Oscilator sa faznim pomerajem, izvodjenje

sistem jednacina po potencijalima cvorova

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(%i1) e1: v1=vin;
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$$(\%o1)\quad v1 = vin$$

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(%i2) e2: -Y*v1 + (1/R+2*Y)*v2 - Y*v3 = 0;
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$$(\%o2)\quad v2\left(2\,Y+\frac{1}{R}\right) - v3\,Y - v1\,Y = 0$$

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(%i3) e3: -v2*Y + v3*(2*Y+1/R) - Y*vout = 0;
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$$(\%o3)\quad v3\left(2\,Y+\frac{1}{R}\right) - vout\,Y - v2\,Y = 0$$

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(%i4) e4: -v3*Y + vout*(1/R + Y) = 0;
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$$(\%o4)\quad vout\left(Y+\frac{1}{R}\right) - v3\,Y = 0$$

eliminacija

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(%i5) sol: eliminate([e1, e2, e3, e4], [v1, v2, v3]);
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$$(\%o5)\quad \left[-\left(vout - vin\right)R^3\,Y^3 - 6\,vout\,R^2\,Y^2 - 5\,vout\,R\,Y - vout\right]$$

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(%i6) sol: sol[1];
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$$(\%o6)\quad -\left(vout - vin\right)R^3\,Y^3 - 6\,vout\,R^2\,Y^2 - 5\,vout\,R\,Y - vout$$

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(%i7) sol: subst(s*C, Y, sol);
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$$(\%o7)\quad -s^3\left(vout - vin\right)C^3\,R^3 - 6\,s^2\,vout\,C^2\,R^2 - 5\,s\,vout\,C\,R - vout$$

funkcija prenosa

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(%i8) tf: solve(sol, vout);
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$$(\%o8)\quad \left[vout = \frac{s^3\,vin\,C^3\,R^3}{s^3\,C^3\,R^3 + 6\,s^2\,C^2\,R^2 + 5\,s\,C\,R + 1}\right]$$

(%i9) tf: tf[1];

(%o9) $$vout = \frac{s^3\ vin\ C^3\ R^3}{s^3\ C^3\ R^3 + 6\ s^2\ C^2\ R^2 + 5\ s\ C\ R + 1}$$

FUNKCIJA PRENOSA

(%i10) tf: rhs(tf)/vin;

(%o10) $$\frac{s^3\ C^3\ R^3}{s^3\ C^3\ R^3 + 6\ s^2\ C^2\ R^2 + 5\ s\ C\ R + 1}$$

normalizacija,

NORMALIZOVANA FUNKCIJA PRENOSA

(%i11) tf: subst(s/(R*C), s, tf);

(%o11) $$\frac{s^3}{s^3 + 6\ s^2 + 5\ s + 1}$$

prelaz na jw osu

(%i12) hjw: subst(%i*w, s, tf);

(%o12) $$-\frac{\%i\ w^3}{-\%i\ w^3 - 6\ w^2 + 5\ \%i\ w + 1}$$

(%i13) declare(w, real);

(%o13) *done*

"fazna rezonansa"

(%i14) ihjw: imagpart(hjw);

(%o14) $$-\frac{w^3\left(1 - 6\ w^2\right)}{\left(5\ w - w^3\right)^2 + \left(1 - 6\ w^2\right)^2}$$

(%i15) wr: solve(ihjw, w);

(%o15) $[w=-\frac{1}{\sqrt{6}},w=\frac{1}{\sqrt{6}},w=0]$

FREKVENCIJA OSCILOVANJA, frekvencija "fazne rezonanse"

(%i16) wr: rhs(wr[2]);

(%o16) $\frac{1}{\sqrt{6}}$

(%i17) hjwr: subst(wr, w, hjw);

(%o17) $-\frac{\%i}{6^{3/2}\left(\frac{5\,\%i}{\sqrt{6}}-\frac{\%i}{6^{3/2}}\right)}$

SLABLJENJE BETA MREZE NA FREKVENCIJI OSCILOVANJA

(%i18) hjwr: ratsimp(hjwr);

(%o18) $-\frac{1}{29}$