УДК 622.232

MATHEMATICAL MODELING OF TRANSIENT PROCESSES ASYNCHRONOUS MOTOR DRIVE AS PART OF MINING MACHINES

N. Posternikov, *student of group EPR-10 English*
V. Zenzerov, *candidate of engineering's sciences, associate professor of department of Calculable Mathematics and Programming*
Donetsk national technical university

В статье приведены результаты математического моделирования на ПЭВМ изменения основных параметров переходного процесса запуска асинхронного электродвигателя при постоянном моменте сопротивления на исполнительном органе привода горной машины.

У статті приведені результати математичного моделювання на ПЕВМ зміни основних параметрів перехідного процесу запуску асинхронного електродвигуна при постійному моменті опору на виконавчому органі приводу гірничої машини.

In the article results of mathematical modeling on the personal computer changes of key parameters of transient of start of the asynchronous electric motor are resulted at the permanent moment of resistance on an executive branch of a drive of the mining machine.

Induction motor today constitute the majority of electrical machines. They are mostly used to convert electrical energy into mechanical energy and have a number of advantages compared to synchronous motors. Of the merits of such motors can be noted in the ease of manufacture, as well as the absence of mechanical contact with the static part of the machine (the collector brushes are available). The latter is most important because the mining conditions of service exposed parts of electrical circuits is a complex and expensive, which leads to downtime and maintenance costs. This type of motor has its drawbacks. A small torque, which can be compensated by installing a large gear ratio. Thus, this type of engine has a bigger compared to other motor inrush current, but this is easily compensated by the choice of electric cables of large cross section. In general, these shortcomings do not diminish the prospects of using induction motors in the drives of mining machines. For modeling the electric circuit used in Fig. 1.

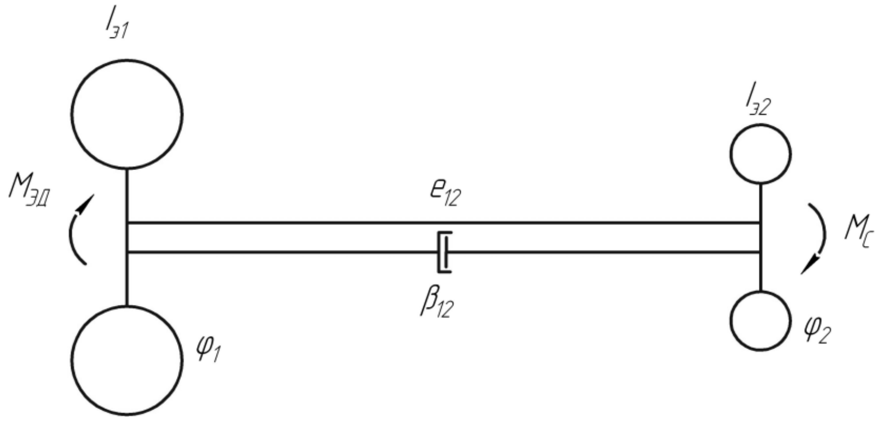


Fig. 1

On fig. 1 the following designations are used:
β_{12} - coefficient of linear damping in the gear, Nm^2;
e_{12} - yielding transmission, $N^{-1}m^{-1}$;
$I_{э1}$ - the moment of inertia rotor, kgm^2;
$I_{э2}$ - the moment of inertia of the executive body, kgm^2;
$\varphi 1$ - rotor angle, rad;
$\varphi 2$ - the angle of rotation of the executive body, rad;
$M_{эд}(t)$ - function of the electromagnetic torque from time to time, Nm;
M_e - medium level of resistance moment, Nm.

Behavior of the system described by the following differential equations:

$$y1'(t) \cdot I_{э1} = -\beta_{12}\big(y1(t)\big) - y2(t)\big) - \frac{1}{e_{12}} * (\varphi 1(t) - \varphi 2(t)) + \frac{2 \cdot M_{кф} \cdot (\omega_c - y1(t))}{\omega_c \cdot S_k}$$

$$y2'(t) \cdot I_{э2} = -\beta_{12}\big(y1(t)\big) - y2(t)\big) - \frac{1}{e_{12}} * (\varphi 1(t) - \varphi 2(t)) + M_{сопр}(t)$$

$$\varphi 1'(t) = y1(t)$$

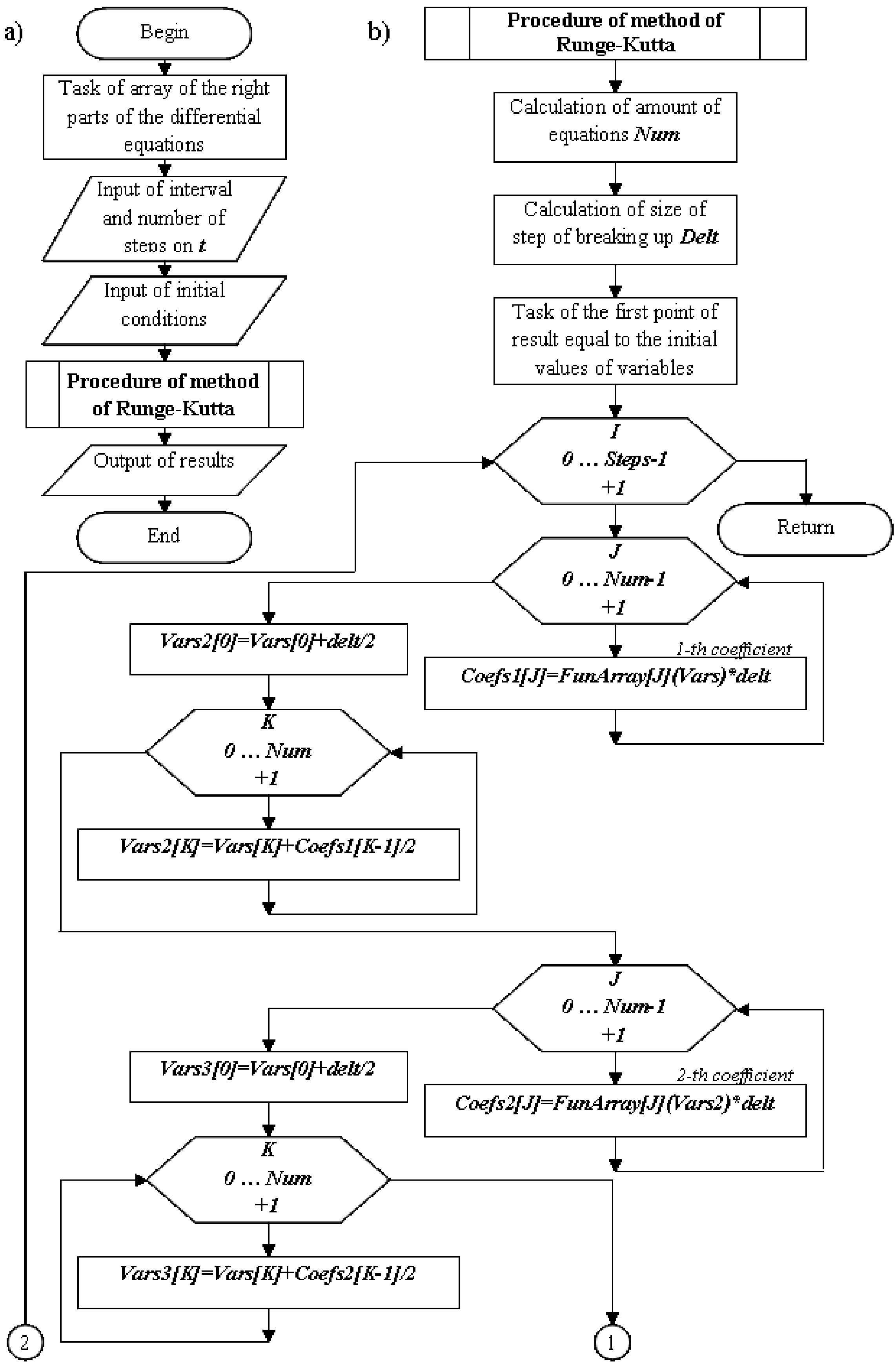
$$\varphi 2'(t) = y2(t)$$

For the numerical solution of this system of differential equations was used Runge-Kutta method of order 4 The flow-chart of algorithm resulted on Fig. 2 has been developed for implementation of the given model (a) – the main program; b) – the Runge-Kutta method subroutine), according to which the program in algorithmic language Delphi is developed.

Responses of this model are the following:

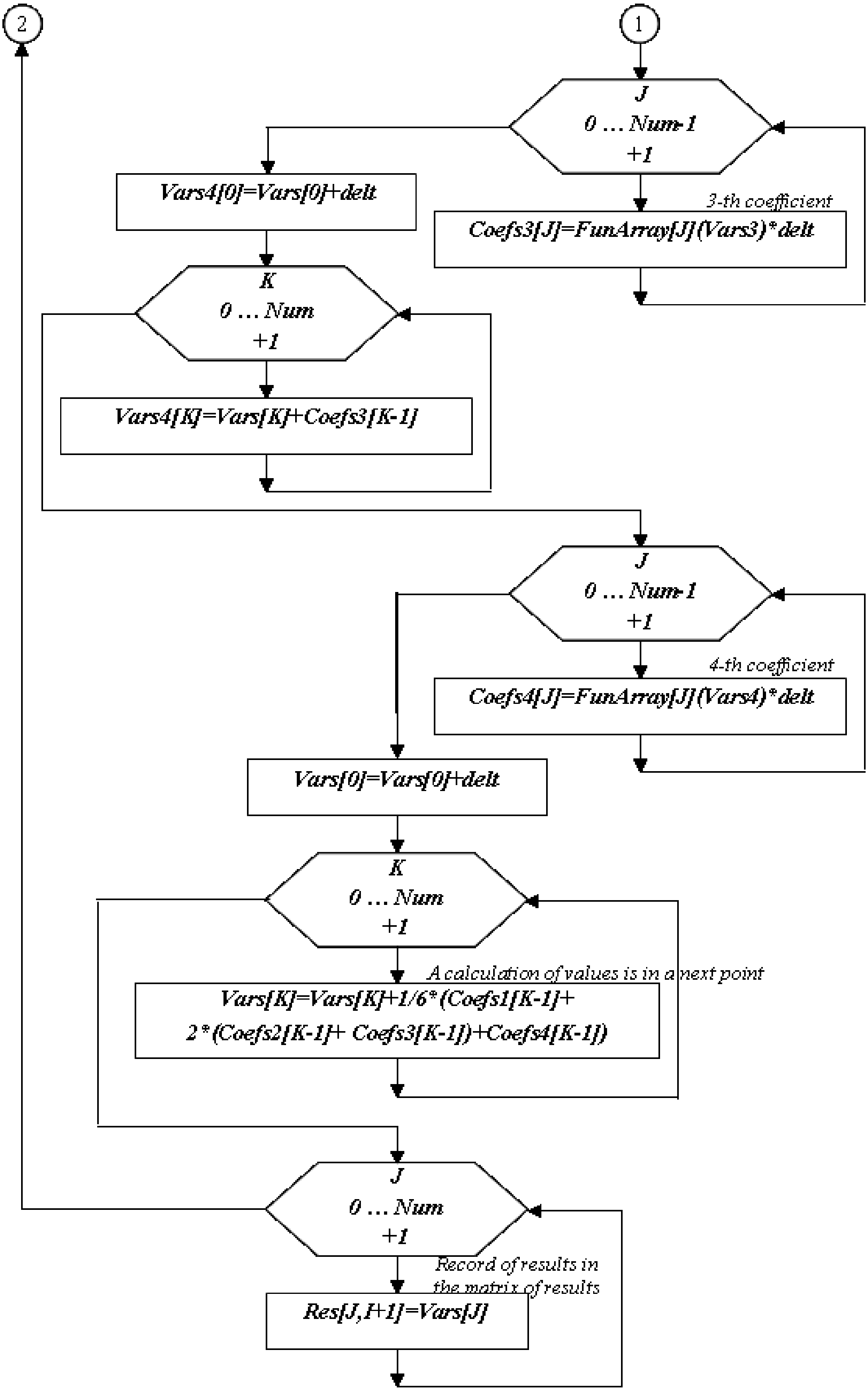
$$M_{эд}(t) = \frac{2 \cdot M_{кф} \cdot (\omega_c - y1(t))}{\omega_c \cdot S_k}$$ - electromagnetic torque motor;

$M_{кф}$ - the actual critical moment, Nm;
Wc - synchronous angular velocity, s^{-1};
$S_к$ - the critical slip;
$\omega 1(t) = y1(t)$ - angular rotor speed, s^{-1};



a)
Begin
Task of array of the right parts of the differential equations
Input of interval and number of steps on t
Input of initial conditions
Procedure of method of Runge-Kutta
Output of results
End
b)
Procedure of method of Runge-Kutta
Calculation of amount of equations Num
Calculation of size of step of breaking up Delt
Task of the first point of result equal to the initial values of variables
I
0 … Steps-1
+1
Return
J
0 … Num-1
+1
1-th coefficient
Coefs1[J]=FunArray[J](Vars)*delt
Vars2[0]=Vars[0]+delt/2
K
0 … Num
+1
Vars2[K]=Vars[K]+Coefs1[K-1]/2
J
0 … Num-1
+1
2-th coefficient
Coefs2[J]=FunArray[J](Vars2)*delt
Vars3[0]=Vars[0]+delt/2
K
0 … Num
+1
Vars3[K]=Vars[K]+Coefs2[K-1]/2
2
1

Fig. 2.



Continuation of Fig. 2

$y1(t)=\varphi 1(t)$.

The results of the numerical solution are on Fig. 3 and Fig. 4.

As a result of the conducted researches an algorithm and program of design of change of basic parameters of start of asynchronous electric motor are worked out at the permanent moment of resistance on the executive branch of drive of mining machine.

As the simulated processes was chosen as the angular velocity and electromagnetic torque. Analysis of the graphs showed that the motor has a transient duration of 0.2 – 0.35 sec. Developed algorithm and program, with sufficient accuracy for engineering calculations, can be used in designing of mining machines and devices containing drives on induction motors with mechanical transformations.

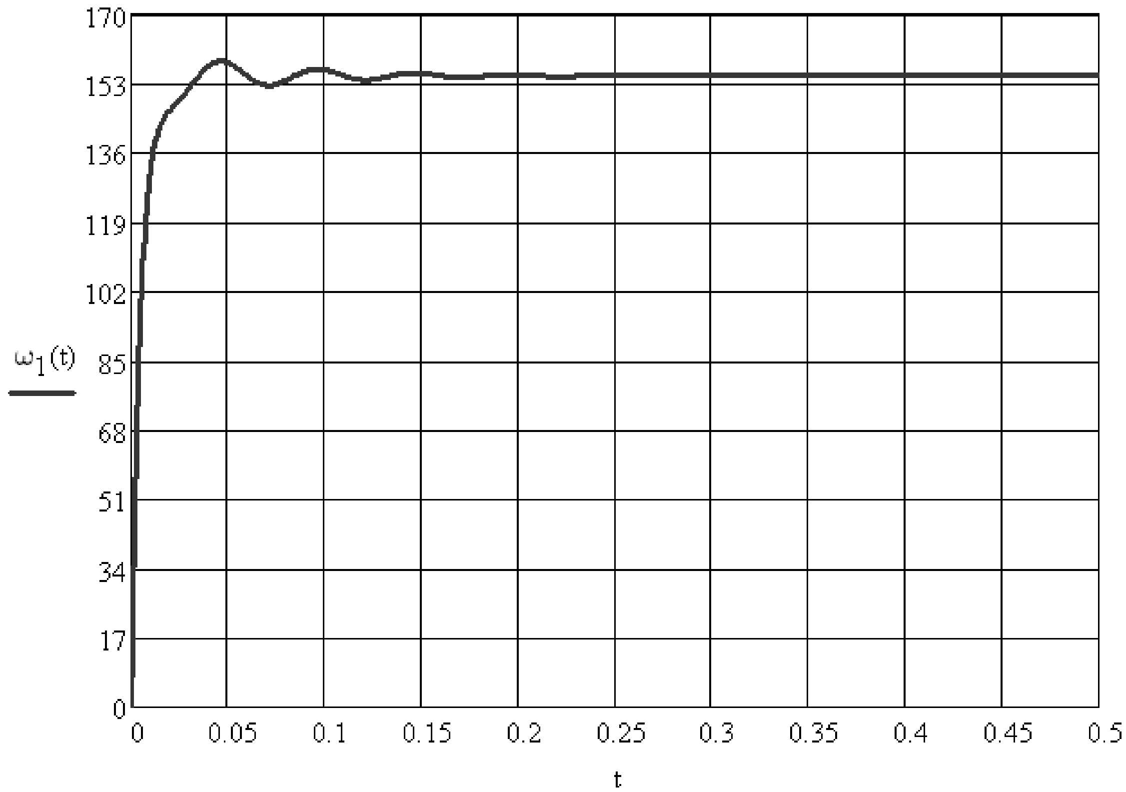


Fig. 3

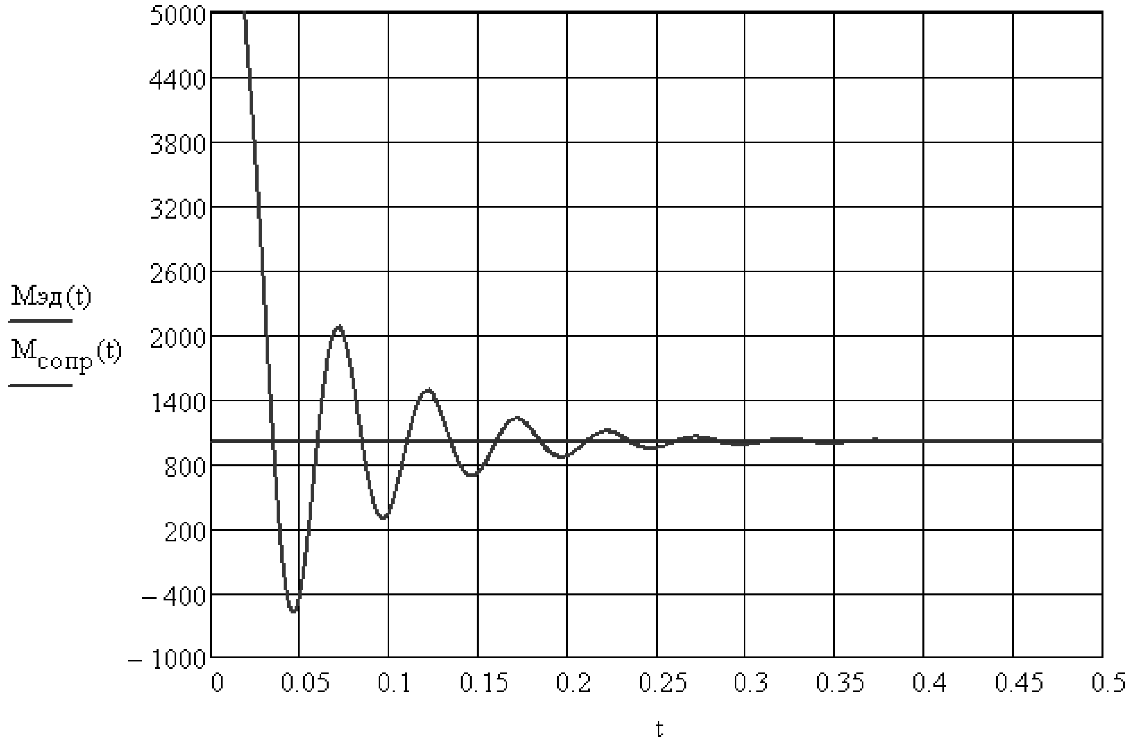


Fig. 4

The Literature:

1. Семенченко А.К. Научные основы многокритериального синтеза горных машин как пространственных многомассовых динамических систем переменной структуры: Автореф. дис. … докт. техн. наук. – Донецк: ДонГТУ, 1997. – 33с.
2. Семенченко А.К., Кравченко В.М., Шабаев О.Е. Теоретические основы анализа и синтеза горных машин и процесса их восстановления как динамических систем. – Донецк: РИА ДонНТУ, 2002. – 302с.
3. Бойко Н.Г. Привод исполнительных органов очистных комбайнов. – Донецк: РИА ДонНТУ, 2005. – 140с.