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Mathematical design and operations of electronic vehicles management and introduction of results of researches in an educational process

Vitalij Ulshin, Victoria Smoliy, Yaroslav Fomyn

Volodymyr Dahl East-Ukrainian National University, Lugansk, Ukraine

S u m m a r y. In work is grounded and is offered mathematical model and transmissions functions of the adjusting system for the process of production of electronic vehicles for the different setting and external environments. Also work is devoted to introduction of the got results in an educational process, namely in the process of teaching of students

K e y w o r d s: management, process of production, electronic vehicle, mathematical model, process of production, channels of influencing, introduction, educational process.

INTRODUCTION

In the modern terms of work of higher educational establishments it is necessary to instill skills of analysis and generalization of the got information to the students. This task can successfully decide within the framework of educational-research work of students. That this work joins in a curriculum is the feature of educational-research work of students, and to the individual jobs processing all students of educational group are brought over. During organization of educational-research work of students it is necessary widely to use possibilities of modern computer technique application of which allows to show out educational-research work of students on a high-quality new level [1].

OBJECTS AND PROBLEMS

The improvement of method of teaching to the students, providing establishment and cooperate to the realized application of mathematical design, is the purpose of researches, to research of transmissions functions of the systems of adjusting, channels of influencing, operator calculation directly for the process of production of electronic vehicles of the different setting and external environments [2].

For the decision of the set problem functional dependence of process of production of block of electronic vehicle of the domestic setting was got as the stochastic model of type [3]:

$$y=3.721*10^{-4}+0.435(0.013+0.895((1.876*10^{-4}+6.167*10^{-3}* x^{<4>}-2.04*10^{-3}* x^{<7>}+5.628*10^{-3*}x^{<4>}*x^{<7>}-2.317*$$
$$*10^{-3}*(x^{<4>})^2+4.873*10^{-4}*(x^{<7>})^2))-0.047((7.897*10^{-6}+7.642*10^{-4}* x^{<3>}-1.171*10^{-3}* x^{<9>}+1.169*10^{-3*} x^{<3>} *$$
$$* x^{<9>}-3.953*10^{-4}*(x^{<3>})^2+9.188*10^{-5}*(x^{<9>})^2))+ 7.427*10^{-3}(1.876*10^{-4}+6.167*10^{-3}* x^{<4>}-2.04*10^{-3}* x^{<7>}+$$
$$+5.628*10^{-3*} x^{<4>} * x^{<7>}-2.317*10^{-3}*(x^{<4>})^2+4.873*10^{-4}*(x^{<7>})^2)(7.897*10^{-6}+7.642*10^{-4}* x^{<3>}-1.171*10^{-3}*$$
$$*x^{<9>}+1.169*10^{-3*} x^{<3>} * x^{<9>}-3.953*10^{-4}*(x^{<3>})^2+9.188*10^{-5}*(x^{<9>})^2)+ 0.317(1.876*10^{-4}+6.167*10^{-3}* x^{<4>}-$$
$$- 2.04*10^{-3}* x^{<7>}+5.628*10^{-3*} x^{<4>} * x^{<7>}-2.317*10^{-3}*(x^{<4>})^2+4.873*10^{-4}*(x^{<7>})^2)^2-0.018(7.897*10^{-6}+7.642*$$
$$*10^{-4}* x^{<3>}-1.171*10^{-3}* x^{<9>}+1.169*10^{-3*} x^{<3>} * x^{<9>}-3.953*10^{-4}*(x^{<3>})^2+9.188*10^{-5}*(x^{<9>})^2)^2)+0.508 (1.459*$$
$$*10^{-5}+5.611*10^{-3}*x^{<4>}+4.329*10^{-3}*x^{<19>}+1.518*10^{-3*}x^{<4>}*x^{<19>}-1.843*10^{-3}*(x^{<4>})^2-4.444*10^{-4}*(x^{<19>})^2)+$$
$$+2.142 *10^{-4}(0.013+0.895((1.876*10^{-4}+6.167*10^{-3}* x^{<4>}-2.04*10^{-3}*x^{<7>}+5.628*10^{-3*} x^{<4>} *x^{<7>}- 2.317*10^{-3}*$$
$$*(x^{<4>})^2+4.873*10^{-4}*(x^{<7>})^2))- 0.047((7.897*10^{-6}+7.642*10^{-4}*x^{<3>}-1.171*10^{-3}*x^{<9>}+1.169*10^{-3}*x^{<3>} *x^{<9>}-$$
$$-3.953*10^{-4}*(x^{<3>})^2+9.188*10^{-5}*(x^{<9>})^2))+7.427*10^{-3}(1.876*10^{-4}+6.167*10^{-3}* x^{<4>}-2.04*10^{-3}* x^{<7>}+5.628*$$
$$*10^{-3*} x^{<4>} * x^{<7>}-2.317*10^{-3}*(x^{<4>})^2+4.873*10^{-4}*(x^{<7>})^2)*(7.897*10^{-6}+7.642*10^{-4}* x^{<3>}-1.171*10^{-3}* x^{<9>}+$$
$$+1.169*10^{-3*} *x^{<3>} * x^{<9>}-3.953*10^{-4}*(x^{<3>})^2+9.188*10^{-5}*(x^{<9>})^2)+ 0.317(1.876*10^{-4}+6.167*10^{-3}* x^{<4>}- 2.04*$$
$$*10^{-3}* x^{<7>}+5.628*10^{-3*} x^{<4>} * x^{<7>}-2.317*10^{-3}*(x^{<4>})^2+4.873*10^{-4}*(x^{<7>})^2)^2-0.018(7.897*10^{-6}+7.642*10^{-4}*$$

$$\begin{gathered}
*x^{\langle 3\rangle}-1.171*10^{-3}*x^{\langle 9\rangle}+1.169*10^{-3*}x^{\langle 3\rangle}*x^{\langle 9\rangle}-3.953*10^{-4}*(x^{\langle 3\rangle})^2+9.188*10^{-5}*(x^{\langle 9\rangle})^2)^2)(1.459*10^{-5}+5.611*\\
*10^{-3}*x^{\langle 4\rangle}+4.329*10^{-3}*x^{\langle 19\rangle}+1.518*10^{-3}**x^{\langle 4\rangle}*x^{\langle 19\rangle}-1.843*10^{-3}**(x^{\langle 4\rangle})^2-4.444*10^{-4}*(x^{\langle 19\rangle})^2)+0.153*\\
*(0.013+0.895((1.876*10^{-4}+6.167*10^{-3}*x^{\langle 4\rangle}-2.04*10^{-3}*x^{\langle 7\rangle}+5.628*x10^{-3*}x^{\langle 4\rangle}*x^{\langle 7\rangle}-2.317*10^{-3}*(x^{\langle 4\rangle})^2+\\
+4.873*10^{-4}*(x^{\langle 7\rangle})^2))-0.047((7.897*10^{-6}+7.642*10^{-4}*x^{\langle 3\rangle}-1.171*10^{-3}**x^{\langle 9\rangle}+1.169*10^{-3*}x^{\langle 3\rangle}*x^{\langle 9\rangle}-3.953*\\
10^{-4}(x^{\langle 3\rangle})^2+9.188*10^{-5}*(x^{\langle 9\rangle})^2))+7.427*10^{-3}(1.876*10^{-4}+6.167*10^{-3}*x^{\langle 4\rangle}-2.04*10^{-3}*x^{\langle 7\rangle}+5.628*10^{-3*}x^{\langle 4\rangle}*\\
*x^{\langle 7\rangle}-2.317*10^{-3}*(x^{\langle 4\rangle})^2+4.873*10^{-4}*(x^{\langle 7\rangle})^2)(7.897*10^{-6}+7.642*10^{-4}*x^{\langle 3\rangle}-1.171*10^{-3}*x^{\langle 9\rangle}+1.169*10^{-3}*x^{\langle 3\rangle}*\\
*x^{\langle 9\rangle}-3.953*10^{-4}*(x^{\langle 3\rangle})^2+9.188*10^{-5}*(x^{\langle 9\rangle})^2)+0.317(1.876*10^{-4}+6.167*10^{-3}*x^{\langle 4\rangle}-2.04*10^{-3}**x^{\langle 7\rangle}+5.628*\\
*10^{-3*}x^{\langle 4\rangle}*x^{\langle 7\rangle}-2.317*10^{-3}*(x^{\langle 4\rangle})^2+4.873*10^{-4}*(x^{\langle 7\rangle})^2)^2-0.018*(7.897*10^{-6}+7.642*10^{-4}*x^{\langle 3\rangle}-1.171*10^{-3}*\\
*x^{\langle 9\rangle}+1.169*10^{-3*}x^{\langle 3\rangle}*x^{\langle 9\rangle}-3.953*10^{-4}*(x^{\langle 3\rangle})^2+9.188*10^{-5}*(x^{\langle 9\rangle})^2)^2)^2+0.161(1.459*10^{-5}+5.611*10^{-3}*x^{\langle 4\rangle}+\\
+4.329*10^{-3}*x^{\langle 19\rangle}+1.518*10^{-3*}x^{\langle 4\rangle}*x^{\langle 19\rangle}-1.843*10^{-3}*(x^{\langle 4\rangle})^2-4.444*10^{-4}*(x^{\langle 19\rangle})^2)^2. \qquad (1)
\end{gathered}$$

All coefficients at variables in (1) is determined in accordance with the selection of applicants by the method of group account of argument [4, 6, 11].

Examining the got type of model, it is necessary to estimate its sensitiveness on the explored channels, signals on the other channels we suppose equal to the zero. At the same time we determine Laplas's transformation for the subsequent receipt of transmission function on the explored channel of influencing [9, 10].

After transformation [14, 16], adduction of similar and simplifications (1) for a channel x3 the following model of influencing was got:

$$\begin{gathered}
y_{x3\rightarrow y}=6.1339*10^{-3}-1.5768*10^{-5}*x3+8.1522*\\
*10^{-6}*x3^2+4.5704*10^{-9}*x3^3-\\
-1.1822*10^{-9}*x3^4+9.2704*10^{-14}*x3^5-\\
-1.5963*10^{-14}*x3^6-9.3602*10^{-18}*x3^7+\\
+1.2104*10^{-18}*x3^8. \qquad (2)
\end{gathered}$$

Laplas's transformation for (2) looks like:

$$\begin{gathered}
L\{y_{x3\rightarrow y}\}=6.1339*10^{-3}*1/s-1.5768*10^{-5}*1/s^2+\\
+1.6304*10^{-5}*1/s^3+2.7423*10^{-8}*1/s^4-\\
-2.8374*10^{-8}*1/s^5+1.1125*10^{-11}*1/s^6-\\
-1.1494*10^{-11}*1/s^7-4.7175*10^{-14}*1/s^8+\\
+4.8805*10^{-14}*1/s^9. \qquad (3)
\end{gathered}$$

For a channel x4 the following model of influencing was got:

$$\begin{gathered}
y_{x4\rightarrow y}=6.1339*10^{-3}+5.2739*10^{-3}*x4-1.8318*\\
*10^{-3}*x4^2-1.0795*10^{-5}*x4^3+\\
+1.930*10^{-6}*x4^4+8.5962*10^{-9}*x4^5-1.0619*\\
*10^{-9}*x4^6-4.7176*10^{-12}*x4^7+\\
+4.4311*10^{-13}*x4^8. \qquad (4)
\end{gathered}$$

Laplas's transformation for (4) looks like:

$$\begin{gathered}
L\{y_{x4\rightarrow y}\}=6.1339*10^{-3}*1/s+5.2739*10^{-3}*1/s^2-\\
-3.6635*10^{-3}*1/s^3-6.4768*10^{-5}*1/s^4+\\
+4.6320*10^{-5}*1/s^5+1.0315*10^{-6}*1/s^6-\\
-7.6455*10^{-7}*1/s^7-2.3777*10^{-8}*1/s^8+\\
+1.7866*10^{-8}*1/s^9. \qquad (5)
\end{gathered}$$

For a channel x7 the following model of influencing was got:

$$\begin{gathered}
y_{x7\rightarrow y}=6.1339*10^{-3}-8.0169*10^{-4}*x7+1.9259*\\
*10^{-4}*x7^2-5.2117*10^{-7}*x7^3+\\
+6.2687*10^{-8}*x7^4-1.2644*10^{-10}*x7^5+\\
+1.0139*10^{-11}*x7^6-1.4517*10^{-14}*x7^7+\\
+8.6695*10^{-16}*x7^8. \qquad (6)
\end{gathered}$$

Laplas's transformation for (6) looks like:

$$\begin{gathered}
L\{y_{x7\rightarrow y}\}=6.1339*10^{-3}*1/s-8.0169*10^{-4}*1/s^2+\\
+3.8518*10^{-4}*1/s^3-3.1271*10^{-6}*1/s^4+\\
+1.5045*10^{-6}*1/s^5-1.5173*10^{-8}*1/s^6+\\
+7.2997*10^{-9}*1/s^7-7.31678*10^{-11}*1/s^8+\\
+3.4956*10^{-11}*1/s^9. \qquad (7)
\end{gathered}$$

For a channel x9 the following model of influencing was got:

$$\begin{gathered}
y_{x9\rightarrow y}=6.1339*10^{-3}+2.4162*10^{-5}*x9-1.9062*\\
*10^{-6}*x9^2+1.6273*10^{-9}*x9^3-\\
-6.3762*10^{-11}*x9^4-7.7064*10^{-15}*\\
*x9^5+2.0423*10^{-16}*x9^6-1.8011*10^{-19}*x9^7+\\
+3.5328*10^{-21}*x9^8. \qquad (8)
\end{gathered}$$

Laplas's transformation for (8) looks like:

$$\begin{gathered}
L\{y_{x9\rightarrow y}\}=6.1339*10^{-3}*1/s+2.4162*10^{-5}*1/s^2-\\
-3.8124*10^{-6}*1/s^3+9.7641*10^{-9}*1/s^4-\\
-1.5303*10^{-9}*1/s^5-9.2477*10^{-13}*1/s^6+\\
+1.4705*10^{-13}*1/s^7-9.0771*10^{-16}*1/s^8+\\
+1.4244*10^{-16}*1/s^9. \qquad (9)
\end{gathered}$$

For a channel x19 the following model of influencing was got:

$$\begin{gathered}
y_{x19\rightarrow y}=6.1339*10^{-3}+2.1992*10^{-3}*x19-2.2274*\\
*10^{-4}*x19^2-6.1947*10^{-7}*x19^3+\\
+3.1796*10^{-8}*x19^4. \qquad (10)
\end{gathered}$$

Laplas's transformation for (10) looks like:

$$\begin{gathered}
L\{y_{x19\rightarrow y}\}=6.1339*10^{-3}*1/s+2.1992*10^{-3}*1/s^2-\\
-4.4548*10^{-4}*1/s^3-3.7168*10^{-6*}1/s^4+\\
+7.6311*10^{-7}*1/s^5. \qquad (11)
\end{gathered}$$

Supposing that on the entrance of the system discrete moments of time discrete signals enter, as entrance influence on the explored channels we will take $\delta(t)$- function for which $L\{\delta(t)\}=1$. For construction of the control [2, 5, 18] system, we unite the explored channels parallel, on their basis we build the watching system. A public transmission function will look like on the taken into account in a model channels of management, incorporated parallel [12, 13]:

$$W(s)=\frac{\begin{pmatrix}3.067\cdot10^{25}\cdot s^{8}+6.680\cdot10^{24}\cdot s^{7}-\\ -3.711\cdot10^{24}\cdot s^{6}-7.158\cdot10^{22}\cdot s^{5}+\\ +4.856\cdot10^{22}\cdot s^{4}+1.016\cdot10^{21}\cdot s^{3}-\\ -7.573\cdot10^{20}\cdot s^{2}-2.385\cdot10^{19}\cdot s+\\ +1.790\cdot10^{19}\end{pmatrix}}{\begin{pmatrix}1.000\cdot10^{27}\cdot s^{9}+3.067\cdot10^{25}\cdot s^{8}+\\ +6.680\cdot10^{24}\cdot s^{7}-3.711\cdot10^{24}\cdot s^{6}-\\ -7.157\cdot10^{22}\cdot s^{5}+4.856\cdot10^{22}\cdot s^{4}+\\ +1.016\cdot10^{21}\cdot s^{3}-7.573\cdot10^{20}\cdot s^{2}-\\ -2.385\cdot10^{19}\cdot s+1.790\cdot10^{19}\end{pmatrix}}. \qquad (12)$$

Examining the discrete system [7,8 17], for the receipt of impulsive transmission function from the got continuous function, examining five parallel united blocks incorporated parallel, realized (3), (5), (7), (9), (11). Limited to consideration of region of frequencies substantially less frequencies of quantum, organizing watching system, we get a discrete transmission function realizing (12), which looks like:

$$W(z)=\left(\sum_{p_k}\frac{z}{z-e^{p_k/T}}\operatorname{Res}\left(W\left(p_k\right)\right)\right), \qquad (13)$$

where: p_k – poles continuous transmission function (12), $\mathrm{Res}(W(p_k))$ - deduction (coefficient at p_k in decomposition in the Loran’s row of continuous transmission function (12)) .

After transformation (12) and substitution in (13), the last expression will assume an air:

$$W(z)=\begin{pmatrix}\frac{2.0\cdot10^{18}\cdot z}{z-e^{-0.123/T}}+\\ +\frac{(8.621\cdot10^{18}+3.445\cdot10^{18}\cdot i)\cdot z}{z-e^{-9.136\cdot10^{-2}-8.973\cdot10^{-2}\cdot i/T}}+\\ +\frac{(8.621\cdot10^{18}-3.445\cdot10^{18}\cdot i)\cdot z}{z-e^{-9.136\cdot10^{-2}+8.973\cdot10^{-2}\cdot i/T}}+\\ +\frac{(1.062\cdot10^{19}-9.981\cdot10^{18}\cdot i)\cdot z}{z-e^{-6.461\cdot10^{-2}-0.171\cdot i/T}}+\\ +\frac{(1.062\cdot10^{19}+9.981\cdot10^{18}\cdot i)\cdot z}{z-e^{-6.461\cdot10^{-2}+0.171\cdot i/T}}-\\ -\frac{0.5\cdot z}{z-e^{7.431\cdot10^{-2}-9.756\cdot10^{-2}\cdot i/T}}-\\ -\frac{0.5\cdot z}{z-e^{7.431\cdot10^{-2}+9.756\cdot10^{-2}\cdot i/T}}+\\ +\frac{(1.0-9.999\cdot10^{18}\cdot i)\cdot z}{z-e^{0.127-3.471\cdot10^{-2}\cdot i/T}}+\\ +\frac{(1.0+9.999\cdot10^{18}\cdot i)\cdot z}{z-e^{0.127+3.471\cdot10^{-2}\cdot i/T}}\end{pmatrix}. \qquad (14)$$

Structure of calculable block, realizing (14), simultaneously being part of the intellectual system of support of decision-making for production of electronic vehicles [3, 15], will look like, represented on a fig. 1.

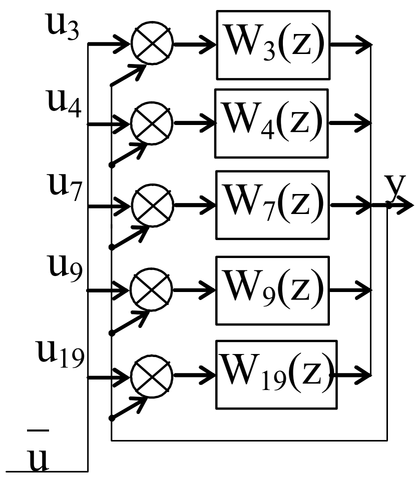

Fig. 1. Calculable block of case frame for production of domestic electronic vehicle

For a fig. 1 acting discrete signals on the entrance of the digital summarizing are processed in accordance with (14) and due to the watching system high exactness and fast-acting of all chart is provided, however at construction of the system it is necessary to consider ceiling of the variables selected as managing influences, for the electronic vehicles of the different setting of the general intellectual control system [19, 20].

Implementation of similar variant of individual tasks of educational-research work of students is instrumental in intellectual development of students, systematization of the accumulated and again got knowledges, capture by the methods of estimation of designers decisions. Teaching to the receipt of transmissions functions of the system and its elements, public transmission function of the system, theorem of deductions, is carried out on the examples of the known environment of constructing and production of electronic vehicles, that acts not unimportant part in intellectual development of taught.

CONCLUSIONS

As a result of the conducted researches, the improved method of teaching of disciplines for students, providing establishment and cooperant to the realized application of mathematical design, was offered, researches of transmissions functions of the systems of adjusting, channels of influencing, operator calculation directly for the process of production of electronic vehicles of the different setting and external environments.

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МАТЕМАТИЧЕСКОЕ МОДЕЛИРОВАНИЕ И УПРАВЛЕНИЕ ПРОИЗВОДСТВОМ ЭЛЕКТРОННЫХ АППАРАТОВ И ВНЕДРЕНИЕ РЕЗУЛЬТАТОВ ИССЛЕДОВАНИЙ В УЧЕБНЫЙ ПРОЦЕСС

Виталий Ульшин, Виктория Смолий, Ярослав Фомин

Аннотация. В работе обосновывается и предлагается математическая модель и передаточные функции системы регулирования для процесса производства электронных аппаратов различного назначения и условий эксплуатации. Также работа посвящена внедрению полученных результатов в учебный процесс, а именно в процесс обучения студентов.
Ключевые слова: управление, процесс производства, электронный аппарат, математическая модель, процесс производства, каналы влияния, внедрение, учебный процесс.