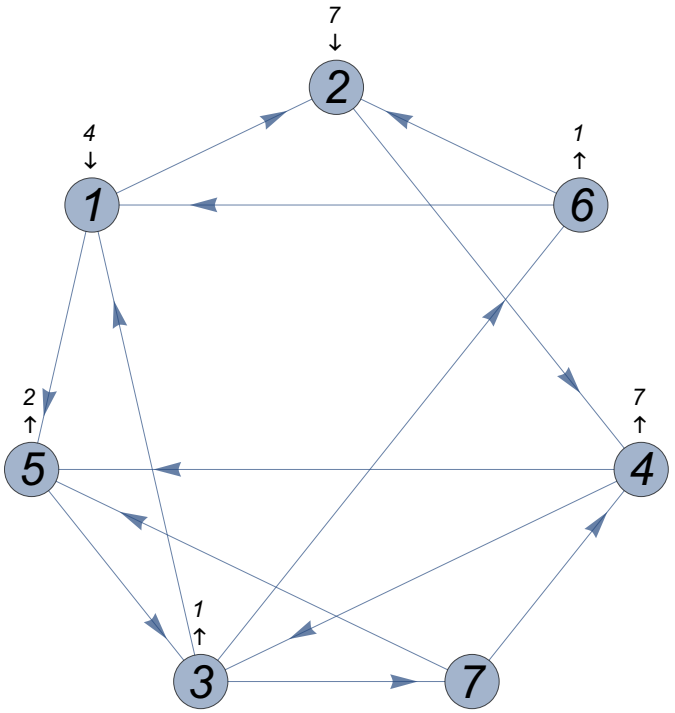
In[1]:=
```
ClearAll["Global`*"]
SetDirectory[NotebookDirectory[]];
Needs["FlowSolver`"]
```

In[4]:=
```
readGraph1[file_, dir_] := Module[{
    fn = FileNameJoin[{dir, file}],
    stream, imod, umod, u, b, q, λ, α
    },
    stream = OpenRead[fn];
    imod = Read[stream, {Word, Number}][[2]];
    umod = Read[stream, {Word, Number}][[2]];
    u = #[[1]] ↔ #[[2]] & /@ ReadList[stream, Expression, umod];
    b = ConstantArray[0, imod];
    (b[[Read[StringToStream[StringTake[#1, {5, -3}]], Number]]] = #2) &@@@
   ReadList[stream, {Word, Number}, imod];
  q = Read[stream, {Word, Number}][[2]];

  λ = Reap[Do[Do[Sow[Read[stream, {Word, Number}][[2]], j], {j, q}], {i, umod}]];
  α = ReadList[stream, {Word, Number}, q][[All, 2]];
{Graph[u, VertexSize -> Medium, VertexLabels -> {x_ :> Placed[{x, Style[{{
{{
 {-b[[x]]},
 {"↑"}
}, b[[x]] < 0},
{{
 {b[[x]]},
 {"↓"}
}, b[[x]] > 0},
{"", True}
} // TableForm , Medium]}, {Center, Above}]},
    VertexLabelStyle -> Directive[Black, Italic, 24], EdgeShapeFunction ->
     GraphElementData[{"Arrow"}], GraphLayout -> "CircularEmbedding"], b, λ, α}
]
```

In[7]:=
```
{g, b, λ, α} = readGraph1["gr.txt", NotebookDirectory[]];
λ = λ[[2]];
g
```

Out[9]=



In[10]:=
```
buildt = Timing[t = buildTree[g, 3];][[1]]
TableForm[t[[1 ;; 4]],
 TableHeadings → {{"pred", "dir", "depth", "d"}, t // pred // Length // Range}]
```

Out[10]= 0.

Out[11]//TableForm=

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

In[12]:=
```
pst = Timing[ps = partSolve[g, b, t, x̃]][[1]]
```

```
{5, 6, 7, 2, 3, 1, 4}
```

Out[12]= 0.

In[13]:=
```
"partSolve:"
{"x"_#, "=", x̃_#} & /@ (g // EdgeList) /. ps // TableForm
```

Out[13]= partSolve:

Out[14]//TableForm=

$x_{1\leftrightarrow 2}$	=	0
$x_{1\leftrightarrow 5}$	=	3
$x_{2\leftrightarrow 4}$	=	7
$x_{3\leftrightarrow 1}$	=	0
$x_{3\leftrightarrow 6}$	=	0
$x_{3\leftrightarrow 7}$	=	0
$x_{4\leftrightarrow 3}$	=	0
$x_{4\leftrightarrow 5}$	=	0
$x_{5\leftrightarrow 3}$	=	1
$x_{6\leftrightarrow 1}$	=	−1
$x_{6\leftrightarrow 2}$	=	0
$x_{7\leftrightarrow 5}$	=	0
$x_{7\leftrightarrow 4}$	=	0

In[15]:=
```
syst = Timing[eq = eqSystem[g];][[1]]
"equations test:"
notOdnorEq = MapThread[#1 == -#2 &, {eq, b}];
odnorEq = (# == 0) & /@ eq;
(notOdnorEq /. x → x̃) /. ps
```

Out[15]= 0.

Out[16]= equations test:

Out[19]= {True, True, True, True, True, True, True}

In[20]:=
```
matrt = Timing[δMatr = δ1[g, t];][[1]]
```

Out[20]= 0.

In[25]:=
```
solAt = Timing[s = solveAll[g, t]];
solAt[[1]]
s // TableForm
```

Out[26]= 0.03125

Out[27]//TableForm=

$$x_{1\leftrightarrow 5} \to 3 + x_{3\leftrightarrow 1} + x_{3\leftrightarrow 6} + x_{3\leftrightarrow 7} - x_{4\leftrightarrow 3} - x_{4\leftrightarrow 5} - x_{7\leftrightarrow 5}$$
$$x_{2\leftrightarrow 4} \to 7 - x_{3\leftrightarrow 7} + x_{4\leftrightarrow 3} + x_{4\leftrightarrow 5} + x_{7\leftrightarrow 5}$$
$$x_{5\leftrightarrow 3} \to 1 + x_{3\leftrightarrow 1} + x_{3\leftrightarrow 6} + x_{3\leftrightarrow 7} - x_{4\leftrightarrow 3}$$
$$x_{6\leftrightarrow 1} \to -1 + x_{1\leftrightarrow 2} + x_{3\leftrightarrow 6} + x_{3\leftrightarrow 7} - x_{4\leftrightarrow 3} - x_{4\leftrightarrow 5} - x_{7\leftrightarrow 5}$$
$$x_{6\leftrightarrow 2} \to -x_{1\leftrightarrow 2} - x_{3\leftrightarrow 7} + x_{4\leftrightarrow 3} + x_{4\leftrightarrow 5} + x_{7\leftrightarrow 5}$$
$$x_{7\leftrightarrow 4} \to x_{3\leftrightarrow 7} - x_{7\leftrightarrow 5}$$

In[29]:=
```
dopEq = MapThread[#1 == #2 &, {Flatten[λ.{x_# & /@ EdgeList[g]}^T], α}];
dopEq // TableForm
```

$$9\,x_{1\leftrightarrow 2} - 6\,x_{1\leftrightarrow 5} - 5\,x_{2\leftrightarrow 4} + 10\,x_{3\leftrightarrow 1} + 3\,x_{3\leftrightarrow 6} + 3\,x_{3\leftrightarrow 7} + 5\,x_{4\leftrightarrow 5} - 4\,x_{5\leftrightarrow 3} + 3\,x_{6\leftrightarrow 1} - 10\,x_{6\leftrightarrow 2} + 8\,x_{7\leftrightarrow 4} - 7\,x_{7\leftrightarrow 5} == 7$$
$$8\,x_{1\leftrightarrow 2} - 7\,x_{1\leftrightarrow 5} - 4\,x_{2\leftrightarrow 4} + 10\,x_{3\leftrightarrow 1} + 3\,x_{3\leftrightarrow 6} + 6\,x_{3\leftrightarrow 7} + 10\,x_{4\leftrightarrow 3} + 8\,x_{4\leftrightarrow 5} + x_{5\leftrightarrow 3} + 5\,x_{6\leftrightarrow 1} + 2\,x_{6\leftrightarrow 2} + 10\,x_{7\leftrightarrow 4} + x_{7\leftrightarrow 5} == -1$$
$$-9\,x_{1\leftrightarrow 2} - 4\,x_{1\leftrightarrow 5} + 3\,x_{2\leftrightarrow 4} - 6\,x_{3\leftrightarrow 7} - x_{4\leftrightarrow 3} + 4\,x_{4\leftrightarrow 5} + 2\,x_{5\leftrightarrow 3} + 7\,x_{6\leftrightarrow 1} + x_{6\leftrightarrow 2} - 4\,x_{7\leftrightarrow 4} - 7\,x_{7\leftrightarrow 5} == -4$$

In[40]:=
```
Λ = λ.δMatr^T;
"cicle det's:"
Grid[Λ, Frame → All]
```

Out[41]= cicle det's:

Out[42]=

22	0	−4	19	−8	−7	−27
11	4	2	17	9	8	−9
−3	−2	5	−9	−2	5	−2

In[43]:=
```
"U_c="
U_c = {1, 2, 3}
"U_nc="
U_nc = {4, 5, 6, 7}
```

Out[43]= $U_c =$

Out[44]= $\{1, 2, 3\}$

Out[45]= $U_{nc} =$

Out[46]= $\{4, 5, 6, 7\}$

In[47]:=
```
Λc = Λ[[All, U_c]];
Λnc = Λ[[All, U_nc]];
"Λ_c="
Λc // MatrixForm
```

Out[49]= $\Lambda_c =$

Out[50]//MatrixForm=

$$\begin{pmatrix} 22 & 0 & -4 \\ 11 & 4 & 2 \\ -3 & -2 & 5 \end{pmatrix}$$

In[51]:=
```
"det(Λ_c)="
Det[Λc]
```

Out[51]= $\det(\Lambda_c) =$

Out[52]= 568

In[53]:=
```
"U_T="
utind = Cases[t[[6]], ξ_ /; ξ ≠ 0];
U_T = EdgeList[g][[utind]]
```

Out[53]= $U_T =$

Out[55]= $\{1 \bullet\!\!\rightarrow 5, 6 \bullet\!\!\rightarrow 2, 2 \bullet\!\!\rightarrow 4, 5 \bullet\!\!\rightarrow 3, 6 \bullet\!\!\rightarrow 1, 7 \bullet\!\!\rightarrow 4\}$

In[56]:=
```
"U_Nb="
U_Nb = uNb[g, t]
```

Out[56]= $U_{Nb} =$

Out[57]= $\{1 \bullet\!\!\rightarrow 2, 3 \bullet\!\!\rightarrow 1, 3 \bullet\!\!\rightarrow 6, 3 \bullet\!\!\rightarrow 7, 4 \bullet\!\!\rightarrow 3, 4 \bullet\!\!\rightarrow 5, 7 \bullet\!\!\rightarrow 5\}$

In[58]:=
```
A = α - λ.{x̃# & /@ EdgeList[g]}^T /. ps;
"A="
A // MatrixForm
```

Out[59]= A=

Out[60]//MatrixForm=

$$\begin{pmatrix} 67 \\ 52 \\ -8 \end{pmatrix}$$

In[64]:=
```
β = A - Λnc.{x# & /@ U_Nb[[U_nc]]}^T;
"β="
β // TableForm
```

Out[65]= $\beta=$

Out[66]//TableForm=

$$67 - 19\,x_{3.\to 7} + 8\,x_{4.\to 3} + 7\,x_{4.\to 5} + 27\,x_{7.\to 5}$$
$$52 - 17\,x_{3.\to 7} - 9\,x_{4.\to 3} - 8\,x_{4.\to 5} + 9\,x_{7.\to 5}$$
$$-8 + 9\,x_{3.\to 7} + 2\,x_{4.\to 3} - 5\,x_{4.\to 5} + 2\,x_{7.\to 5}$$

In[67]:=
```
"решаем уравнение Λc xc=β:"
xc = LinearSolve[Λc, β]
```

Out[67]= решаем уравнение $\Lambda_c x_c=\beta$:

Out[68]=
$$\left\{\left\{\frac{1}{71}\left(237 - 56\,x_{3.\to 7} + 19\,x_{4.\to 3} + 3\,x_{4.\to 5} + 94\,x_{7.\to 5}\right)\right\},\right.$$
$$\left\{\frac{1}{568}\left(1713 - 1299\,x_{3.\to 7} - 1546\,x_{4.\to 3} - 771\,x_{4.\to 5} - 941\,x_{7.\to 5}\right)\right\},$$
$$\left.\left\{\frac{1}{284}\left(457 + 117\,x_{3.\to 7} - 150\,x_{4.\to 3} - 431\,x_{4.\to 5} + 151\,x_{7.\to 5}\right)\right\}\right\}$$

In[69]:=
```
xcp = MapThread[x#1 → #2 &, {U_Nb[[U_c]], Flatten[xc]}]
```

Out[69]=
$$\left\{x_{1.\to 2} \to \frac{1}{71}\left(237 - 56\,x_{3.\to 7} + 19\,x_{4.\to 3} + 3\,x_{4.\to 5} + 94\,x_{7.\to 5}\right),\right.$$
$$x_{3.\to 1} \to \frac{1}{568}\left(1713 - 1299\,x_{3.\to 7} - 1546\,x_{4.\to 3} - 771\,x_{4.\to 5} - 941\,x_{7.\to 5}\right),$$
$$\left.x_{3.\to 6} \to \frac{1}{284}\left(457 + 117\,x_{3.\to 7} - 150\,x_{4.\to 3} - 431\,x_{4.\to 5} + 151\,x_{7.\to 5}\right)\right\}$$

In[70]:=
```
"общее решение:"
xsol = ((s /. xcp) ~Join~ xcp);
xsol // TableForm
```

Out[70]= общее решение:

$$x_{1\leftrightarrow 5} \to 3 + x_{3\leftrightarrow 7} - x_{4\leftrightarrow 3} - x_{4\leftrightarrow 5} + \frac{1}{568}\left(1713 - 1299\, x_{3\leftrightarrow 7} - 1546\, x_{4\leftrightarrow 3} - 771\, x_{4\leftrightarrow 5} - 941\, x_{7\leftrightarrow 5}\right) - x_{7\leftrightarrow 5} + \frac{1}{284}\left(457 + 117\, x_{3\leftrightarrow 7} - 150\, x_{4\leftrightarrow 3} - 431\, x_{4\leftrightarrow 5} + 151\, x_{7\leftrightarrow 5}\right)$$

$$x_{2\leftrightarrow 4} \to 7 - x_{3\leftrightarrow 7} + x_{4\leftrightarrow 3} + x_{4\leftrightarrow 5} + x_{7\leftrightarrow 5}$$

$$x_{5\leftrightarrow 3} \to 1 + x_{3\leftrightarrow 7} - x_{4\leftrightarrow 3} + \frac{1}{568}\left(1713 - 1299\, x_{3\leftrightarrow 7} - 1546\, x_{4\leftrightarrow 3} - 771\, x_{4\leftrightarrow 5} - 941\, x_{7\leftrightarrow 5}\right) + \frac{1}{284}\left(457 + 117\, x_{3\leftrightarrow 7} - 150\, x_{4\leftrightarrow 3} - 431\, x_{4\leftrightarrow 5} + 151\, x_{7\leftrightarrow 5}\right)$$

$$x_{6\leftrightarrow 1} \to -1 + x_{3\leftrightarrow 7} - x_{4\leftrightarrow 3} - x_{4\leftrightarrow 5} - x_{7\leftrightarrow 5} + \frac{1}{71}\left(237 - 56\, x_{3\leftrightarrow 7} + 19\, x_{4\leftrightarrow 3} + 3\, x_{4\leftrightarrow 5} + 94\, x_{7\leftrightarrow 5}\right) + \frac{1}{284}\left(457 + 117\, x_{3\leftrightarrow 7} - 150\, x_{4\leftrightarrow 3} - 431\, x_{4\leftrightarrow 5} + 151\, x_{7\leftrightarrow 5}\right)$$

$$x_{6\leftrightarrow 2} \to -x_{3\leftrightarrow 7} + x_{4\leftrightarrow 3} + x_{4\leftrightarrow 5} + \frac{1}{71}\left(-237 + 56\, x_{3\leftrightarrow 7} - 19\, x_{4\leftrightarrow 3} - 3\, x_{4\leftrightarrow 5} - 94\, x_{7\leftrightarrow 5}\right) + x_{7\leftrightarrow 5}$$

$$x_{7\leftrightarrow 4} \to x_{3\leftrightarrow 7} - x_{7\leftrightarrow 5}$$

$$x_{1\leftrightarrow 2} \to \frac{1}{71}\left(237 - 56\, x_{3\leftrightarrow 7} + 19\, x_{4\leftrightarrow 3} + 3\, x_{4\leftrightarrow 5} + 94\, x_{7\leftrightarrow 5}\right)$$

$$x_{3\leftrightarrow 1} \to \frac{1}{568}\left(1713 - 1299\, x_{3\leftrightarrow 7} - 1546\, x_{4\leftrightarrow 3} - 771\, x_{4\leftrightarrow 5} - 941\, x_{7\leftrightarrow 5}\right)$$

$$x_{3\leftrightarrow 6} \to \frac{1}{284}\left(457 + 117\, x_{3\leftrightarrow 7} - 150\, x_{4\leftrightarrow 3} - 431\, x_{4\leftrightarrow 5} + 151\, x_{7\leftrightarrow 5}\right)$$

In[73]:=
```
"eq test:"
Simplify[dopEq /. s /. xcp]
```

Out[73]= eq test:

Out[74]= {True, True, True}

Листинг 3

```
/*|I|*/ 7
/*|U|*/ 13
{1,2}
{1,5}
{2,4}
{3,1}
{3,6}
{3,7}
{4,3}
{4,5}
{5,3}
{6,1}
{6,2}
{7,5}
{7,4}
/*b_1*/ 4
/*b_2*/ 7
/*b_3*/ -1
/*b_4*/ -7
/*b_5*/ -2
/*b_6*/ -1
/*b_7*/ 0
/*q*/ 3
/*lambda_1_2_1*/ 9
/*lambda_1_2_2*/ 8
/*lambda_1_2_3*/ -9
/*lambda_1_5_1*/ -6
/*lambda_1_5_2*/ -7
/*lambda_1_5_3*/ -4
/*lambda_2_4_1*/ -5
/*lambda_2_4_2*/ -4
/*lambda_2_4_3*/ 3
/*lambda_3_1_1*/ 10
/*lambda_3_1_2*/ 10
/*lambda_3_1_3*/ 0
/*lambda_3_6_1*/ 3
/*lambda_3_6_2*/ 3
/*lambda_3_6_3*/ 0
/*lambda_3_7_1*/ 3
/*lambda_3_7_2*/ 6
/*lambda_3_7_3*/ -6
/*lambda_4_3_1*/ 0
/*lambda_4_3_2*/ 10
/*lambda_4_3_3*/ -1
/*lambda_4_5_1*/ 5
/*lambda_4_5_2*/ 8
/*lambda_4_5_3*/ 4
/*lambda_5_3_1*/ -4
```

/*lambda_5_3_2*/ 1
/*lambda_5_3_3*/ 2
/*lambda_6_1_1*/ 3
/*lambda_6_1_2*/ 5
/*lambda_6_1_3*/ 7
/*lambda_6_2_1*/ -10
/*lambda_6_2_2*/ 2
/*lambda_6_2_3*/ 1
/*lambda_7_5_1*/ -7
/*lambda_7_5_2*/ 1
/*lambda_7_5_3*/ -7
/*lambda_7_4_1*/ 8
/*lambda_7_4_2*/ 10
/*lambda_7_4_3*/ -4
/*alpha_1*/ 7
/*alpha_2*/ -1
/*alpha_3*/ -4