

PROCEDURĂ DE SORTARE A TERMENILOR DIN NUMĂRĂTORUL ȘI NUMITORUL FUNCȚIEI DE CIRCUIT ÎN FORMĂ REDUSĂ

Mihail Dumitrache

Universitatea "Politehnica" București

Rezumat: În proiectarea circuitelor electrice și electronice, adesea, este mai convenabil ca laturile circuitului să fie descrise prin șiruri de simboluri, iar rezultatul analizei să fie obținut sub forma unei expresii algebrice depinzând de timp sau frecvență și de parametri simbolici ai circuitului. Această informație stă la baza optimizării asistate de calculator a acestor circuite, în raport cu performanțele urmărite, oferind posibilitatea obținerii unei imagini de ansamblu asupra comportării circuitului, a controlului erorilor, a evaluării sensibilităților, în scopul îmbunătățirii unor topologii de circuite.

Pentru circuite complexe, funcțiile de circuit sunt de dimensiuni mari (număr mare de termeni) și sunt greu de urmărit și de interpretat. O sortare a termenilor din numărătorul și numitorul funcției de circuit permite o vizualizare adecvată și ușurează modul de simplificare al acestor funcții prin eliminarea unor termeni mai puțin semnificativi, cu pondere mică.

Cuvinte cheie: funcție de circuit, circuite electrice și electronice, circuit liniar, circuit în formă redusă, procedură de sortare, analiza simbolică a circuitelor, optimizare circuit.

1. Introducere

În proiectarea asistată de calculator a circuitelor electronice, primul pas îl reprezintă calculul funcției de circuit, următorii pași fiind reprezentați de determinarea sensibilităților funcției raportată la diferiți parametri ai circuitului precum și determinarea valorilor polilor și zerourilor.

O metodă unitară de studiu a răspunsurilor naturale, forțate, tranzitorii, de regim permanent, a răspunsului complet, precum și a răspunsului în frecvență al circuitului, îl reprezintă utilizarea funcțiilor de circuit.

1.1. Definirea funcțiilor de circuit

Fiind dat un circuit liniar invariabil în timp, alcătuit din rezistoare, bobine cuplate magnetic sau nu, condensatoare și orice tip de surse independente sau comandate, semnalul aplicat $x(t)$ și răspunsul circuitului $y(t)$, sunt, în general, legate printr-o ecuație diferențială liniară de forma:

$$b_n \frac{d^n y}{dt^n} + \dots + b_1 \frac{dy}{dt} + b_0 y = a_m \frac{d^m x}{dt^m} + \dots + a_1 \frac{dx}{dt} + a_0 x,$$

unde a_0, \dots, a_m și b_0, \dots, b_n sunt coeficienți (numerici – reali, sau simbolici) ale căror expresii depind de parametrii circuitului.

În domeniul Laplace, ecuația de mai sus ia forma:

$$D(s)Y = N(s)X,$$

unde $D(s)$ și $N(s)$ sunt polinoame în s de gradul n , respectiv m , $n > m$; X și Y sunt imaginile, în condiții inițiale de zero, ale mărimii de intrare (excitație) și, respectiv, ale răspunsului circuitului.

Mărimia

$$H(s) = \frac{Y}{X} = \frac{N(s)}{D(s)} = \frac{a_m s^m + \dots + a_1 s + a_0}{b_n s^n + \dots + b_1 s + b_0}$$

se numește funcție de circuit (de rețea sau de transfer).

În funcție de natura lui x și y , ca și de poarta la care se aplică x și se determină y , se obțin diferite funcții de circuit ce pot fi clasificate în două categorii: funcții de intrare (impedanțe și admitanțe denumite generic imitanțe) și funcții de transfer (impedanțe, admitanțe, amplificări în tensiune și, respectiv, în curent).

În general, se numește funcție de transfer de la latura j la latura k , pentru un circuit liniar pasiv cu condiții inițiale de zero, raportul dintre mărimea de ieșire din latura k , m_k^e (sau transformata Laplace a acesteia) și mărimea de intrare (de excitație) din latura j , m_j^i (sau transformata Laplace a acestei mărimi):

$$H(s) = F_{kj} = \frac{m_k^e}{m_j^i} \left(= \frac{\mathcal{L}\{m_k^e\}}{\mathcal{L}\{m_j^i\}} \right),$$

unde m_k^e poate fi o tensiune sau un curent, iar m_j^i poate fi o sursă de t.e.m. sau o sursă de curent.

2. Procedura de sortare a termenilor din numărătorul și numitorul funcției de circuit

Procedura de sortare a termenilor din numărătorul și numitorul funcției de circuit în formă redusă în ordine descrescătoare a puterilor și modulelor coeficienților lui s a fost realizată în limbajul de programare *Borland Pascal 7.0*.

Procedura are ca date de intrare funcția de circuit în formă redusă, ea fiind un fișier de tip *ex.txt*, și este rezultatul programului ASINOM (*Analiza Simbolică bazată pe metoda NODală MODificată*). În acest fișier, se pot introduce diferite valori pentru elementele de circuit. În cazul în care pentru un element de circuit nu i se atribuie nici o valoare, atunci valoarea implicită care va fi luată în calcul este valoarea 1.

Metoda folosită pentru procedura de sortare este numită metoda *bulelor*, metodă care va fi descrisă în continuare.

Procedura de sortare conține următorii pași:

- **Pasul 1:**

- se citește din fișierul *ex.txt* de pe liniile de la început atribuirile valorilor pentru variabilele cunoscute (dacă acestea nu există, fiecărei variabile i se va atribui valoarea 1);
- se transformă fiecare linie a fișierului inițial astfel încât să avem pe fiecare linie câte o expresie, adică, dacă se întâlnesc semnele „+”, „-”, „/”, se va trece pe linie nouă.

- **Pasul 2:**

- se fac transformări asupra fișierului obținut la *pasul 1* astfel încât se va trece pe o nouă linie dacă se întâlnesc caracterele „)”, „*”, „s”, „(”.

- **Pasul 3:**

- se determină factorul comun și se distribuie la termenii care îi aparțin ținând seama și de semn.

- **Pasul 4:**

- se evaluează expresiile, se sortează și se scriu în fișierul de ieșire expresiile și valorile lor.

Parcursul primilor 3 pași este necesar pentru a aduce fișierul inițial într-o formă convenabilă.

Algoritmul de sortare este:

Pentru $i=1, n-1$ execută

Pentru $j=i+1, n$ execută

Dacă $\exp(\text{aux}[i]) < \exp(\text{aux}[j])$, atunci

Interschimb cele două valori:

(n este numărul de termeni, $\text{aux}[i]$ sunt termenii fiecărui factor de forma $(\exp 1 + \exp 2 + \dots + \exp n) s^x$).

Acest algoritm este folosit de 4 ori deoarece sortarea s -a împărțit în 4 părți astfel:

1. sortarea numărătorului până la factorul liber;
2. sortarea factorului liber;
3. sortarea numitorului până la factorul liber;
4. sortarea factorului liber de la numitor.

În programul principal, se apelează cele 4 proceduri în ordinea dată.

Fișierul de ieșire *ex. 4* va fi rezultatul căutat.

Algoritmul pas1

Nrv=0
Repetă
Citește s din fișier
nrv=nrv+1
Nume[nrv]=nume variabilă
Valoare[nrv]=valoarea variabilă
Până când s începe cu r
Repetă
Citește s din fișier
Prelucrez s și se scrie în noul fișier
 {adică se împart expresiile pe linii diferite la întâlnirea semnelor +, -, /}
Până când se sfârșește fișierul

Algoritmul pas2

Repetă
Citește s din fișier
Prelucrez s și îl scriu în noul fișier
 {adică verific dacă s conține „) * s” , dacă conține „(” , dacă se termina cu „)”}
Până când se sfârșește fișierul

Algoritmul pas3

Citește s {factorul comun}
Dacă începe cu – semn=1
Altfel semn=0
Fc=s {Fc este factorul comun}
Fcs=x {la ce putere este s în factorul comun , dacă nu există este 0}

Repetă

Citește s din fișier
Până la „/” prelucrez expresiile {adică numai la numărător distribuim factorul comun}
Până când se sfârșește fișierul

Algoritmul pas4

Repetă
Sortez la numărător până la termenul liber
Scriu în fișier și expresiile și valorile
Sortez la numărător termenul liber
Scriu în fișier și expresiile și valorile
Sortez la numitor până la termenul liber
Scriu în fișier și expresiile și valorile
Sortez la numitor termenul liber
Scriu în fișier și expresiile și valorile
Până când se sfârșește fișierul

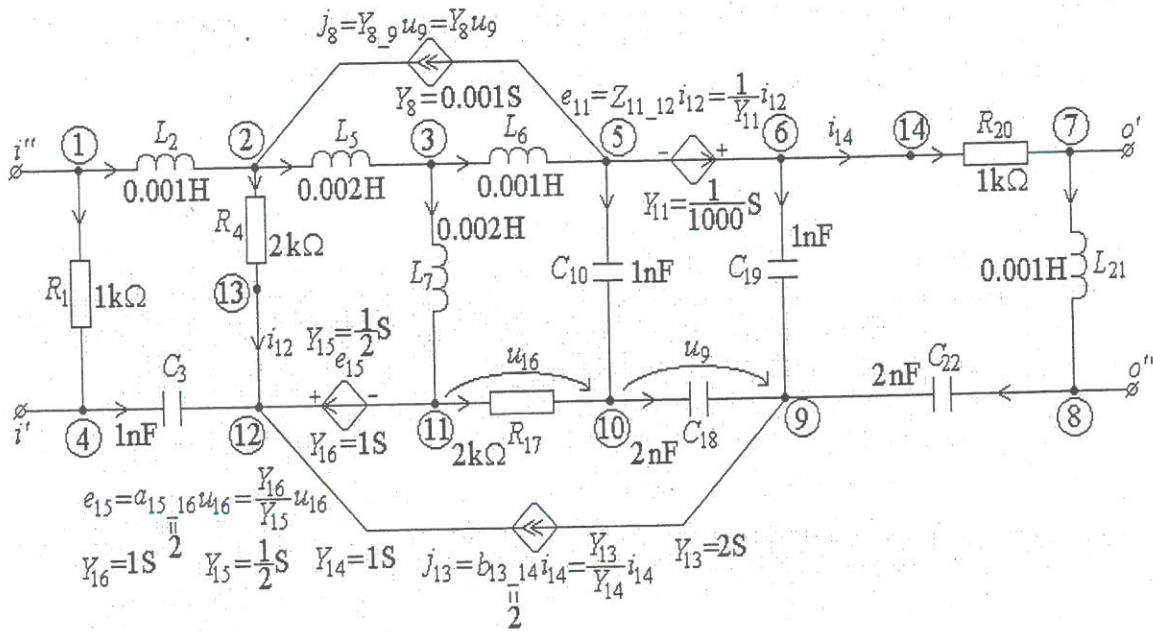


Figura 1. Diagrama circuitului

Exemplu de calcul

Funcția de circuit în formă redusă pentru circuitul din Figura 1 în format *ex.txt* împreună cu valorile numerice ale elementelor de circuit arată astfel:

```

R1=1000
L2=0.001
C3=1E-9
R4=2000
L5=0.002
L6=0.003
L7=0.004
Y8=0.005
C10=3E-9
Y11=0.00033
Y16=1
Y15=0.5
Y14=1
Y13=5
R17=4000
C18=2E-9
C19=1E-9
R20=1000
L21=0.004
C22=2E-9
rez1 := {Aei = C3*s^4*Y14*C18*C22*L21*((L5*L6*C10*Y15+L5*C10*L7*Y15+L6*C10*L7*
Y15)*s^2+(L7*C10*R17*Y15+C10*L7*R17*Y16+L5*C10*Y15*R17)*s+L5*Y15+Y11*R4*L7*Y15
+L7*Y15)/((C3*L2*C19*Y14*Y11*Y15*L6*L21*C22*C18*L7+C3*L2*Y14*Y11*Y15*L5*C18*
C22*L21*C10*L6+C3*L2*Y14*Y11*Y15*L5*L21*C22*C18*L7*C10+C3*L2*Y14*Y11*Y15*L21*
C22*C18*L7*C10*L6+C3*L2*C19*Y14*Y11*Y15*L5*L21*C22*C18*L7+C3*L2*C19*Y14*Y11*

```

$$\begin{aligned}
& Y15 * L5 * L6 * C18 * C22 * L21 + C3 * L2 * C19 * Y14 * Y11 * Y15 * L5 * L21 * C22 * L7 * C10 + C3 * L2 * C19 * Y14 * \\
& Y11 * Y15 * L5 * L21 * C22 * C10 * L6 + C3 * L2 * C19 * Y14 * Y11 * Y15 * L6 * L21 * C22 * L7 * C10 + C3 * L2 * C19 * \\
& Y15 * Y14 * L5 * Y8 * L21 * C22 * C10 * L6 + C3 * L2 * C19 * Y15 * Y14 * L5 * Y8 * L21 * C22 * L7 * C10 + C3 * L2 * C19 * \\
& Y15 * Y14 * L6 * L21 * C22 * L7 * C10 * Y8) * s^7 + (C3 * R4 * L2 * C19 * Y14 * Y11 * Y15 * L21 * C22 * C10 * L6 + C3 * \\
& R4 * L2 * C19 * Y14 * Y11 * Y15 * L6 * C18 * C22 * L21 + C3 * R4 * L2 * C19 * Y14 * Y11 * Y15 * L21 * C22 * L7 * C10 + \\
& C3 * R4 * L2 * C19 * Y14 * Y11 * Y15 * L21 * C22 * C18 * L7 + C3 * L2 * Y11 * C19 * Y14 * Y16 * R17 * L21 * C22 * C10 * \\
& L7 + C3 * L2 * Y11 * C19 * Y14 * Y16 * R17 * L7 * L21 * C18 * C22 + C3 * L2 * Y11 * Y14 * L21 * C22 * C18 * C10 * L7 * \\
& R17 * Y16 + C3 * R4 * C19 * Y14 * Y11 * Y15 * L6 * L21 * C22 * C18 * L7 + C3 * R4 * C19 * Y14 * Y11 * Y15 * L5 * L21 * \\
& C22 * L7 * C10 + C3 * R4 * C19 * Y14 * Y11 * Y15 * L5 * L21 * C22 * C18 * L7 + C3 * L2 * Y14 * Y11 * Y15 * C10 * C18 * \\
& C22 * R20 * L7 * L6 + C3 * L2 * Y14 * Y11 * Y15 * C18 * L7 * R17 * C22 * L21 * C10 + C3 * R4 * Y14 * Y11 * Y15 * L5 * \\
& L21 * C22 * C18 * L7 * C10 + C3 * R4 * C19 * Y14 * Y11 * Y15 * L6 * L21 * C22 * L7 * C10 - 1. * C3 * L2 * C19 * Y14 * \\
& Y11 * Y15 * L5 * Y8 * L7 * C22 * L21 + C3 * L2 * C19 * Y14 * Y11 * Y15 * L5 * L6 * R20 * C22 * C10 - 1. * C3 * L2 * Y14 * \\
& C19 * Y16 * R17 * Y8 * L6 * L21 * C22 * C10 + C3 * L2 * Y14 * Y11 * Y15 * L5 * C10 * C18 * R17 * C22 * L21 + C3 * L2 * \\
& Y14 * Y11 * Y15 * L5 * C18 * R20 * C22 * C10 * L6 + C3 * L2 * Y14 * Y11 * Y15 * L5 * C10 * C18 * C22 * R20 * L7 - 1. * \\
& C3 * L2 * C19 * Y14 * Y11 * Y15 * L5 * Y8 * L21 * C22 * L6 + C3 * L2 * C19 * Y14 * Y11 * Y15 * C18 * L7 * R17 * C22 * \\
& L21 + C3 * L2 * C19 * Y14 * Y11 * Y15 * L6 * C10 * R20 * L7 * C22 - 1. * C3 * L2 * C19 * Y14 * Y11 * Y15 * L7 * C22 * \\
& L21 * L6 * Y8 + C3 * L2 * C19 * Y14 * Y11 * Y15 * L6 * C18 * C22 * R20 * L7 + C3 * L2 * C19 * Y14 * Y11 * Y15 * L7 * R17 \\
& * C22 * L21 * C10 + C3 * L2 * C19 * Y14 * Y11 * Y15 * L5 * C10 * R17 * C22 * L21 + C3 * L2 * C19 * Y14 * Y11 * Y15 * L5 \\
& * C10 * R20 * L7 * C22 + C3 * L2 * C19 * Y14 * Y11 * Y15 * L5 * L6 * C18 * R20 * C22 + C3 * L2 * C19 * Y14 * Y11 * Y15 * \\
& L5 * C18 * R17 * C22 * L21 + C3 * L2 * C19 * Y14 * Y11 * Y15 * L5 * C18 * C22 * R20 * L7 + C3 * L2 * C19 * Y15 * Y14 * \\
& L5 * Y8 * C10 * R17 * C22 * L21 + C3 * L2 * C19 * Y15 * Y14 * L21 * C22 * C18 * L7 + C3 * L2 * C19 * Y15 * Y14 * L5 * Y8 \\
& * L6 * R20 * C22 * C10 + C3 * L2 * C19 * Y15 * Y14 * L5 * Y8 * C10 * R20 * L7 * C22 + C3 * L2 * C19 * Y15 * Y14 * L6 * \\
& C10 * R20 * L7 * C22 * Y8 + C3 * R4 * Y14 * Y11 * Y15 * L5 * C18 * C22 * L21 * C10 * L6 + C3 * R4 * Y14 * Y11 * Y15 * \\
& L21 * C22 * C18 * L7 * C10 * L6 + C3 * R4 * C19 * Y14 * Y11 * Y15 * L5 * L6 * C18 * C22 * L21 + C3 * R4 * C19 * Y14 * \\
& Y11 * Y15 * L5 * L21 * C22 * C10 * L6 + C3 * R4 * L2 * Y14 * Y11 * Y15 * L21 * C22 * C18 * L7 * C10 + C3 * R4 * L2 * Y14 \\
& * Y11 * Y15 * C18 * C22 * L21 * C10 * L6) * s^6 + (Y11 * Y15 * C19 * Y14 * L6 * L21 * C22 * C18 * L7 + C19 * Y15 * \\
& Y14 * L5 * Y8 * L21 * C22 * C10 * L6 + Y11 * Y15 * C19 * Y14 * L5 * L21 * C22 * L7 * C10 + Y11 * Y15 * C19 * Y14 * L5 * \\
& L21 * C22 * C10 * L6 + Y11 * Y15 * C19 * Y14 * L5 * L6 * C18 * C22 * L21 + Y11 * Y15 * C19 * Y14 * L5 * L21 * C22 * \\
& C18 * L7 + Y11 * Y15 * C19 * Y14 * L6 * L21 * C22 * L7 * C10 + Y14 * Y11 * Y15 * L5 * L21 * C22 * C18 * L7 * C10 + Y14 \\
& * Y11 * Y15 * L21 * C22 * C18 * L7 * C10 * L6 + C3 * L2 * C19 * Y15 * Y14 * L6 * C10 * L7 * Y8 + C3 * L2 * C19 * Y15 * \\
& Y14 * C18 * C22 * R20 * L7 + Y14 * Y11 * Y15 * L5 * C18 * C22 * L21 * C10 * L6 + C19 * Y15 * Y14 * L5 * Y8 * L21 * C22 \\
& * L7 * C10 + C19 * Y15 * Y14 * L6 * L21 * C22 * L7 * C10 * Y8 + C3 * L2 * Y14 * Y11 * Y15 * L5 * C18 * L7 * C22 + C3 * L2 \\
& * Y14 * Y11 * Y15 * L5 * C18 * C22 * L21 + C3 * L2 * Y14 * Y11 * Y15 * L6 * C10 * C18 * L7 + C3 * L2 * Y14 * Y11 * Y15 * \\
& L21 * C22 * C18 * L7 + C3 * L2 * Y11 * C19 * Y14 * Y16 * R17 * L7 * C22 * R20 * C18 + C3 * R4 * Y11 * C19 * Y14 * Y16 * \\
& R17 * L21 * C22 * C10 * L7 + C3 * R4 * Y11 * C19 * Y14 * Y16 * R17 * L7 * L21 * C18 * C22 + C3 * L2 * Y11 * C19 * Y14 * \\
& R20 * L7 * R17 * Y16 * C22 * C10 + C3 * L2 * Y11 * Y14 * Y16 * R17 * L7 * C22 * R20 * C18 * C10 + C3 * R4 * Y11 * Y14 * \\
& L21 * C22 * C18 * C10 * L7 * R17 * Y16 + C3 * R4 * Y14 * Y11 * Y15 * L5 * C10 * C18 * R17 * C22 * L21 + C3 * R4 * Y14 * \\
& Y11 * Y15 * L5 * C18 * R20 * C22 * C10 * L6 + C3 * L2 * Y14 * Y11 * Y15 * L6 * C18 * L7 * C22 + C3 * L2 * Y14 * Y11 * \\
& Y15 * R20 * C18 * L7 * R17 * C22 * C10 + C3 * R4 * L2 * C19 * Y14 * Y11 * Y15 * C10 * R20 * L7 * C22 + C3 * R4 * L2 * \\
& C19 * Y14 * Y11 * Y15 * C18 * R17 * C22 * L21 + C3 * R4 * L2 * C19 * Y14 * Y11 * Y15 * L6 * R20 * C22 * C10 + C3 * R4 *
\end{aligned}$$

$L2 * C19 * Y14 * Y11 * Y15 * L6 * C18 * R20 * C22 - 1. * C3 * R4 * L2 * C19 * Y14 * Y11 * Y15 * Y8 * L21 * C22 * L6 + C3$
 $* R4 * L2 * C19 * Y14 * Y11 * Y15 * C10 * R17 * C22 * L21 + C3 * R4 * L2 * C19 * Y14 * Y11 * Y15 * C18 * C22 * R20 * L7$
 $+ C3 * L2 * Y14 * Y11 * Y15 * L5 * C10 * C18 * L7 - 1. * C3 * R4 * C19 * Y14 * Y11 * Y15 * L5 * Y8 * L21 * C22 * L6 - 1. *$
 $C3 * R4 * C19 * Y14 * Y11 * Y15 * L5 * Y8 * L7 * C22 * L21 + C3 * R4 * C19 * Y14 * Y11 * Y15 * L5 * L6 * C18 * R20 * C22$
 $+ C3 * R4 * C19 * Y14 * Y11 * Y15 * L5 * L6 * R20 * C22 * C10 - 1. * C3 * R4 * C19 * Y14 * Y11 * Y15 * L7 * C22 * L21 *$
 $L6 * Y8 + C3 * R4 * C19 * Y14 * Y11 * Y15 * L5 * C18 * C22 * R20 * L7 + C3 * R4 * C19 * Y14 * Y11 * Y15 * L5 * C18 * R17$
 $* C22 * L21 + C3 * R4 * C19 * Y14 * Y11 * Y15 * L5 * C10 * R17 * C22 * L21 + C3 * R4 * C19 * Y14 * Y11 * Y15 * L5 * C10$
 $* R20 * L7 * C22 - 1. * C3 * L2 * Y13 * Y15 * L5 * Y8 * C10 * L7 * C22 - 1. * C3 * L2 * Y13 * Y15 * L6 * C10 * L7 * C22 *$
 $Y8 + C3 * L2 * Y13 * Y15 * C18 * L7 * R17 * C22 * C10 - 1. * C3 * L2 * Y13 * Y11 * Y15 * L6 * C10 * L7 * C22 - 1. * C3 *$
 $L2 * Y13 * Y15 * L5 * Y8 * L6 * C10 * C22 + C3 * L2 * C19 * Y14 * Y11 * Y15 * L6 * C10 * L7 - 1. * C3 * L2 * Y13 * Y11 *$
 $Y15 * L5 * L6 * C10 * C22 + C3 * L2 * Y14 * Y11 * Y15 * L5 * C10 * L7 * C22 + C3 * L2 * Y14 * Y11 * Y15 * L6 * C10 * L7 *$
 $C22 - 1. * C3 * L2 * Y14 * C19 * L21 * C22 * C18 * R17 * Y16 - 1. * C3 * L2 * Y14 * C19 * R20 * R17 * Y16 * C22 * C10 *$
 $L6 * Y8 + C3 * L2 * Y14 * Y11 * Y15 * L5 * L6 * C10 * C22 + C3 * L2 * Y14 * Y11 * Y15 * L5 * L6 * C18 * C22 + C3 * L2 *$
 $Y14 * Y11 * Y15 * L5 * C10 * C22 * C18 * R20 * R17 + C3 * L2 * Y14 * Y11 * Y15 * L5 * L6 * C10 * C18 - 1. * C3 * L2 *$
 $Y13 * Y11 * Y15 * L5 * C10 * L7 * C22 - 1. * C3 * L2 * C19 * Y14 * Y11 * Y15 * L5 * Y8 * R20 * C22 * L6 + C3 * L2 * C19 *$
 $Y15 * Y14 * L5 * Y8 * C10 * L7 + C3 * L2 * C19 * Y15 * Y14 * L5 * Y8 * C10 * L6 + C3 * L2 * C19 * Y15 * Y14 * L5 * Y8 *$
 $C10 * R20 * R17 * C22 + C3 * R4 * Y14 * Y11 * Y15 * C18 * L7 * R17 * C22 * L21 * C10 + C3 * R4 * Y14 * Y11 * Y15 * L5 *$
 $C10 * C18 * C22 * R20 * L7 + C3 * R4 * Y14 * Y11 * Y15 * C10 * C18 * C22 * R20 * L7 * L6 + C3 * L2 * C19 * Y14 * Y11 *$
 $Y15 * L5 * C18 * L7 + C3 * L2 * C19 * Y14 * Y11 * Y15 * L5 * L6 * C18 + C3 * L2 * C19 * Y14 * Y11 * Y15 * L5 * C10 * L7 +$
 $C3 * L2 * C19 * Y14 * Y11 * Y15 * L5 * C10 * L6 + C3 * L2 * C19 * Y14 * Y11 * Y15 * L5 * L21 * C22 + C3 * L2 * C19 * Y14$
 $* Y11 * Y15 * L6 * C18 * L7 + C3 * L2 * C19 * Y14 * Y11 * Y15 * L7 * C22 * L21 + C3 * L2 * C19 * Y14 * Y11 * Y15 * R20 *$
 $C18 * L7 * R17 * C22 + C3 * L2 * C19 * Y14 * Y11 * Y15 * R20 * L7 * R17 * C22 * C10 + C3 * L2 * C19 * Y14 * Y11 * Y15 *$
 $L5 * C22 * C18 * R20 * R17 - 1. * C3 * L2 * C19 * Y14 * Y11 * Y15 * R20 * L7 * C22 * L6 * Y8 - 1. * C3 * L2 * C19 * Y14 *$
 $Y11 * Y15 * L5 * Y8 * R20 * L7 * C22 + C3 * L2 * C19 * Y14 * Y11 * Y15 * L5 * C10 * R20 * R17 * C22 + C3 * R4 * C19 *$
 $Y14 * Y11 * Y15 * L6 * C18 * C22 * R20 * L7 + C3 * R4 * C19 * Y14 * Y11 * Y15 * L7 * R17 * C22 * L21 * C10 + C3 * R4 *$
 $C19 * Y14 * Y11 * Y15 * L6 * C10 * R20 * L7 * C22 + C3 * L2 * Y15 * Y14 * L5 * Y8 * L6 * C10 * C22 + C3 * L2 * Y15 * Y14$
 $* L5 * Y8 * C10 * L7 * C22 + C3 * L2 * Y15 * Y14 * L6 * C10 * L7 * C22 * Y8 + C3 * L2 * C19 * Y15 * Y14 * L5 * Y8 * L21 *$
 $C22 + C3 * R4 * L2 * Y14 * Y11 * Y15 * C10 * C18 * C22 * R20 * L7 + C3 * R4 * C19 * Y14 * Y11 * Y15 * C18 * L7 * R17 *$
 $C22 * L21 + C3 * R4 * L2 * Y14 * Y11 * Y15 * C18 * R20 * C22 * C10 * L6 + C3 * R4 * L2 * Y14 * Y11 * Y15 * C10 * C18 *$
 $R17 * C22 * L21 + C3 * L2 * Y13 * C22 * C18 * R17 * Y16 * C10 * L6 + C3 * L2 * Y13 * L7 * C22 * C18 * R17 * Y16 * C10)$
 $* s^5 + (C3 * L2 * C19 * Y15 * Y14 * L5 * Y8 * R17 * C10 + C3 * L2 * C19 * Y15 * Y14 * C18 * L7 + C3 * L2 * Y14 * Y11 *$
 $Y15 * L5 * C10 * C18 * R17 + C3 * L2 * Y14 * Y11 * Y15 * L5 * C18 * R20 * C22 + C3 * R4 * Y11 * C19 * Y14 * R20 * L7 *$
 $R17 * Y16 * C22 * C10 + C3 * R4 * Y11 * C19 * Y14 * Y16 * R17 * L7 * C22 * R20 * C18 - 1. * C3 * L2 * Y11 * Y13 * L7 *$
 $C22 * C18 * R17 * Y16 + C3 * L2 * Y11 * Y14 * C22 * L7 * R17 * Y16 * C10 + C3 * L2 * Y11 * Y14 * C10 * Y16 * R17 * C18$
 $* L7 + C3 * R4 * Y11 * Y14 * Y16 * R17 * L7 * C22 * R20 * C18 * C10 + Y11 * C19 * Y14 * Y16 * R17 * L21 * C22 * C10 *$
 $+ C3 * R4 * L2 * C19 * Y14 * Y11 * Y15 * C18 * L7 + C3 * R4 * L2 * C19 * Y14 * Y11 * Y15 * L21 * C22 + R4 * C19 * Y14 *$
 $Y11 * Y15 * L6 * C18 * C22 * L21 + R4 * C19 * Y14 * Y11 * Y15 * L21 * C22 * L7 * C10 + R4 * C19 * Y14 * Y11 * Y15 *$
 $L21 * C22 * C18 * L7 - 1. * C3 * R4 * L2 * C19 * Y14 * Y11 * Y15 * Y8 * R20 * C22 * L6 + C3 * R4 * L2 * C19 * Y14 * Y11 *$
 $Y15 * L6 * C18 + C3 * R4 * L2 * C19 * Y14 * Y11 * Y15 * C10 * R20 * R17 * C22 + C3 * R4 * L2 * C19 * Y14 * Y11 * Y15 *$

$C10*L7+R4*C19*Y14*Y11*Y15*L21*C22*C10*L6+C3*R4*L2*C19*Y14*Y11*Y15*C10*L6+C3*R4$
 $*Y14*Y11*Y15*L5*C10*L7*C22+C3*R4*Y14*Y11*Y15*L21*C22*C18*L7+C3*R4*Y14*Y11*Y15*$
 $L5*L6*C10*C22+C3*R4*Y14*Y11*Y15*L6*C10*L7*C22+C3*L2*Y14*Y11*Y15*C10*C18*L7*R17$
 $+C3*L2*Y14*Y11*Y15*C18*C22*R20*L7+C3*R4*L2*Y14*Y11*Y15*L6*C10*C18+C3*L2*Y11*$
 $C19*Y14*L7*R17*Y16*C10+C3*L2*Y11*C19*Y14*Y16*R17*C18*L7+C3*R4*L2*Y14*Y11*Y15*$
 $C18*C22*L21+C3*R4*L2*Y14*Y11*Y15*C18*L7*C22+C3*R4*L2*Y14*Y11*Y15*C10*C22*C18*$
 $R20*R17+C3*R4*L2*Y14*Y11*Y15*L6*C18*C22+C3*R4*L2*Y14*Y11*Y15*C10*L7*C22+C3*R4*$
 $L2*Y14*Y11*Y15*C10*C18*L7+C3*R4*C19*Y14*Y11*Y15*R20*C18*L7*R17*C22+C3*R4*C19*$
 $Y14*Y11*Y15*L5*C10*L7+C3*R4*C19*Y14*Y11*Y15*L7*C22*L21+C3*R4*Y14*Y11*Y15*L5*$
 $C18*C22*L21+C3*R4*Y14*Y11*Y15*L5*C18*L7*C22+C3*R4*Y14*Y11*Y15*L6*C10*C18*L7+C3$
 $*R4*Y14*Y11*Y15*L6*C18*L7*C22+C3*R4*Y14*Y11*Y15*L5*C10*C18*L7-1.*C3*L2*Y13*Y11$
 $*Y15*C18*L7*R17*C22-1.*C3*L2*Y13*Y11*Y15*C10*L7*R17*C22+C3*R4*Y14*Y11*Y15*L5*$
 $L6*C10*C18+C3*R4*Y14*Y11*Y15*L5*L6*C18*C22+C3*R4*Y14*Y11*Y15*L5*C10*C22*C18*$
 $R20*R17-1.*C3*L2*Y13*Y11*Y15*L5*C18*R17*C22+C3*L2*Y13*Y11*Y15*L7*C22*L6*Y8+C3*$
 $L2*Y13*Y11*Y15*L5*Y8*C22*L6+C3*L2*Y13*Y11*Y15*L5*Y8*L7*C22-1.*C3*L2*Y13*Y11*$
 $Y15*L5*C10*R17*C22+Y14*Y11*Y15*L5*C10*C18*R17*C22*L21+Y14*Y11*Y15*L5*C10*C18*$
 $C22*R20*L7+Y14*Y11*Y15*L5*C18*R20*C22*C10*L6+C3*R4*C19*Y14*Y11*Y15*R20*L7*R17*$
 $C22*C10+C3*R4*C19*Y14*Y11*Y15*L5*C18*L7+C3*L2*Y14*Y11*Y15*C10*L7*R17*C22+C3*L2$
 $*Y14*Y11*Y15*C18*L7*R17*C22+C3*L2*Y14*Y11*Y15*L5*C10*R17*C22+C3*L2*Y14*Y11*Y15$
 $*L5*C18*R17*C22-1.*C3*L2*Y14*Y11*Y15*L5*Y8*L7*C22-1.*C3*L2*Y14*Y11*Y15*L7*C22*$
 $L6*Y8-1.*C3*L2*Y14*C19*Y16*R17*C10*L6*Y8-1.*C3*L2*Y13*Y15*C10*R17*C22*Y8*L5-1.$
 $*C3*L2*Y14*Y11*Y15*L5*Y8*C22*L6-1.*C3*L2*Y14*C19*C18*R20*R17*Y16*C22+C3*R4*C19$
 $*Y14*Y11*Y15*L6*C18*L7+Y11*Y14*C18*L21*C22*C10*L7*Y16*R17+C3*R4*C19*Y14*Y11*$
 $Y15*L5*L21*C22-1.*C3*R4*Y13*Y11*Y15*L5*C10*L7*C22-1.*C3*R4*Y13*Y11*Y15*L5*L6*$
 $C10*C22+C3*L2*Y15*Y14*C18*L7*C22+Y14*Y11*Y15*C18*L7*R17*C22*L21*C10+Y14*Y11*$
 $Y15*C10*C18*C22*R20*L7*L6+C3*L2*C19*Y14*Y11*Y15*C18*L7*R17+C3*L2*C19*Y14*Y11*$
 $Y15*R20*L7*C22-1.*C3*L2*Y14*Y16*R17*C22*C10*L6*Y8+C3*R4*Y14*Y11*Y15*R20*C18*L7$
 $*R17*C22*C10-1.*C3*L2*C19*Y14*Y11*Y15*L5*Y8*L7+C3*L2*C19*Y14*Y11*Y15*L5*R17*$
 $C10-1.*C3*L2*C19*Y14*Y11*Y15*L5*Y8*L6+C3*L2*C19*Y14*Y11*Y15*L5*R20*C22+C3*L2*$
 $C19*Y14*Y11*Y15*L5*C18*R17-1.*C3*L2*C19*Y14*Y11*Y15*L6*L7*Y8+C3*L2*C19*Y14*Y11$
 $*Y15*L7*R17*C10-1.*C3*R4*Y13*Y11*Y15*L6*C10*L7*C22+C3*R4*C19*Y14*Y11*Y15*L5*$
 $C22*C18*R20*R17+C3*R4*C19*Y14*Y11*Y15*L6*C10*L7+C3*R4*C19*Y14*Y11*Y15*L5*L6*$
 $C18-1.*C3*R4*L2*Y13*Y11*Y15*C10*L7*C22+C3*R4*C19*Y14*Y11*Y15*L5*C10*L6-1.*C3*$
 $R4*L2*Y13*Y11*Y15*L6*C10*C22-1.*Y14*C19*Y16*R17*Y8*L6*L21*C22*C10+Y11*Y15*C19*$
 $Y14*C18*L7*R17*C22*L21+Y11*Y15*C19*Y14*L7*R17*C22*L21*C10+Y11*Y15*C19*Y14*L5*$
 $C10*R20*L7*C22+Y11*Y15*C19*Y14*L5*C18*R17*C22*L21+Y11*Y15*C19*Y14*L5*C10*R17*$
 $C22*L21+Y11*Y15*C19*Y14*L5*C18*C22*R20*L7-1.*Y11*Y15*C19*Y14*L7*C22*L21*L6*Y8+$
 $Y11*Y15*C19*Y14*L6*C10*R20*L7*C22+Y11*Y15*C19*Y14*L6*C18*C22*R20*L7-1.*Y11*Y15$
 $*C19*Y14*L5*Y8*L21*C22*L6-1.*Y11*Y15*C19*Y14*L5*Y8*L7*C22*L21+Y11*Y15*C19*Y14*$
 $L5*L6*R20*C22*C10+Y11*Y15*C19*Y14*L5*L6*C18*R20*C22+C3*L2*C19*Y15*Y14*L5*Y8*$

$R20 * C22 + C3 * L2 * Y15 * Y14 * C10 * R17 * C22 * Y8 * L5 - I. * C3 * R4 * C19 * Y14 * Y11 * Y15 * L5 * Y8 * R20 * L7 * C22 + C3 * R4 * C19 * Y14 * Y11 * Y15 * L5 * C10 * R20 * R17 * C22 + R4 * Y14 * Y11 * Y15 * L21 * C22 * C18 * L7 * C10 + R4 * Y14 * Y11 * Y15 * C18 * C22 * L21 * C10 * L6 + C19 * Y15 * Y14 * L5 * Y8 * C10 * R20 * L7 * C22 + C19 * Y15 * Y14 * L6 * C10 * R20 * L7 * C22 * Y8 + C19 * Y15 * Y14 * L5 * Y8 * L6 * R20 * C22 * C10 + C19 * Y15 * Y14 * L5 * Y8 * C10 * R17 * C22 * L21 + C19 * Y15 * Y14 * L21 * C22 * C18 * L7 - I. * C3 * R4 * C19 * Y14 * Y11 * Y15 * L5 * Y8 * R20 * C22 * L6 + C3 * R4 * L2 * Y14 * Y11 * Y15 * L6 * C10 * C22 - I. * C3 * R4 * C19 * Y14 * Y11 * Y15 * R20 * L7 * C22 * L6 * Y8 + C3 * L2 * Y11 * Y14 * L7 * C22 * C18 * R17 * Y16 + C3 * L2 * Y13 * Y16 * R17 * C22 * C10 * L6 * Y8 - I. * C3 * L2 * Y11 * Y13 * C22 * L7 * R17 * Y16 * C10) * s^4 + (-I. * Y13 * Y15 * L5 * Y8 * L6 * C10 * C22 - I. * Y13 * Y15 * L6 * C10 * L7 * C22 * Y8 - I. * Y13 * Y15 * L5 * Y8 * C10 * L7 * C22 + C3 * L2 * Y14 * Y11 * Y15 * C18 * L5 + C3 * L2 * Y14 * Y11 * Y15 * C18 * L7 + C3 * L2 * Y14 * Y11 * Y15 * L7 * C22 + Y11 * Y15 * C19 * Y14 * L5 * C18 * L7 + Y13 * Y15 * C18 * L7 * R17 * C22 * C10 + Y11 * Y15 * C19 * Y14 * L5 * C10 * L7 - I. * C3 * L2 * Y14 * C19 * C18 * R17 * Y16 - I. * Y13 * Y11 * Y15 * L5 * C10 * L7 * C22 + Y11 * Y15 * C19 * Y14 * L5 * L21 * C22 - I. * Y13 * Y11 * Y15 * L6 * C10 * L7 * C22 - I. * C3 * L2 * Y13 * Y15 * C22 * Y8 * L5 + Y11 * Y15 * C19 * Y14 * L5 * L6 * C18 - I. * C3 * L2 * Y13 * Y11 * Y15 * C22 * L5 + Y11 * Y15 * C19 * Y14 * L5 * C10 * L6 - I. * C3 * L2 * Y14 * C22 * C18 * R17 * Y16 - I. * C3 * L2 * Y13 * Y11 * Y15 * L7 * C22 + Y14 * Y11 * Y15 * L21 * C22 * C18 * L7 + Y14 * Y11 * Y15 * L6 * C18 * L7 * C22 + Y14 * Y11 * Y15 * L5 * C10 * L7 * C22 + Y14 * Y11 * Y15 * L5 * L6 * C18 * C22 + Y14 * Y11 * Y15 * L5 * C18 * C22 * L21 + Y14 * Y11 * Y15 * L5 * C18 * L7 * C22 + Y14 * Y11 * Y15 * L6 * C10 * L7 * C22 + Y14 * Y11 * Y15 * L6 * C10 * C18 * L7 + C3 * L2 * C19 * Y15 * Y14 * Y8 * L5 + C3 * R4 * Y11 * C19 * Y14 * L7 * R17 * Y16 * C10 + C3 * R4 * Y11 * C19 * Y14 * Y16 * R17 * C18 * L7 + C3 * R4 * Y11 * Y14 * C10 * Y16 * R17 * C18 * L7 + C3 * R4 * Y11 * Y14 * L7 * C22 * C18 * R17 * Y16 + R4 * C19 * Y14 * Y11 * Y15 * L6 * C18 * R20 * C22 + R4 * C19 * Y14 * Y11 * Y15 * C10 * R17 * C22 * L21 + R4 * C19 * Y14 * Y11 * Y15 * C10 * R20 * L7 * C22 + R4 * C19 * Y14 * Y11 * Y15 * L6 * R20 * C22 * C10 + Y11 * C19 * Y14 * C22 * R20 * L7 * C18 * R17 * Y16 + C3 * R4 * Y11 * Y14 * C22 * L7 * R17 * Y16 * C10 + R4 * C19 * Y14 * Y11 * Y15 * C18 * R17 * C22 * L21 + Y11 * C19 * Y14 * R20 * L7 * R17 * Y16 * C22 * C10 - I. * C3 * R4 * L2 * C19 * Y14 * Y11 * Y15 * Y8 * L6 + C3 * R4 * L2 * C19 * Y14 * Y11 * Y15 * R17 * C10 - I. * R4 * C19 * Y14 * Y11 * Y15 * Y8 * L21 * C22 * L6 - I. * C3 * R4 * Y14 * Y11 * Y15 * L7 * C22 * L6 * Y8 + C3 * R4 * Y14 * Y11 * Y15 * C10 * L7 * R17 * C22 + C3 * R4 * L2 * C19 * Y14 * Y11 * Y15 * R20 * C22 + C3 * R4 * L2 * C19 * Y14 * Y11 * Y15 * C18 * R17 + C3 * R4 * Y14 * Y11 * Y15 * C18 * L7 * R17 * C22 - I. * C3 * R4 * Y14 * Y11 * Y15 * L5 * Y8 * C22 * L6 - I. * C3 * R4 * Y14 * Y11 * Y15 * L5 * Y8 * L7 * C22 + C3 * R4 * Y14 * Y11 * Y15 * L5 * C10 * R17 * C22 + C3 * R4 * Y14 * Y11 * Y15 * C18 * C22 * R20 * L7 + C3 * R4 * C19 * Y14 * Y11 * Y15 * L5 * R17 * C10 + C3 * R4 * C19 * Y14 * Y11 * Y15 * L5 * R20 * C22 + C3 * L2 * Y15 * Y14 * C22 * Y8 * L5 + C3 * R4 * Y14 * Y11 * Y15 * L5 * C10 * C18 * R17 + C3 * R4 * C19 * Y14 * Y11 * Y15 * L7 * R17 * C10 + Y14 * Y11 * Y15 * L5 * L6 * C10 * C22 - I. * C3 * R4 * L2 * Y13 * Y11 * Y15 * C10 * R17 * C22 - I. * C3 * R4 * L2 * Y13 * Y11 * Y15 * C18 * R17 * C22 + C3 * R4 * C19 * Y14 * Y11 * Y15 * R20 * L7 * C22 + R4 * C19 * Y14 * Y11 * Y15 * C18 * C22 * R20 * L7 - I. * C3 * R4 * C19 * Y14 * Y11 * Y15 * L5 * Y8 * L7 + C3 * R4 * C19 * Y14 * Y11 * Y15 * C18 * L7 * R17 - I. * C3 * R4 * C19 * Y14 * Y11 * Y15 * L5 * Y8 * L6 + C3 * L2 * C19 * Y14 * Y11 * Y15 * L7 + C3 * R4 * Y13 * Y11 * Y15 * L7 * C22 * L6 * Y8 - I. * C3 * R4 * Y13 * Y11 * Y15 * C10 * L7 * R17 * C22 - I. * C3 * R4 * Y13 * Y11 * Y15 * C18 * L7 * R17 * C22 - I. * Y13 * Y11 * Y15 * L5 * L6 * C10 * C22 + Y11 * Y14 * C18 * C22 * R20 * C10 * L7 * Y16 * R17 + Y14 * Y11 * Y15 * L5 * C10 * C22 * C18 * R20 * R17 + Y14 * Y11 * Y15 * L5 * L6 * C10 * C18 + Y14 * Y11 * Y15 * R20 * C18 * L7 * R17 * C22 * C10 + C3 * R4 * Y14 * Y11 * Y15 * L5 * C18 * R20 * C22 + C3 * R4 * Y14 * Y11 * Y15 * C10 * C18 * L7 * R17 - I. * C3 * R4 * Y13 * Y11 * Y15 * L5 * C10 * R17 * C22 - I. * C3 * R4 * Y13 * Y11 * Y15 * L5 * C18 * R17 * C22 - I. * C3 * R4 * Y11 * Y13 * C22 * L7 * R17 * Y16 * C10 + C3 * R4 * Y13 * Y11 * Y15 * L5 * Y8 * L7 * C22 + C3 * R4 * Y13 * Y11$

$*Y15*L5*Y8*C22*L6+C3*L2*C19*Y14*Y11*Y15*L5-I.*C3*R4*L2*Y14*Y11*Y15*Y8*C22*L6+$
 $C3*L2*Y14*Y11*Y15*C22*L5+C3*R4*C19*Y14*Y11*Y15*L5*C18*R17+C3*R4*L2*Y13*Y11*Y15$
 $*Y8*C22*L6-I.*C3*R4*C19*Y14*Y11*Y15*L6*L7*Y8+Y11*Y15*C19*Y14*R20*L7*R17*C22*$
 $C10+Y11*Y15*C19*Y14*R20*C18*L7*R17*C22-I.*Y14*C19*R20*R17*Y16*C22*C10*L6*Y8-I.$
 $*Y11*Y15*C19*Y14*L5*Y8*R20*C22*L6-I.*Y11*Y15*C19*Y14*L5*Y8*R20*L7*C22+Y11*Y15*$
 $C19*Y14*L5*C10*R20*R17*C22+Y11*Y15*C19*Y14*L5*C22*C18*R20*R17-I.*Y11*Y15*C19*$
 $Y14*R20*L7*C22*L6*Y8+C3*R4*L2*Y14*Y11*Y15*C10*R17*C22+C3*R4*L2*Y14*Y11*Y15*C10$
 $*C18*R17+C3*R4*L2*Y14*Y11*Y15*C18*R17*C22+C3*R4*L2*Y14*Y11*Y15*C18*R20*C22+R4*$
 $Y14*Y11*Y15*C18*R20*C22*C10*L6+R4*Y14*Y11*Y15*C10*C18*R17*C22*L21+R4*Y14*Y11*$
 $Y15*C10*C18*C22*R20*L7+C19*Y15*Y14*L6*C10*L7*Y8+C19*Y15*Y14*C18*C22*R20*L7+C19$
 $*Y15*Y14*L5*Y8*C10*L7+C19*Y15*Y14*L5*Y8*L21*C22+C19*Y15*Y14*L5*Y8*C10*L6+C19*$
 $Y15*Y14*L5*Y8*C10*R20*R17*C22-I.*C3*R4*Y11*Y13*L7*C22*C18*R17*Y16+Y11*Y15*C19*$
 $Y14*L6*C10*L7+Y11*Y15*C19*Y14*L7*C22*L21+Y11*Y15*C19*Y14*L6*C18*L7-I.*Y14*C19*$
 $L21*C22*C18*R17*Y16+C3*L2*Y13*C22*C18*R17*Y16+Y13*L7*C22*C18*R17*Y16*C10+Y13*$
 $C22*C18*R17*Y16*C10*L6+Y15*Y14*L5*Y8*L6*C10*C22+Y15*Y14*L5*Y8*C10*L7*C22+Y15*$
 $Y14*L6*C10*L7*C22*Y8+Y14*Y11*Y15*L5*C10*C18*L7)*s^3+(Y11*Y14*C18*L7*C22*R17*$
 $Y16-I.*Y14*Y16*R17*C22*C10*L6*Y8+R4*C19*Y14*Y11*Y15*C18*L7+R4*C19*Y14*Y11*Y15*$
 $C10*L7-I.*Y13*Y15*C10*R17*C22*Y8*L5+Y13*Y11*Y15*L5*Y8*L7*C22-I.*Y13*Y11*Y15*L5$
 $*C10*R17*C22+Y13*Y11*Y15*L7*C22*L6*Y8-I.*Y13*Y11*Y15*L5*C18*R17*C22-I.*Y13*Y11$
 $*Y15*C10*L7*R17*C22-I.*Y13*Y11*Y15*C18*L7*R17*C22+Y13*Y11*Y15*L5*Y8*C22*L6-I.*$
 $C3*R4*Y13*Y11*Y15*L7*C22-I.*C3*R4*Y13*Y11*Y15*C22*L5+C3*R4*Y14*Y11*Y15*C18*L5+$
 $Y11*Y15*C19*Y14*C18*L7*R17-I.*Y11*Y15*C19*Y14*L6*L7*Y8+Y11*Y15*C19*Y14*L7*R17*$
 $C10+Y14*Y11*Y15*L5*C10*R17*C22-I.*Y14*Y11*Y15*L5*Y8*L7*C22-I.*Y14*Y11*Y15*L5*$
 $Y8*C22*L6+Y14*Y11*Y15*L5*C10*C18*R17+Y11*Y15*C19*Y14*R20*L7*C22+C19*Y15*Y14*L5$
 $*Y8*R20*C22+C19*Y15*Y14*L5*Y8*R17*C10+Y11*Y14*C22*C10*L7*R17*Y16+R4*C19*Y14*$
 $Y11*Y15*C10*R20*R17*C22+R4*C19*Y14*Y11*Y15*C22*L21+Y11*Y14*C18*C10*L7*Y16*R17+$
 $R4*C19*Y14*Y11*Y15*C22*C18*R20*R17+C3*R4*C19*Y14*Y11*Y15*L7+Y15*Y14*C18*L7*C22$
 $+C3*R4*L2*Y14*Y11*Y15*C22+R4*Y14*Y11*Y15*C10*C22*C18*R20*R17+R4*Y14*Y11*Y15*$
 $C10*L7*C22+R4*Y14*Y11*Y15*C10*C18*L7+R4*Y14*Y11*Y15*C18*C22*L21+R4*Y14*Y11*Y15$
 $*C18*L7*C22+R4*Y14*Y11*Y15*L6*C18*C22+R4*Y14*Y11*Y15*L6*C10*C22+R4*Y14*Y11*Y15$
 $*L6*C10*C18+R4*C19*Y14*Y11*Y15*L6*C18-I.*R4*C19*Y14*Y11*Y15*Y8*R20*C22*L6+C19*$
 $Y15*Y14*C18*L7+C3*R4*C19*Y14*Y11*Y15*L5+C3*R4*L2*Y14*Y11*Y15*C18+C3*R4*Y14*Y11$
 $*Y15*C18*L7-I.*Y11*Y15*C19*Y14*L5*Y8*L7+C3*R4*Y14*Y11*Y15*L7*C22+C3*R4*Y14*Y11$
 $*Y15*C22*L5+R4*C19*Y14*Y11*Y15*C10*L6+Y11*Y15*C19*Y14*L5*R17*C10+C3*R4*L2*C19*$
 $Y14*Y11*Y15-I.*Y11*Y15*C19*Y14*L5*Y8*L6-I.*Y11*Y13*C22*C10*L7*R17*Y16-I.*Y11*$
 $Y13*C18*L7*C22*R17*Y16+Y11*C19*Y14*L7*R17*Y16*C10+Y11*Y15*C19*Y14*L5*R20*C22+$
 $Y11*C19*Y14*L7*C18*R17*Y16-I.*Y14*C19*Y16*R17*C10*L6*Y8+Y11*Y15*C19*Y14*L5*C18$
 $*R17-I.*Y14*C19*C18*R20*R17*Y16*C22-I.*C3*R4*L2*Y13*Y11*Y15*C22-I.*R4*Y13*Y11*$
 $Y15*C10*L7*C22-I.*R4*Y13*Y11*Y15*L6*C10*C22+Y13*Y16*R17*C22*C10*L6*Y8+Y14*Y11*$
 $Y15*L5*C18*R17*C22+Y14*Y11*Y15*L5*C18*R20*C22-I.*Y14*Y11*Y15*L7*C22*L6*Y8+Y14*$

$$\begin{aligned}
& Y11*Y15*C10*C18*L7*R17+Y14*Y11*Y15*C10*L7*R17*C22+Y14*Y11*Y15*C18*L7*R17*C22+ \\
& Y14*Y11*Y15*C18*C22*R20*L7+Y15*Y14*C10*R17*C22*Y8*L5)*s^2+(-1.*Y13*Y11*Y15*C22 \\
& *L5+R4*C19*Y14*Y11*Y15*C18*R17+R4*C19*Y14*Y11*Y15*R20*C22+R4*C19*Y14*Y11*Y15* \\
& C10*R17-1.*R4*C19*Y14*Y11*Y15*Y8*L6+Y14*Y11*Y15*C22*L5+C19*Y14*Y11*Y15*L5-1.* \\
& Y11*L7*C22*Y13*Y15+C18*Y11*L7*Y14*Y15+Y11*L7*Y14*C22*Y15+Y11*L7*Y14*C19*Y15+ \\
& Y14*Y11*Y15*C18*L5+C19*Y15*Y14*Y8*L5-1.*Y14*C22*C18*R17*Y16+Y15*Y14*C22*Y8*L5+ \\
& R4*Y14*Y11*Y15*C10*R17*C22+R4*Y14*Y11*Y15*C10*C18*R17+R4*Y14*Y11*Y15*C18*R17* \\
& C22+R4*Y14*Y11*Y15*C18*R20*C22-1.*R4*Y14*Y11*Y15*Y8*C22*L6+Y13*C22*C18*R17*Y16 \\
& +R4*Y13*Y11*Y15*Y8*C22*L6-1.*R4*Y13*Y11*Y15*C10*R17*C22-1.*R4*Y13*Y11*Y15*C18* \\
& R17*C22-1.*Y14*C19*C18*R17*Y16-1.*Y13*Y15*C22*Y8*L5)*s+R4*C19*Y14*Y11*Y15-1.* \\
& R4*Y13*Y11*Y15*C22+R4*Y14*Y11*Y15*C22+R4*Y14*Y11*Y15*C18});
\end{aligned}$$

Rezultatele procedurii de sortare a termenilor din numărătorul și numitorul funcției de circuit în formă redusă în ordine descrescătoare a puterilor și coeficienților lui „s” pentru circuitul din figura 1 arată astfel:

rez1 := {Aei =

$$\begin{aligned}
& ((\\
& +C3*Y14*C18*C22*L21*L6*C10*L7*Y15 + 2.880000000000000E-0043 \\
& +C3*Y14*C18*C22*L21*L5*C10*L7*Y15 + 1.920000000000000E-0043 \\
& +C3*Y14*C18*C22*L21*L5*L6*C10*Y15 + 1.440000000000000E-0043 \\
&)*s^6 \\
& +(\\
& +C3*Y14*C18*C22*L21*C10*L7*R17*Y16 + 7.680000000000000E-0037 \\
& +C3*Y14*C18*C22*L21*L5*C10*Y15*R17 + 1.920000000000000E-0037 \\
&)*s^5 \\
& +(\\
& +C3*Y14*C18*C22*L21*L7*Y15 + 3.200000000000000E-0032 \\
& +C3*Y14*C18*C22*L21*Y11*R4*L7*Y15 + 2.112000000000000E-0032 \\
& +C3*Y14*C18*C22*L21*L5*Y15 + 1.600000000000000E-0032 \\
&)*s^4 \\
&) \\
& /((\\
& +C3*L2*C19*Y15*Y14*L6*L21*C22*L7*C10*Y8 + 7.200000000000000E-0049 \\
& +C3*L2*C19*Y15*Y14*L5*Y8*L21*C22*L7*C10 + 4.800000000000000E-0049 \\
& +C3*L2*C19*Y15*Y14*L5*Y8*L21*C22*C10*L6 + 3.600000000000000E-0049 \\
& +C3*L2*Y14*Y11*Y15*L21*C22*C18*L7*C10*L6 + 9.504000000000000E-0050 \\
& +C3*L2*Y14*Y11*Y15*L5*L21*C22*C18*L7*C10 + 6.336000000000000E-0050 \\
& +C3*L2*C19*Y14*Y11*Y15*L6*L21*C22*L7*C10 + 4.752000000000000E-0050 \\
& +C3*L2*Y14*Y11*Y15*L5*C18*C22*L21*C10*L6 + 4.752000000000000E-0050 \\
& +C3*L2*C19*Y14*Y11*Y15*L6*L21*C22*C18*L7 + 3.168000000000000E-0050 \\
& +C3*L2*C19*Y14*Y11*Y15*L5*L21*C22*L7*C10 + 3.168000000000000E-0050 \\
& +C3*L2*C19*Y14*Y11*Y15*L5*L21*C22*C10*L6 + 2.376000000000000E-0050
\end{aligned}$$

+C3*L2*C19*Y14*Y11*Y15*L5*L21*C22*C18*L7 + 2.112000000000000E-0050
 +C3*L2*C19*Y14*Y11*Y15*L5*L6*C18*C22*L21 + 1.584000000000000E-0050
)*s^7
 +(
 -C3*L2*Y14*C19*Y16*R17*Y8*L6*L21*C22*C10 - 1.440000000000000E-0042
 +C3*L2*C19*Y15*Y14*L5*Y8*C10*R17*C22*L21 + 4.800000000000000E-0043
 +C3*L2*Y11*Y14*L21*C22*C18*C10*L7*R17*Y16 + 2.534400000000000E-0043
 +C3*R4*Y14*Y11*Y15*L21*C22*C18*L7*C10*L6 + 1.900800000000000E-0043
 +C3*L2*C19*Y15*Y14*L6*C10*R20*L7*C22*Y8 + 1.800000000000000E-0043
 +C3*L2*Y14*Y11*Y15*C18*L7*R17*C22*L21*C10 + 1.267200000000000E-0043
 +C3*R4*Y14*Y11*Y15*L5*L21*C22*C18*L7*C10 + 1.267200000000000E-0043
 +C3*L2*Y11*C19*Y14*Y16*R17*L21*C22*C10*L7 + 1.267200000000000E-0043
 +C3*L2*C19*Y15*Y14*L5*Y8*C10*R20*L7*C22 + 1.200000000000000E-0043
 +C3*R4*Y14*Y11*Y15*L5*C18*C22*L21*C10*L6 + 9.504000000000000E-0044
 +C3*R4*C19*Y14*Y11*Y15*L6*L21*C22*L7*C10 + 9.504000000000000E-0044
 +C3*L2*C19*Y15*Y14*L5*Y8*L6*R20*C22*C10 + 9.000000000000000E-0044
 +C3*L2*Y11*C19*Y14*Y16*R17*L7*L21*C18*C22 + 8.448000000000000E-0044
 -C3*L2*C19*Y14*Y11*Y15*L7*C22*L21*L6*Y8 - 7.920000000000000E-0044
 +C3*L2*Y14*Y11*Y15*L5*C10*C18*R17*C22*L21 + 6.336000000000000E-0044
 +C3*R4*C19*Y14*Y11*Y15*L5*L21*C22*L7*C10 + 6.336000000000000E-0044
 +C3*L2*C19*Y14*Y11*Y15*L7*R17*C22*L21*C10 + 6.336000000000000E-0044
 +C3*R4*L2*Y14*Y11*Y15*L21*C22*C18*L7*C10 + 6.336000000000000E-0044
 +C3*R4*C19*Y14*Y11*Y15*L6*L21*C22*C18*L7 + 6.336000000000000E-0044
 -C3*L2*C19*Y14*Y11*Y15*L5*Y8*L7*C22*L21 - 5.280000000000000E-0044
 +C3*R4*C19*Y14*Y11*Y15*L5*L21*C22*C10*L6 + 4.752000000000000E-0044
 +C3*R4*L2*Y14*Y11*Y15*C18*C22*L21*C10*L6 + 4.752000000000000E-0044
 +C3*L2*C19*Y14*Y11*Y15*C18*L7*R17*C22*L21 + 4.224000000000000E-0044
 +C3*R4*C19*Y14*Y11*Y15*L5*L21*C22*C18*L7 + 4.224000000000000E-0044
 -C3*L2*C19*Y14*Y11*Y15*L5*Y8*L21*C22*L6 - 3.960000000000000E-0044
 +C3*L2*C19*Y15*Y14*L21*C22*C18*L7 + 3.200000000000000E-0044
 +C3*L2*C19*Y14*Y11*Y15*L5*C10*R17*C22*L21 + 3.168000000000000E-0044
 +C3*R4*L2*C19*Y14*Y11*Y15*L21*C22*L7*C10 + 3.168000000000000E-0044
 +C3*R4*C19*Y14*Y11*Y15*L5*L6*C18*C22*L21 + 3.168000000000000E-0044
 +C3*L2*Y14*Y11*Y15*C10*C18*C22*R20*L7*L6 + 2.376000000000000E-0044
 +C3*L2*C19*Y14*Y11*Y15*L5*C18*R17*C22*L21 + 2.112000000000000E-0044
 +C3*R4*L2*C19*Y14*Y11*Y15*L21*C22*C18*L7 + 2.112000000000000E-0044
 +C3*L2*Y14*Y11*Y15*L5*C10*C18*C22*R20*L7 + 1.584000000000000E-0044
 +C3*R4*L2*C19*Y14*Y11*Y15*L6*C18*C22*L21 + 1.584000000000000E-0044
 +C3*L2*C19*Y14*Y11*Y15*L6*C10*R20*L7*C22 + 1.188000000000000E-0044
 +C3*L2*Y14*Y11*Y15*L5*C18*R20*C22*C10*L6 + 1.188000000000000E-0044

+C3*L2*C19*Y14*Y11*Y15*L5*C10*R20*L7*C22 + 7.920000000000000E-0045
 +C3*L2*C19*Y14*Y11*Y15*L6*C18*C22*R20*L7 + 7.920000000000000E-0045
 +C3*L2*C19*Y14*Y11*Y15*L5*L6*R20*C22*C10 + 5.940000000000000E-0045
 +C3*L2*C19*Y14*Y11*Y15*L5*C18*C22*R20*L7 + 5.280000000000000E-0045
 +C3*L2*C19*Y14*Y11*Y15*L5*L6*C18*R20*C22 + 3.960000000000000E-0045
)*s^6
 +(
 +C3*L2*Y13*L7*C22*C18*R17*Y16*C10 + 9.600000000000000E-0037
 -C3*L2*Y13*Y15*L6*C10*L7*C22*Y8 - 9.000000000000000E-0037
 +C3*L2*Y13*C22*C18*R17*Y16*C10*L6 + 7.200000000000000E-0037
 +C19*Y15*Y14*L6*L21*C22*L7*C10*Y8 + 7.200000000000000E-0037
 -C3*L2*Y13*Y15*L5*Y8*C10*L7*C22 - 6.000000000000000E-0037
 +C3*R4*Y11*Y14*L21*C22*C18*C10*L7*R17*Y16 + 5.068800000000000E-0037
 +C19*Y15*Y14*L5*Y8*L21*C22*L7*C10 + 4.800000000000000E-0037
 +C3*L2*Y13*Y15*C18*L7*R17*C22*C10 + 4.800000000000000E-0037
 -C3*L2*Y13*Y15*L5*Y8*L6*C10*C22 - 4.500000000000000E-0037
 +C19*Y15*Y14*L5*Y8*L21*C22*C10*L6 + 3.600000000000000E-0037
 -C3*L2*Y14*C19*R20*R17*Y16*C22*C10*L6*Y8 - 3.600000000000000E-0037
 +C3*R4*Y11*C19*Y14*Y16*R17*L21*C22*C10*L7 + 2.534400000000000E-0037
 +C3*R4*Y14*Y11*Y15*C18*L7*R17*C22*L21*C10 + 2.534400000000000E-0037
 +C3*L2*Y15*Y14*L6*C10*L7*C22*Y8 + 1.800000000000000E-0037
 +C3*R4*Y11*C19*Y14*Y16*R17*L7*L21*C18*C22 + 1.689600000000000E-0037
 -C3*R4*C19*Y14*Y11*Y15*L7*C22*L21*L6*Y8 - 1.584000000000000E-0037
 +C3*R4*C19*Y14*Y11*Y15*L7*R17*C22*L21*C10 + 1.267200000000000E-0037
 +C3*R4*Y14*Y11*Y15*L5*C10*C18*R17*C22*L21 + 1.267200000000000E-0037
 +C3*L2*C19*Y15*Y14*L5*Y8*C10*R20*R17*C22 + 1.200000000000000E-0037
 +C3*L2*Y15*Y14*L5*Y8*C10*L7*C22 + 1.200000000000000E-0037
 -C3*R4*C19*Y14*Y11*Y15*L5*Y8*L7*C22*L21 - 1.056000000000000E-0037
 +Y14*Y11*Y15*L21*C22*C18*L7*C10*L6 + 9.504000000000000E-0038
 +C3*L2*C19*Y15*Y14*L6*C10*L7*Y8 + 9.000000000000000E-0038
 +C3*L2*Y15*Y14*L5*Y8*L6*C10*C22 + 9.000000000000000E-0038
 +C3*R4*C19*Y14*Y11*Y15*C18*L7*R17*C22*L21 + 8.448000000000000E-0038
 -C3*R4*C19*Y14*Y11*Y15*L5*Y8*L21*C22*L6 - 7.920000000000000E-0038
 -C3*L2*Y14*C19*L21*C22*C18*R17*Y16 - 6.400000000000000E-0038
 +Y14*Y11*Y15*L5*L21*C22*C18*L7*C10 + 6.336000000000000E-0038
 +C3*L2*Y11*Y14*Y16*R17*L7*C22*R20*C18*C10 + 6.336000000000000E-0038
 +C3*R4*C19*Y14*Y11*Y15*L5*C10*R17*C22*L21 + 6.336000000000000E-0038
 +C3*R4*L2*Y14*Y11*Y15*C10*C18*R17*C22*L21 + 6.336000000000000E-0038
 +C3*L2*C19*Y15*Y14*L5*Y8*C10*L7 + 6.000000000000000E-0038
 -C3*L2*Y13*Y11*Y15*L6*C10*L7*C22 - 5.940000000000000E-0038

+C3*R4*Y14*Y11*Y15*C10*C18*C22*R20*L7*L6 + 4.75200000000000E-0038
 +Y14*Y11*Y15*L5*C18*C22*L21*C10*L6 + 4.75200000000000E-0038
 +Y11*Y15*C19*Y14*L6*L21*C22*L7*C10 + 4.75200000000000E-0038
 +C3*L2*C19*Y15*Y14*L5*Y8*C10*L6 + 4.50000000000000E-0038
 +C3*R4*C19*Y14*Y11*Y15*L5*C18*R17*C22*L21 + 4.22400000000000E-0038
 +C3*L2*C19*Y15*Y14*L5*Y8*L21*C22 + 4.00000000000000E-0038
 -C3*L2*Y13*Y11*Y15*L5*C10*L7*C22 - 3.96000000000000E-0038
 -C3*R4*L2*C19*Y14*Y11*Y15*Y8*L21*C22*L6 - 3.96000000000000E-0038
 +C3*L2*Y14*Y11*Y15*R20*C18*L7*R17*C22*C10 + 3.16800000000000E-0038
 +Y11*Y15*C19*Y14*L5*L21*C22*L7*C10 + 3.16800000000000E-0038
 +C3*R4*L2*C19*Y14*Y11*Y15*C10*R17*C22*L21 + 3.16800000000000E-0038
 +C3*L2*Y11*C19*Y14*R20*L7*R17*Y16*C22*C10 + 3.16800000000000E-0038
 +C3*R4*Y14*Y11*Y15*L5*C10*C18*C22*R20*L7 + 3.16800000000000E-0038
 -C3*L2*Y13*Y11*Y15*L5*L6*C10*C22 - 2.97000000000000E-0038
 +C3*R4*C19*Y14*Y11*Y15*L6*C10*R20*L7*C22 + 2.37600000000000E-0038
 +Y11*Y15*C19*Y14*L5*L21*C22*C10*L6 + 2.37600000000000E-0038
 +C3*R4*Y14*Y11*Y15*L5*C18*R20*C22*C10*L6 + 2.37600000000000E-0038
 +Y11*Y15*C19*Y14*L5*L21*C22*C18*L7 + 2.11200000000000E-0038
 +C3*R4*L2*C19*Y14*Y11*Y15*C18*R17*C22*L21 + 2.11200000000000E-0038
 +C3*L2*Y11*C19*Y14*Y16*R17*L7*C22*R20*C18 + 2.11200000000000E-0038
 -C3*L2*C19*Y14*Y11*Y15*R20*L7*C22*L6*Y8 - 1.98000000000000E-0038
 +C3*L2*Y14*Y11*Y15*L5*C10*C22*C18*R20*R17 + 1.58400000000000E-0038
 +C3*R4*L2*Y14*Y11*Y15*C10*C18*C22*R20*L7 + 1.58400000000000E-0038
 +Y11*Y15*C19*Y14*L5*L6*C18*C22*L21 + 1.58400000000000E-0038
 +C3*L2*C19*Y14*Y11*Y15*R20*L7*R17*C22*C10 + 1.58400000000000E-0038
 +C3*R4*C19*Y14*Y11*Y15*L5*C10*R20*L7*C22 + 1.58400000000000E-0038
 +C3*R4*C19*Y14*Y11*Y15*L6*C18*C22*R20*L7 + 1.58400000000000E-0038
 -C3*L2*C19*Y14*Y11*Y15*L5*Y8*R20*L7*C22 - 1.32000000000000E-0038
 +C3*R4*L2*Y14*Y11*Y15*C18*R20*C22*C10*L6 + 1.18800000000000E-0038
 +C3*R4*C19*Y14*Y11*Y15*L5*L6*R20*C22*C10 + 1.18800000000000E-0038
 +C3*L2*Y14*Y11*Y15*L6*C10*L7*C22 + 1.18800000000000E-0038
 +C3*L2*Y14*Y11*Y15*L6*C10*C18*L7 + 1.18800000000000E-0038
 +C3*L2*Y14*Y11*Y15*L21*C22*C18*L7 + 1.05600000000000E-0038
 +C3*L2*C19*Y14*Y11*Y15*R20*C18*L7*R17*C22 + 1.05600000000000E-0038
 +C3*R4*C19*Y14*Y11*Y15*L5*C18*C22*R20*L7 + 1.05600000000000E-0038
 -C3*L2*C19*Y14*Y11*Y15*L5*Y8*R20*C22*L6 - 9.90000000000000E-0039
 +C3*L2*C19*Y15*Y14*C18*C22*R20*L7 + 8.00000000000000E-0039
 +C3*L2*Y14*Y11*Y15*L5*C10*L7*C22 + 7.92000000000000E-0039
 +C3*R4*L2*C19*Y14*Y11*Y15*C10*R20*L7*C22 + 7.92000000000000E-0039
 +C3*L2*C19*Y14*Y11*Y15*L5*C10*R20*R17*C22 + 7.92000000000000E-0039

+C3*L2*Y14*Y11*Y15*L5*C10*C18*L7 + 7.920000000000000E-0039
 +C3*L2*Y14*Y11*Y15*L6*C18*L7*C22 + 7.920000000000000E-0039
 +C3*R4*C19*Y14*Y11*Y15*L5*L6*C18*R20*C22 + 7.920000000000000E-0039
 +C3*L2*C19*Y14*Y11*Y15*L6*C10*L7 + 5.940000000000000E-0039
 +C3*L2*Y14*Y11*Y15*L5*L6*C10*C18 + 5.940000000000000E-0039
 +C3*R4*L2*C19*Y14*Y11*Y15*L6*R20*C22*C10 + 5.940000000000000E-0039
 +C3*L2*Y14*Y11*Y15*L5*L6*C10*C22 + 5.940000000000000E-0039
 +C3*L2*C19*Y14*Y11*Y15*L7*C22*L21 + 5.280000000000000E-0039
 +C3*R4*L2*C19*Y14*Y11*Y15*C18*C22*R20*L7 + 5.280000000000000E-0039
 +C3*L2*Y14*Y11*Y15*L5*C18*C22*L21 + 5.280000000000000E-0039
 +C3*L2*C19*Y14*Y11*Y15*L5*C22*C18*R20*R17 + 5.280000000000000E-0039
 +C3*L2*Y14*Y11*Y15*L5*C18*L7*C22 + 5.280000000000000E-0039
 +C3*L2*C19*Y14*Y11*Y15*L5*C10*L7 + 3.960000000000000E-0039
 +C3*L2*C19*Y14*Y11*Y15*L6*C18*L7 + 3.960000000000000E-0039
 +C3*R4*L2*C19*Y14*Y11*Y15*L6*C18*R20*C22 + 3.960000000000000E-0039
 +C3*L2*Y14*Y11*Y15*L5*L6*C18*C22 + 3.960000000000000E-0039
 +C3*L2*C19*Y14*Y11*Y15*L5*C10*L6 + 2.970000000000000E-0039
 +C3*L2*C19*Y14*Y11*Y15*L5*L21*C22 + 2.640000000000000E-0039
 +C3*L2*C19*Y14*Y11*Y15*L5*C18*L7 + 2.640000000000000E-0039
 +C3*L2*C19*Y14*Y11*Y15*L5*L6*C18 + 1.980000000000000E-0039
)*s^5
 +(
 +C3*L2*Y13*Y16*R17*C22*C10*L6*Y8 + 1.800000000000000E-0030
 -Y14*C19*Y16*R17*Y8*L6*L21*C22*C10 - 1.440000000000000E-0030
 -C3*L2*Y13*Y15*C10*R17*C22*Y8*L5 - 6.000000000000000E-0031
 +C19*Y15*Y14*L5*Y8*C10*R17*C22*L21 + 4.800000000000000E-0031
 -C3*L2*Y14*Y16*R17*C22*C10*L6*Y8 - 3.600000000000000E-0031
 +Y11*Y14*C18*L21*C22*C10*L7*Y16*R17 + 2.534400000000000E-0031
 +C19*Y15*Y14*L6*C10*R20*L7*C22*Y8 + 1.800000000000000E-0031
 -C3*L2*Y14*C19*Y16*R17*C10*L6*Y8 - 1.800000000000000E-0031
 -C3*L2*Y11*Y13*C22*L7*R17*Y16*C10 - 1.584000000000000E-0031
 +C3*R4*Y11*Y14*Y16*R17*L7*C22*R20*C18*C10 + 1.267200000000000E-0031
 +Y14*Y11*Y15*C18*L7*R17*C22*L21*C10 + 1.267200000000000E-0031
 +Y11*C19*Y14*Y16*R17*L21*C22*C10*L7 + 1.267200000000000E-0031
 +C3*L2*Y15*Y14*C10*R17*C22*Y8*L5 + 1.200000000000000E-0031
 +C19*Y15*Y14*L5*Y8*C10*R20*L7*C22 + 1.200000000000000E-0031
 -C3*R4*Y13*Y11*Y15*L6*C10*L7*C22 - 1.188000000000000E-0031
 -C3*L2*Y11*Y13*L7*C22*C18*R17*Y16 - 1.056000000000000E-0031
 +C3*L2*Y13*Y11*Y15*L7*C22*L6*Y8 + 9.900000000000000E-0032
 +C19*Y15*Y14*L5*Y8*L6*R20*C22*C10 + 9.000000000000000E-0032

+Y11*C19*Y14*L21*C22*L7*C18*R17*Y16 + 8.448000000000000E-0032
 -Y11*Y15*C19*Y14*L7*C22*L21*L6*Y8 - 7.920000000000000E-0032
 -C3*L2*Y13*Y11*Y15*C10*L7*R17*C22 - 7.920000000000000E-0032
 -C3*R4*Y13*Y11*Y15*L5*C10*L7*C22 - 7.920000000000000E-0032
 +C3*L2*Y13*Y11*Y15*L5*Y8*L7*C22 + 6.600000000000000E-0032
 +Y11*Y15*C19*Y14*L7*R17*C22*L21*C10 + 6.336000000000000E-0032
 +C3*R4*Y11*C19*Y14*R20*L7*R17*Y16*C22*C10 + 6.336000000000000E-0032
 +C3*R4*Y14*Y11*Y15*R20*C18*L7*R17*C22*C10 + 6.336000000000000E-0032
 +Y14*Y11*Y15*L5*C10*C18*R17*C22*L21 + 6.336000000000000E-0032
 +R4*Y14*Y11*Y15*L21*C22*C18*L7*C10 + 6.336000000000000E-0032
 -C3*R4*Y13*Y11*Y15*L5*L6*C10*C22 - 5.940000000000000E-0032
 -C3*L2*Y13*Y11*Y15*C18*L7*R17*C22 - 5.280000000000000E-0032
 -Y11*Y15*C19*Y14*L5*Y8*L7*C22*L21 - 5.280000000000000E-0032
 +C3*L2*Y13*Y11*Y15*L5*Y8*C22*L6 + 4.950000000000000E-0032
 +R4*Y14*Y11*Y15*C18*C22*L21*C10*L6 + 4.752000000000000E-0032
 +C3*R4*Y11*C19*Y14*Y16*R17*L7*C22*R20*C18 + 4.224000000000000E-0032
 +Y11*Y15*C19*Y14*C18*L7*R17*C22*L21 + 4.224000000000000E-0032
 -C3*R4*C19*Y14*Y11*Y15*R20*L7*C22*L6*Y8 - 3.960000000000000E-0032
 -C3*R4*L2*Y13*Y11*Y15*C10*L7*C22 - 3.960000000000000E-0032
 -C3*L2*Y13*Y11*Y15*L5*C10*R17*C22 - 3.960000000000000E-0032
 -Y11*Y15*C19*Y14*L5*Y8*L21*C22*L6 - 3.960000000000000E-0032
 +C19*Y15*Y14*L21*C22*C18*L7 + 3.200000000000000E-0032
 +C3*R4*C19*Y14*Y11*Y15*R20*L7*R17*C22*C10 + 3.168000000000000E-0032
 +C3*R4*Y14*Y11*Y15*L5*C10*C22*C18*R20*R17 + 3.168000000000000E-0032
 +C3*L2*Y11*Y14*C22*L7*R17*Y16*C10 + 3.168000000000000E-0032
 +Y11*Y15*C19*Y14*L5*C10*R17*C22*L21 + 3.168000000000000E-0032
 +C3*L2*Y11*Y14*C10*Y16*R17*C18*L7 + 3.168000000000000E-0032
 +R4*C19*Y14*Y11*Y15*L21*C22*L7*C10 + 3.168000000000000E-0032
 -C3*R4*L2*Y13*Y11*Y15*L6*C10*C22 - 2.970000000000000E-0032
 -C3*L2*Y13*Y11*Y15*L5*C18*R17*C22 - 2.640000000000000E-0032
 -C3*R4*C19*Y14*Y11*Y15*L5*Y8*R20*L7*C22 - 2.640000000000000E-0032
 +C3*R4*Y14*Y11*Y15*L6*C10*L7*C22 + 2.376000000000000E-0032
 +C3*R4*Y14*Y11*Y15*L6*C10*C18*L7 + 2.376000000000000E-0032
 +Y14*Y11*Y15*C10*C18*C22*R20*L7*L6 + 2.376000000000000E-0032
 +R4*C19*Y14*Y11*Y15*L21*C22*C10*L6 + 2.376000000000000E-0032
 +C3*L2*Y11*Y14*L7*C22*C18*R17*Y16 + 2.112000000000000E-0032
 +Y11*Y15*C19*Y14*L5*C18*R17*C22*L21 + 2.112000000000000E-0032
 +C3*R4*C19*Y14*Y11*Y15*R20*C18*L7*R17*C22 + 2.112000000000000E-0032
 +R4*C19*Y14*Y11*Y15*L21*C22*C18*L7 + 2.112000000000000E-0032
 +C3*R4*Y14*Y11*Y15*L21*C22*C18*L7 + 2.112000000000000E-0032

$-C3*L2*Y14*Y11*Y15*L7*C22*L6*Y8 - 1.980000000000000E-0032$
 $-C3*R4*C19*Y14*Y11*Y15*L5*Y8*R20*C22*L6 - 1.980000000000000E-0032$
 $-C3*L2*Y14*C19*C18*R20*R17*Y16*C22 - 1.600000000000000E-0032$
 $+C3*L2*Y14*Y11*Y15*C10*C18*L7*R17 + 1.584000000000000E-0032$
 $+C3*L2*Y11*C19*Y14*L7*R17*Y16*C10 + 1.584000000000000E-0032$
 $+C3*R4*L2*Y14*Y11*Y15*C10*C22*C18*R20*R17 + 1.584000000000000E-0032$
 $+C3*L2*Y14*Y11*Y15*C10*L7*R17*C22 + 1.584000000000000E-0032$
 $+C3*R4*C19*Y14*Y11*Y15*L5*C10*R20*R17*C22 + 1.584000000000000E-0032$
 $+C3*R4*Y14*Y11*Y15*L6*C18*L7*C22 + 1.584000000000000E-0032$
 $+C3*R4*Y14*Y11*Y15*L5*C10*C18*L7 + 1.584000000000000E-0032$
 $+C3*R4*Y14*Y11*Y15*L5*C10*L7*C22 + 1.584000000000000E-0032$
 $+Y14*Y11*Y15*L5*C10*C18*C22*R20*L7 + 1.584000000000000E-0032$
 $+R4*C19*Y14*Y11*Y15*L6*C18*C22*L21 + 1.584000000000000E-0032$
 $-C3*L2*Y14*Y11*Y15*L5*Y8*L7*C22 - 1.320000000000000E-0032$
 $+Y14*Y11*Y15*L5*C18*R20*C22*C10*L6 + 1.188000000000000E-0032$
 $+Y11*Y15*C19*Y14*L6*C10*R20*L7*C22 + 1.188000000000000E-0032$
 $+C3*R4*C19*Y14*Y11*Y15*L6*C10*L7 + 1.188000000000000E-0032$
 $+C3*R4*Y14*Y11*Y15*L5*L6*C10*C22 + 1.188000000000000E-0032$
 $+C3*R4*Y14*Y11*Y15*L5*L6*C10*C18 + 1.188000000000000E-0032$
 $+C3*L2*Y14*Y11*Y15*C18*L7*R17*C22 + 1.056000000000000E-0032$
 $+C3*L2*Y11*C19*Y14*Y16*R17*C18*L7 + 1.056000000000000E-0032$
 $+C3*R4*C19*Y14*Y11*Y15*L5*C22*C18*R20*R17 + 1.056000000000000E-0032$
 $+C3*R4*Y14*Y11*Y15*L5*C18*L7*C22 + 1.056000000000000E-0032$
 $+C3*R4*C19*Y14*Y11*Y15*L7*C22*L21 + 1.056000000000000E-0032$
 $+C3*R4*Y14*Y11*Y15*L5*C18*C22*L21 + 1.056000000000000E-0032$
 $+C3*L2*C19*Y15*Y14*L5*Y8*R20*C22 + 1.000000000000000E-0032$
 $-C3*L2*C19*Y14*Y11*Y15*L6*L7*Y8 - 9.900000000000000E-0033$
 $-C3*L2*Y14*Y11*Y15*L5*Y8*C22*L6 - 9.900000000000000E-0033$
 $-C3*R4*L2*C19*Y14*Y11*Y15*Y8*R20*C22*L6 - 9.900000000000000E-0033$
 $+C3*L2*Y15*Y14*C18*L7*C22 + 8.000000000000000E-0033$
 $+C3*L2*Y14*Y11*Y15*L5*C10*C18*R17 + 7.920000000000000E-0033$
 $+C3*L2*Y14*Y11*Y15*L5*C10*R17*C22 + 7.920000000000000E-0033$
 $+C3*R4*L2*C19*Y14*Y11*Y15*C10*R20*R17*C22 + 7.920000000000000E-0033$
 $+C3*L2*C19*Y14*Y11*Y15*L7*R17*C10 + 7.920000000000000E-0033$
 $+C3*R4*Y14*Y11*Y15*L5*L6*C18*C22 + 7.920000000000000E-0033$
 $+C3*R4*L2*Y14*Y11*Y15*C10*C18*L7 + 7.920000000000000E-0033$
 $+Y11*Y15*C19*Y14*L6*C18*C22*R20*L7 + 7.920000000000000E-0033$
 $+C3*R4*L2*Y14*Y11*Y15*C10*L7*C22 + 7.920000000000000E-0033$
 $+Y11*Y15*C19*Y14*L5*C10*R20*L7*C22 + 7.920000000000000E-0033$
 $+C3*R4*C19*Y14*Y11*Y15*L5*C10*L7 + 7.920000000000000E-0033$

+C3*R4*C19*Y14*Y11*Y15*L6*C18*L7 + 7.920000000000000E-0033
 -C3*L2*C19*Y14*Y11*Y15*L5*Y8*L7 - 6.600000000000000E-0033
 +C3*R4*L2*Y14*Y11*Y15*L6*C10*C18 + 5.940000000000000E-0033
 +C3*R4*C19*Y14*Y11*Y15*L5*C10*L6 + 5.940000000000000E-0033
 +Y11*Y15*C19*Y14*L5*L6*R20*C22*C10 + 5.940000000000000E-0033
 +C3*R4*L2*Y14*Y11*Y15*L6*C10*C22 + 5.940000000000000E-0033
 +C3*R4*L2*C19*Y14*Y11*Y15*C22*C18*R20*R17 + 5.280000000000000E-0033
 +C3*L2*C19*Y14*Y11*Y15*C18*L7*R17 + 5.280000000000000E-0033
 +Y11*Y15*C19*Y14*L5*C18*C22*R20*L7 + 5.280000000000000E-0033
 +C3*L2*Y14*Y11*Y15*L5*C18*R17*C22 + 5.280000000000000E-0033
 +C3*R4*C19*Y14*Y11*Y15*L5*L21*C22 + 5.280000000000000E-0033
 +C3*R4*L2*Y14*Y11*Y15*C18*L7*C22 + 5.280000000000000E-0033
 +C3*R4*L2*Y14*Y11*Y15*C18*C22*L21 + 5.280000000000000E-0033
 +C3*R4*C19*Y14*Y11*Y15*L5*C18*L7 + 5.280000000000000E-0033
 -C3*L2*C19*Y14*Y11*Y15*L5*Y8*L6 - 4.950000000000000E-0033
 +C3*L2*C19*Y15*Y14*C18*L7 + 4.000000000000000E-0033
 +C3*L2*C19*Y14*Y11*Y15*L5*R17*C10 + 3.960000000000000E-0033
 +C3*R4*L2*C19*Y14*Y11*Y15*C10*L7 + 3.960000000000000E-0033
 +Y11*Y15*C19*Y14*L5*L6*C18*R20*C22 + 3.960000000000000E-0033
 +C3*R4*L2*Y14*Y11*Y15*L6*C18*C22 + 3.960000000000000E-0033
 +C3*R4*C19*Y14*Y11*Y15*L5*L6*C18 + 3.960000000000000E-0033
 +C3*R4*L2*C19*Y14*Y11*Y15*C10*L6 + 2.970000000000000E-0033
 +C3*L2*C19*Y14*Y11*Y15*L5*C18*R17 + 2.640000000000000E-0033
 +C3*R4*L2*C19*Y14*Y11*Y15*C18*L7 + 2.640000000000000E-0033
 +C3*L2*Y14*Y11*Y15*C18*C22*R20*L7 + 2.640000000000000E-0033
 +C3*R4*L2*C19*Y14*Y11*Y15*L21*C22 + 2.640000000000000E-0033
 +C3*R4*L2*C19*Y14*Y11*Y15*L6*C18 + 1.980000000000000E-0033
 +C3*L2*Y14*Y11*Y15*L5*C18*R20*C22 + 1.320000000000000E-0033
 +C3*L2*C19*Y14*Y11*Y15*R20*L7*C22 + 1.320000000000000E-0033
 +C3*L2*C19*Y14*Y11*Y15*L5*R20*C22 + 6.600000000000000E-0034
)*s^4

+(

 +Y13*L7*C22*C18*R17*Y16*C10 + 9.600000000000000E-0025
 -Y13*Y15*L6*C10*L7*C22*Y8 - 9.000000000000000E-0025
 +Y13*C22*C18*R17*Y16*C10*L6 + 7.200000000000000E-0025
 -Y13*Y15*L5*Y8*C10*L7*C22 - 6.000000000000000E-0025
 +Y13*Y15*C18*L7*R17*C22*C10 + 4.800000000000000E-0025
 -Y13*Y15*L5*Y8*L6*C10*C22 - 4.500000000000000E-0025
 -Y14*C19*R20*R17*Y16*C22*C10*L6*Y8 - 3.600000000000000E-0025
 -C3*R4*Y11*Y13*C22*L7*R17*Y16*C10 - 3.168000000000000E-0025

$-C3*R4*Y11*Y13*L7*C22*C18*R17*Y16 - 2.112000000000000E-0025$
 $+C3*R4*Y13*Y11*Y15*L7*C22*L6*Y8 + 1.980000000000000E-0025$
 $+Y15*Y14*L6*C10*L7*C22*Y8 + 1.800000000000000E-0025$
 $-C3*R4*Y13*Y11*Y15*C10*L7*R17*C22 - 1.584000000000000E-0025$
 $+C3*R4*Y13*Y11*Y15*L5*Y8*L7*C22 + 1.320000000000000E-0025$
 $+Y15*Y14*L5*Y8*C10*L7*C22 + 1.200000000000000E-0025$
 $+C19*Y15*Y14*L5*Y8*C10*R20*R17*C22 + 1.200000000000000E-0025$
 $-C3*R4*Y13*Y11*Y15*C18*L7*R17*C22 - 1.056000000000000E-0025$
 $+C3*R4*Y13*Y11*Y15*L5*Y8*C22*L6 + 9.900000000000000E-0026$
 $+C19*Y15*Y14*L6*C10*L7*Y8 + 9.000000000000000E-0026$
 $+Y15*Y14*L5*Y8*L6*C10*C22 + 9.000000000000000E-0026$
 $+C3*L2*Y13*C22*C18*R17*Y16 + 8.000000000000000E-0026$
 $-C3*R4*Y13*Y11*Y15*L5*C10*R17*C22 - 7.920000000000000E-0026$
 $-Y14*C19*L21*C22*C18*R17*Y16 - 6.400000000000000E-0026$
 $+Y11*Y14*C18*C22*R20*C10*L7*Y16*R17 + 6.336000000000000E-0026$
 $+C3*R4*Y11*Y14*C22*L7*R17*Y16*C10 + 6.336000000000000E-0026$
 $+C3*R4*Y11*Y14*C10*Y16*R17*C18*L7 + 6.336000000000000E-0026$
 $+R4*Y14*Y11*Y15*C10*C18*R17*C22*L21 + 6.336000000000000E-0026$
 $+C19*Y15*Y14*L5*Y8*C10*L7 + 6.000000000000000E-0026$
 $-Y13*Y11*Y15*L6*C10*L7*C22 - 5.940000000000000E-0026$
 $-C3*R4*Y13*Y11*Y15*L5*C18*R17*C22 - 5.280000000000000E-0026$
 $-C3*L2*Y13*Y15*C22*Y8*L5 - 5.000000000000000E-0026$
 $+C3*R4*L2*Y13*Y11*Y15*Y8*C22*L6 + 4.950000000000000E-0026$
 $+C19*Y15*Y14*L5*Y8*C10*L6 + 4.500000000000000E-0026$
 $+C3*R4*Y11*Y14*L7*C22*C18*R17*Y16 + 4.224000000000000E-0026$
 $+C19*Y15*Y14*L5*Y8*L21*C22 + 4.000000000000000E-0026$
 $-C3*R4*L2*Y13*Y11*Y15*C10*R17*C22 - 3.960000000000000E-0026$
 $-Y13*Y11*Y15*L5*C10*L7*C22 - 3.960000000000000E-0026$
 $-R4*C19*Y14*Y11*Y15*Y8*L21*C22*L6 - 3.960000000000000E-0026$
 $-C3*R4*Y14*Y11*Y15*L7*C22*L6*Y8 - 3.960000000000000E-0026$
 $+C3*R4*Y11*C19*Y14*L7*R17*Y16*C10 + 3.168000000000000E-0026$
 $+Y11*C19*Y14*R20*L7*R17*Y16*C22*C10 + 3.168000000000000E-0026$
 $+Y14*Y11*Y15*R20*C18*L7*R17*C22*C10 + 3.168000000000000E-0026$
 $+C3*R4*Y14*Y11*Y15*C10*C18*L7*R17 + 3.168000000000000E-0026$
 $+C3*R4*Y14*Y11*Y15*C10*L7*R17*C22 + 3.168000000000000E-0026$
 $+R4*C19*Y14*Y11*Y15*C10*R17*C22*L21 + 3.168000000000000E-0026$
 $-Y13*Y11*Y15*L5*L6*C10*C22 - 2.970000000000000E-0026$
 $-C3*R4*L2*Y13*Y11*Y15*C18*R17*C22 - 2.640000000000000E-0026$
 $-C3*R4*Y14*Y11*Y15*L5*Y8*L7*C22 - 2.640000000000000E-0026$
 $+C3*R4*Y14*Y11*Y15*C18*L7*R17*C22 + 2.112000000000000E-0026$

+C3*R4*Y11*C19*Y14*Y16*R17*C18*L7 + 2.11200000000000E-0026
 +R4*C19*Y14*Y11*Y15*C18*R17*C22*L21 + 2.11200000000000E-0026
 +Y11*C19*Y14*C22*R20*L7*C18*R17*Y16 + 2.11200000000000E-0026
 -C3*R4*C19*Y14*Y11*Y15*L6*L7*Y8 - 1.98000000000000E-0026
 -Y11*Y15*C19*Y14*R20*L7*C22*L6*Y8 - 1.98000000000000E-0026
 -C3*R4*Y14*Y11*Y15*L5*Y8*C22*L6 - 1.98000000000000E-0026
 -C3*L2*Y14*C22*C18*R17*Y16 - 1.60000000000000E-0026
 +Y11*Y15*C19*Y14*R20*L7*R17*C22*C10 + 1.58400000000000E-0026
 +C3*R4*Y14*Y11*Y15*L5*C10*C18*R17 + 1.58400000000000E-0026
 +R4*Y14*Y11*Y15*C10*C18*C22*R20*L7 + 1.58400000000000E-0026
 +C3*R4*C19*Y14*Y11*Y15*L7*R17*C10 + 1.58400000000000E-0026
 +C3*R4*Y14*Y11*Y15*L5*C10*R17*C22 + 1.58400000000000E-0026
 +Y14*Y11*Y15*L5*C10*C22*C18*R20*R17 + 1.58400000000000E-0026
 -C3*R4*C19*Y14*Y11*Y15*L5*Y8*L7 - 1.32000000000000E-0026
 -Y11*Y15*C19*Y14*L5*Y8*R20*L7*C22 - 1.32000000000000E-0026
 +Y14*Y11*Y15*L6*C10*L7*C22 + 1.18800000000000E-0026
 +Y14*Y11*Y15*L6*C10*C18*L7 + 1.18800000000000E-0026
 +R4*Y14*Y11*Y15*C18*R20*C22*C10*L6 + 1.18800000000000E-0026
 +C3*R4*C19*Y14*Y11*Y15*C18*L7*R17 + 1.05600000000000E-0026
 +Y11*Y15*C19*Y14*R20*C18*L7*R17*C22 + 1.05600000000000E-0026
 +Y14*Y11*Y15*L21*C22*C18*L7 + 1.05600000000000E-0026
 +C3*R4*Y14*Y11*Y15*L5*C18*R17*C22 + 1.05600000000000E-0026
 +C3*L2*Y15*Y14*C22*Y8*L5 + 1.00000000000000E-0026
 -Y11*Y15*C19*Y14*L5*Y8*R20*C22*L6 - 9.90000000000000E-0027
 -C3*R4*C19*Y14*Y11*Y15*L5*Y8*L6 - 9.90000000000000E-0027
 -C3*R4*L2*Y14*Y11*Y15*Y8*C22*L6 - 9.90000000000000E-0027
 -C3*L2*Y14*C19*C18*R17*Y16 - 8.00000000000000E-0027
 +C19*Y15*Y14*C18*C22*R20*L7 + 8.00000000000000E-0027
 +Y11*Y15*C19*Y14*L5*C10*R20*R17*C22 + 7.92000000000000E-0027
 +Y14*Y11*Y15*L6*C18*L7*C22 + 7.92000000000000E-0027
 +C3*R4*L2*Y14*Y11*Y15*C10*R17*C22 + 7.92000000000000E-0027
 +C3*R4*L2*Y14*Y11*Y15*C10*C18*R17 + 7.92000000000000E-0027
 +R4*C19*Y14*Y11*Y15*C10*R20*L7*C22 + 7.92000000000000E-0027
 +C3*R4*C19*Y14*Y11*Y15*L5*R17*C10 + 7.92000000000000E-0027
 +Y14*Y11*Y15*L5*C10*L7*C22 + 7.92000000000000E-0027
 +Y14*Y11*Y15*L5*C10*C18*L7 + 7.92000000000000E-0027
 -C3*L2*Y13*Y11*Y15*L7*C22 - 6.60000000000000E-0027
 +Y11*Y15*C19*Y14*L6*C10*L7 + 5.94000000000000E-0027
 +R4*C19*Y14*Y11*Y15*L6*R20*C22*C10 + 5.94000000000000E-0027
 +Y14*Y11*Y15*L5*L6*C10*C22 + 5.94000000000000E-0027

+Y14*Y11*Y15*L5*L6*C10*C18 + 5.940000000000000E-0027
 +R4*C19*Y14*Y11*Y15*C18*C22*R20*L7 + 5.280000000000000E-0027
 +Y14*Y11*Y15*L5*C18*C22*L21 + 5.280000000000000E-0027
 +C3*R4*Y14*Y11*Y15*C18*C22*R20*L7 + 5.280000000000000E-0027
 +Y11*Y15*C19*Y14*L7*C22*L21 + 5.280000000000000E-0027
 +Y11*Y15*C19*Y14*L5*C22*C18*R20*R17 + 5.280000000000000E-0027
 +Y14*Y11*Y15*L5*C18*L7*C22 + 5.280000000000000E-0027
 +C3*R4*C19*Y14*Y11*Y15*L5*C18*R17 + 5.280000000000000E-0027
 +C3*R4*L2*Y14*Y11*Y15*C18*R17*C22 + 5.280000000000000E-0027
 +C3*L2*C19*Y15*Y14*Y8*L5 + 5.000000000000000E-0027
 -C3*R4*L2*C19*Y14*Y11*Y15*Y8*L6 - 4.950000000000000E-0027
 +C3*R4*L2*C19*Y14*Y11*Y15*R17*C10 + 3.960000000000000E-0027
 +Y11*Y15*C19*Y14*L5*C10*L7 + 3.960000000000000E-0027
 +R4*C19*Y14*Y11*Y15*L6*C18*R20*C22 + 3.960000000000000E-0027
 +Y14*Y11*Y15*L5*L6*C18*C22 + 3.960000000000000E-0027
 +Y11*Y15*C19*Y14*L6*C18*L7 + 3.960000000000000E-0027
 -C3*L2*Y13*Y11*Y15*C22*L5 - 3.300000000000000E-0027
 +Y11*Y15*C19*Y14*L5*C10*L6 + 2.970000000000000E-0027
 +Y11*Y15*C19*Y14*L5*C18*L7 + 2.640000000000000E-0027
 +C3*R4*C19*Y14*Y11*Y15*R20*L7*C22 + 2.640000000000000E-0027
 +Y11*Y15*C19*Y14*L5*L21*C22 + 2.640000000000000E-0027
 +C3*R4*L2*C19*Y14*Y11*Y15*C18*R17 + 2.640000000000000E-0027
 +C3*R4*Y14*Y11*Y15*L5*C18*R20*C22 + 2.640000000000000E-0027
 +Y11*Y15*C19*Y14*L5*L6*C18 + 1.980000000000000E-0027
 +C3*L2*Y14*Y11*Y15*L7*C22 + 1.320000000000000E-0027
 +C3*L2*Y14*Y11*Y15*C18*L7 + 1.320000000000000E-0027
 +C3*R4*L2*Y14*Y11*Y15*C18*R20*C22 + 1.320000000000000E-0027
 +C3*R4*C19*Y14*Y11*Y15*L5*R20*C22 + 1.320000000000000E-0027
 +C3*R4*L2*C19*Y14*Y11*Y15*R20*C22 + 6.600000000000000E-0028
 +C3*L2*C19*Y14*Y11*Y15*L7 + 6.600000000000000E-0028
 +C3*L2*Y14*Y11*Y15*C18*L5 + 6.600000000000000E-0028
 +C3*L2*Y14*Y11*Y15*C22*L5 + 6.600000000000000E-0028
 +C3*L2*C19*Y14*Y11*Y15*L5 + 3.300000000000000E-0028
)*s^3
 +(
 +Y13*Y16*R17*C22*C10*L6*Y8 + 1.800000000000000E-0018
 -Y13*Y15*C10*R17*C22*Y8*L5 - 6.000000000000000E-0019
 -Y14*Y16*R17*C22*C10*L6*Y8 - 3.600000000000000E-0019
 -Y14*C19*Y16*R17*C10*L6*Y8 - 1.800000000000000E-0019
 -Y11*Y13*C22*C10*L7*R17*Y16 - 1.584000000000000E-0019

+Y15*Y14*C10*R17*C22*Y8*L5 + 1.200000000000000E-0019
 -Y11*Y13*C18*L7*C22*R17*Y16 - 1.056000000000000E-0019
 +Y13*Y11*Y15*L7*C22*L6*Y8 + 9.900000000000000E-0020
 -Y13*Y11*Y15*C10*L7*R17*C22 - 7.920000000000000E-0020
 +Y13*Y11*Y15*L5*Y8*L7*C22 + 6.600000000000000E-0020
 +C19*Y15*Y14*L5*Y8*R17*C10 + 6.000000000000000E-0020
 -Y13*Y11*Y15*C18*L7*R17*C22 - 5.280000000000000E-0020
 +Y13*Y11*Y15*L5*Y8*C22*L6 + 4.950000000000000E-0020
 -R4*Y13*Y11*Y15*C10*L7*C22 - 3.960000000000000E-0020
 -Y13*Y11*Y15*L5*C10*R17*C22 - 3.960000000000000E-0020
 +Y11*Y14*C22*C10*L7*R17*Y16 + 3.168000000000000E-0020
 +Y11*Y14*C18*C10*L7*Y16*R17 + 3.168000000000000E-0020
 -R4*Y13*Y11*Y15*L6*C10*C22 - 2.970000000000000E-0020
 -Y13*Y11*Y15*L5*C18*R17*C22 - 2.640000000000000E-0020
 -Y14*Y11*Y15*L7*C22*L6*Y8 - 1.980000000000000E-0020
 -Y14*C19*C18*R20*R17*Y16*C22 - 1.600000000000000E-0020
 +Y11*C19*Y14*L7*R17*Y16*C10 + 1.584000000000000E-0020
 +Y14*Y11*Y15*C10*C18*L7*R17 + 1.584000000000000E-0020
 +Y14*Y11*Y15*C10*L7*R17*C22 + 1.584000000000000E-0020
 +R4*Y14*Y11*Y15*C10*C22*C18*R20*R17 + 1.584000000000000E-0020
 -C3*R4*Y13*Y11*Y15*L7*C22 - 1.320000000000000E-0020
 -Y14*Y11*Y15*L5*Y8*L7*C22 - 1.320000000000000E-0020
 +Y14*Y11*Y15*C18*L7*R17*C22 + 1.056000000000000E-0020
 +Y11*C19*Y14*L7*C18*R17*Y16 + 1.056000000000000E-0020
 +C19*Y15*Y14*L5*Y8*R20*C22 + 1.000000000000000E-0020
 -R4*C19*Y14*Y11*Y15*Y8*R20*C22*L6 - 9.900000000000000E-0021
 -Y14*Y11*Y15*L5*Y8*C22*L6 - 9.900000000000000E-0021
 -Y11*Y15*C19*Y14*L6*L7*Y8 - 9.900000000000000E-0021
 +Y15*Y14*C18*L7*C22 + 8.000000000000000E-0021
 +R4*Y14*Y11*Y15*C10*C18*L7 + 7.920000000000000E-0021
 +Y11*Y15*C19*Y14*L7*R17*C10 + 7.920000000000000E-0021
 +Y14*Y11*Y15*L5*C10*C18*R17 + 7.920000000000000E-0021
 +Y14*Y11*Y15*L5*C10*R17*C22 + 7.920000000000000E-0021
 +R4*C19*Y14*Y11*Y15*C10*R20*R17*C22 + 7.920000000000000E-0021
 +R4*Y14*Y11*Y15*C10*L7*C22 + 7.920000000000000E-0021
 -C3*R4*Y13*Y11*Y15*C22*L5 - 6.600000000000000E-0021
 -Y11*Y15*C19*Y14*L5*Y8*L7 - 6.600000000000000E-0021
 +R4*Y14*Y11*Y15*L6*C10*C22 + 5.940000000000000E-0021
 +R4*Y14*Y11*Y15*L6*C10*C18 + 5.940000000000000E-0021
 +Y14*Y11*Y15*L5*C18*R17*C22 + 5.280000000000000E-0021

+R4*C19*Y14*Y11*Y15*C22*C18*R20*R17 + 5.280000000000000E-0021
 +R4*Y14*Y11*Y15*C18*C22*L21 + 5.280000000000000E-0021
 +Y11*Y15*C19*Y14*C18*L7*R17 + 5.280000000000000E-0021
 +R4*Y14*Y11*Y15*C18*L7*C22 + 5.280000000000000E-0021
 -Y11*Y15*C19*Y14*L5*Y8*L6 - 4.950000000000000E-0021
 +C19*Y15*Y14*C18*L7 + 4.000000000000000E-0021
 +R4*C19*Y14*Y11*Y15*C10*L7 + 3.960000000000000E-0021
 +Y11*Y15*C19*Y14*L5*R17*C10 + 3.960000000000000E-0021
 +R4*Y14*Y11*Y15*L6*C18*C22 + 3.960000000000000E-0021
 -C3*R4*L2*Y13*Y11*Y15*C22 - 3.300000000000000E-0021
 +R4*C19*Y14*Y11*Y15*C10*L6 + 2.970000000000000E-0021
 +Y11*Y15*C19*Y14*L5*C18*R17 + 2.640000000000000E-0021
 +R4*C19*Y14*Y11*Y15*C22*L21 + 2.640000000000000E-0021
 +R4*C19*Y14*Y11*Y15*C18*L7 + 2.640000000000000E-0021
 +Y14*Y11*Y15*C18*C22*R20*L7 + 2.640000000000000E-0021
 +C3*R4*Y14*Y11*Y15*C18*L7 + 2.640000000000000E-0021
 +C3*R4*Y14*Y11*Y15*L7*C22 + 2.640000000000000E-0021
 +R4*C19*Y14*Y11*Y15*L6*C18 + 1.980000000000000E-0021
 +Y14*Y11*Y15*L5*C18*R20*C22 + 1.320000000000000E-0021
 +C3*R4*Y14*Y11*Y15*C18*L5 + 1.320000000000000E-0021
 +C3*R4*Y14*Y11*Y15*C22*L5 + 1.320000000000000E-0021
 +Y11*Y15*C19*Y14*R20*L7*C22 + 1.320000000000000E-0021
 +C3*R4*C19*Y14*Y11*Y15*L7 + 1.320000000000000E-0021
 +Y11*Y15*C19*Y14*L5*R20*C22 + 6.600000000000000E-0022
 +C3*R4*L2*Y14*Y11*Y15*C22 + 6.600000000000000E-0022
 +C3*R4*C19*Y14*Y11*Y15*L5 + 6.600000000000000E-0022
 +C3*R4*L2*Y14*Y11*Y15*C18 + 6.600000000000000E-0022
 +C3*R4*L2*C19*Y14*Y11*Y15 + 3.300000000000000E-0022
)*s^2
 +(
 +Y13*C22*C18*R17*Y16 + 8.000000000000000E-0014
 -Y13*Y15*C22*Y8*L5 - 5.000000000000000E-0014
 +R4*Y13*Y11*Y15*Y8*C22*L6 + 4.950000000000000E-0014
 -R4*Y13*Y11*Y15*C10*R17*C22 - 3.960000000000000E-0014
 -R4*Y13*Y11*Y15*C18*R17*C22 - 2.640000000000000E-0014
 -Y14*C22*C18*R17*Y16 - 1.600000000000000E-0014
 +Y15*Y14*C22*Y8*L5 + 1.000000000000000E-0014
 -R4*Y14*Y11*Y15*Y8*C22*L6 - 9.900000000000000E-0015
 -Y14*C19*C18*R17*Y16 - 8.000000000000000E-0015
 +R4*Y14*Y11*Y15*C10*C18*R17 + 7.920000000000000E-0015

```

+R4*Y14*Y11*Y15*C10*R17*C22 + 7.920000000000000E-0015
-Y11*L7*C22*Y13*Y15 - 6.600000000000000E-0015
+R4*Y14*Y11*Y15*C18*R17*C22 + 5.280000000000000E-0015
+C19*Y15*Y14*Y8*L5 + 5.000000000000000E-0015
-R4*C19*Y14*Y11*Y15*Y8*L6 - 4.950000000000000E-0015
+R4*C19*Y14*Y11*Y15*C10*R17 + 3.960000000000000E-0015
-Y13*Y11*Y15*C22*L5 - 3.300000000000000E-0015
+R4*C19*Y14*Y11*Y15*C18*R17 + 2.640000000000000E-0015
+Y11*L7*Y14*C22*Y15 + 1.320000000000000E-0015
+R4*Y14*Y11*Y15*C18*R20*C22 + 1.320000000000000E-0015
+C18*Y11*L7*Y14*Y15 + 1.320000000000000E-0015
+Y11*L7*Y14*C19*Y15 + 6.600000000000000E-0016
+Y14*Y11*Y15*C18*L5 + 6.600000000000000E-0016
+Y14*Y11*Y15*C22*L5 + 6.600000000000000E-0016
+R4*C19*Y14*Y11*Y15*R20*C22 + 6.600000000000000E-0016
+C19*Y14*Y11*Y15*L5 + 3.300000000000000E-0016
)*s
-R4*Y13*Y11*Y15*C22 - 3.300000000000000E-0009
+R4*Y14*Y11*Y15*C22 + 6.600000000000000E-0010
+R4*Y14*Y11*Y15*C18 + 6.600000000000000E-0010
+R4*C19*Y14*Y11*Y15 + 3.300000000000000E-0010
));

```

3. Concluzii

În proiectarea circuitelor electrice și electronice, adesea, este mai convenabil ca laturile circuitului să fie descrise prin șiruri de simboluri, iar rezultatul analizei să fie obținut sub forma unei expresii algebrice depinzând de timp sau frecvență și de parametri simbolici ai circuitului. Această informație stă la baza optimizării asistate de calculator a acestor circuite, în raport cu performanțele urmărite, oferind posibilitatea obținerii unei imagini de ansamblu asupra comportării circuitului, a controlului erorilor, a evaluării sensibilităților în scopul îmbunătățirii unor topologii de circuite.

Analiza simbolică a circuitelor electrice și electronice este, deci, o metodă formală de determinare a comportării unui circuit, variabilele independente fiind timpul sau frecvența, iar elementele circuitului fiind reprezentate, în totalitate sau numai parțial, prin simboluri. Tehnica simbolică de simulare a circuitelor electrice și electronice este complementară analizei numerice, unde variabilele și elementele de circuit fiind reprezentate prin numere. În cazul circuitelor liniare, invariante în timp, cu parametri concentrați, analiza simbolică generează ecuațiile circuitului în formă simbolică și funcțiile de circuit (de transfer) în formă simbolică sau parțial simbolică.

Pentru generarea de modele analitice și evaluări repetate ale caracteristicilor este nevoie de forma simbolică a funcțiilor de circuit, deoarece cu ajutorul sensibilităților funcțiilor de circuit raportată la diferiți parametri se pot studia performanțele circuitului la variația valorilor acestor parametri, nefiind necesară recalcularea de fiecare dată a circuitului.

Pentru circuite complexe aceste funcții de circuit sunt de dimensiuni mari (număr mare de termeni) și sunt greu de urmărit și de interpretat. O sortare a termenilor din numărătorul și numitorul funcției de circuit permite o vizualizare adecvată și ușurează modul de simplificare al acestor funcții prin eliminarea unor termeni mai puțin semnificativi cu pondere mică.

Bibliografie

1. **IORDACHE, M., L. DUMITRIU:** Simularea asistată de calculator a circuitelor analogice, Editura Politehnica Press, București 2002.
2. **IORDACHE, M., M. PERPELEA:** Analiza asistată de calculator a circuitelor electrice și electronice neliniare complexe de mari dimensiuni, Editura Didactică și Pedagogică, București, 1995.
3. **DUMITRIU, L., M. IORDACHE:** Teoria modernă a circuitelor electrice - Vol. I - Fundamentare teoretică, Aplicații, Algoritmi și Programe de calcul, Editura All Educational S.A., București 1998.
4. **IORDACHE, M., L. DUMITRIU:** Teoria modernă a circuitelor electrice - Vol. II - Fundamentare teoretică, Aplicații, Algoritmi și Programe de calcul, Editura All Educational S.A., București 2000.