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# Forming of universal optimal operation model of frame for coil winding with finished yarn according to selected measuring points based on the effect of mechanical oscillations

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***Summary:*** **-** In order to create a universal optimal model of certitude functioning it is necessary to analytically determine the shape of the transfer functions of the optimal operation model $M_{\xi}(t)_{NK}$ that will define the frequency of the analyzed sklopa.Analiza security model is undertaken stepping and to determine the sub-models according to selected measuring points for determining the mechanical oscillations and then made structures block diagram linking sub-models of transportation mode input processing yarn (carded tape) to the output (cross road).

***Keywords:*** **-** *model, the transfer function, the system for winding yarn, the algorithm, the monitoring system.*

## I. INTRODUCTION-- DESCRIPTION OF A FRAME FOR COIL WINDING WITH FINISHED YARN

Powertrain system of a frame for for coil winding with finished yarn is shown in Figure 1. and consists of the following parts and components which are classified on the basis of spun yarn which is produced by a twist of the rotor (turbine) and on its way to the coil which is wound.

**THREAD GUIDE (F1) -** used to evenly and safely winding yarn on cone coil. His movement is straight with reciprocating, the number of cycles is 120 cycles/minute. It is made from a special type of ceramic with a metal plate on the occurrence of friction-resistant. Installation and removal are very easy.
**CORE HOLDERS (F2) -** are used for alignment and uniform circular rotation of the coil winding. Holders are made of special type of polymer, the special shape drawn on holly bearings. When bearing is broke, due to the effects of dust in it, comes to his seizure, but also to break the insert coil holder.
**TENSIONER AND LIFTER OF A SPOOL (F3) -** a spring lever system which supports the full spools onto the conveyor belt. The spring system is unstrained in coil winding yarn, while at the same full coils are activated and divides the full coil coating in which the coil tighter when reloading.
**SPOOL BRAKE (STOP BEFORE THE YARN BREAK) (F4) -** is a system that consists of a cylindrical lining of which overlaps coil winding in and of the lever which is activated at the binding of a broken yarn.

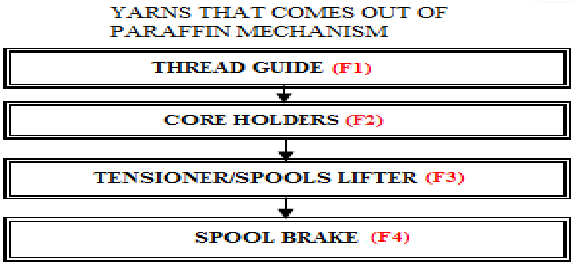



Figure (1). The transmission system of a frame for coil winding with finished yarn

## II. RESEARCH INTO THE CAUSES OF DEFECTIVENESS OF THE POWER TRANSMISSION COMPONENTS FRAME OF THE OE SPINNING MACHINES - FAULT SCAPE ANALYSIS

Failures were due to subassemblies OE - spinning on the basis of elevated levels of mechanical oscillations recorded on the basis of the data collection ie. organization of the course of the level of mechanical oscillations measured values of stochastic signals at selected measuring points. Based on all the registered clients of the analyzed complexes formed integral components of the fault tree circuits OE spinning machines.

Failure analysis on the frames of OE – spinning machines included the use of methods fault tree analysis occurring as a result of mechanical oscillations of the analyzed circuits. This analysis will later be used in the analysis of the reliability of the components of the analyzed components.

From the standpoint of functionality and structural characteristics analyzed circuits of OE - spinning labeled $R_1$ are complex technical circuits in textile technology in terms of operation and maintenance in terms of technology. The structural part of the technical components is derived from the production of components that have a high technological level (very good surface treatment, durability and stability). However, as with all technical components are certain weak points.

The main elements of the transmission circuits are analyzed and their weak points are chosen technical components and are defined as a single weak points where the failures are repeated, and the same can be partly overcome by the introduction of technology proper maintenance on them ie. maintaining the level of mechanical oscillations in the specified bands (within certain limits their their impact). Continuous monitoring of failure occurrence, due to the increased activity of mechanical oscillations, there is the goal of maintaining the condition that. regular preventive maintenance can mitigate the effect of the impact of mechanical oscillations, and thus decrease the number of clients integral components of the analyzed components. Fault tree analysis shows that intensive monitoring of failure leads to the discovery of weakness on the techniques of circuits, which in this part of the analysis done.

Failure analysis is presented deductive technique in which the specification of unintended consequences resulting from the impact of mechanical oscillations (vibrations) that appear in the process of exploitation of the analyzed components OE - spinning. The analysis included the character causes of failure of the main circuit elements (related to the analysis of complex spinning boxing - heart OE spinning machines and assembly of finished coil winding yarn) and the ways in which the cause leads to failure.

The results of the number of poor points failure who receive the service conditions, be used in the safety analysis of the functioning of the analyzed components (determination of the percentage of failures) and to determine their reliability.

In figure 2. are given the reasons for the impact of mechanical oscillations that lead to failure of components and assemblies of components analyzed, based on which one can predict the actions of their preventive maintenance technologies.

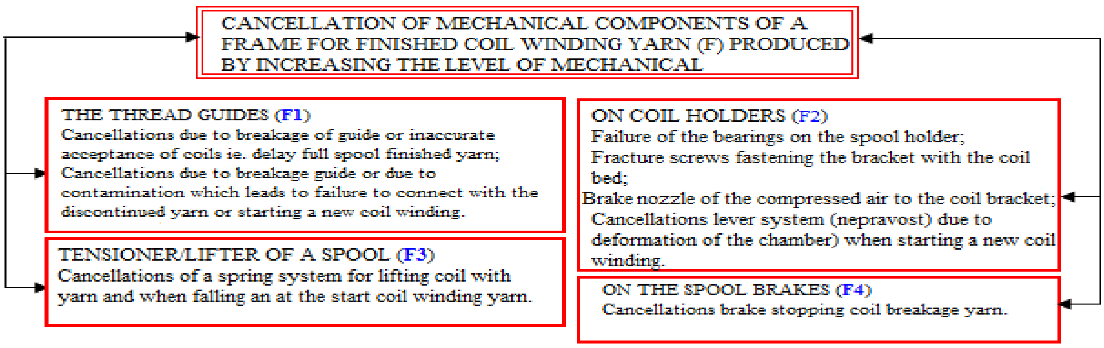


Figure (2). Failures in the constituent assembly components for the finished yarn winding coils due to the increased effects of mechanical oscillations

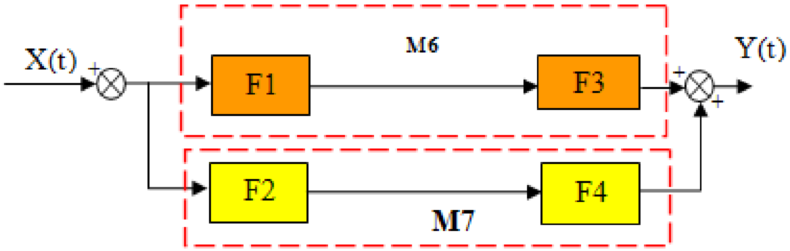
## III. ANALYSIS MODEL

The analysis model included the methodology using an algorithm to determine the security of the constituent components of the clutch system with OE - spinning. The methodology included the construction of the monitoring system (Figure 3.).

## IV. ESTABLISHMENT OF A UNIVERSAL OPTIMAL OPERATION MODEL OF A FRAME FOR COIL WINDING WITH FINISHED YARN ACCORDING TO SELECTED MEASURING POINTS BASED ON EFFECT OF MECHANICAL OSCILLATIONS – DETERMINATION OF FREQUENCY CERTITUDE

In this analysis started from the method for determining the sub-models according to selected measuring points for determining the mechanical oscillations and then was made a structural block diagram submodel in the way of movement and its yarn processing delay.

Structural block diagram of transmission on selected sampling points is shown in Figure 4.,

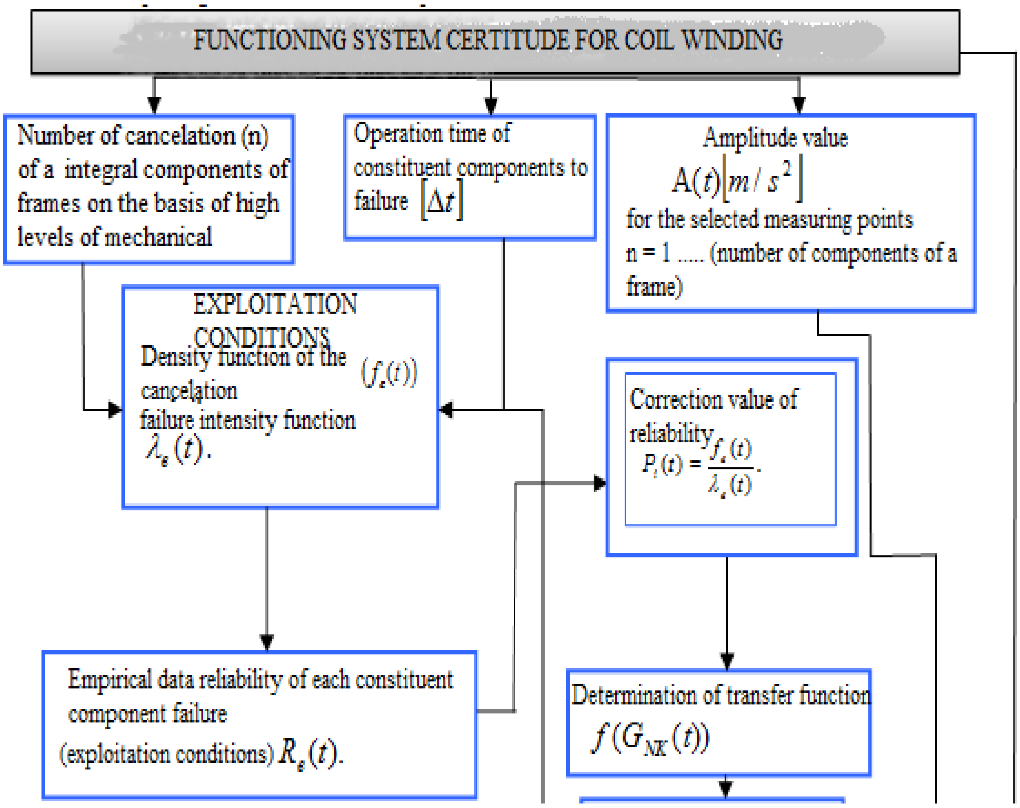



where:

**M6 -** measuring point level fluctuations on the conductor strands and the cylinder to rotate the spool in his winding the finished yarn,

**M7 -** measuring point level fluctuations on the tensioner/lifter spool, and the spool holder.

Figure (4). Display of a frame for coil winding with finished yarn through structural blocks



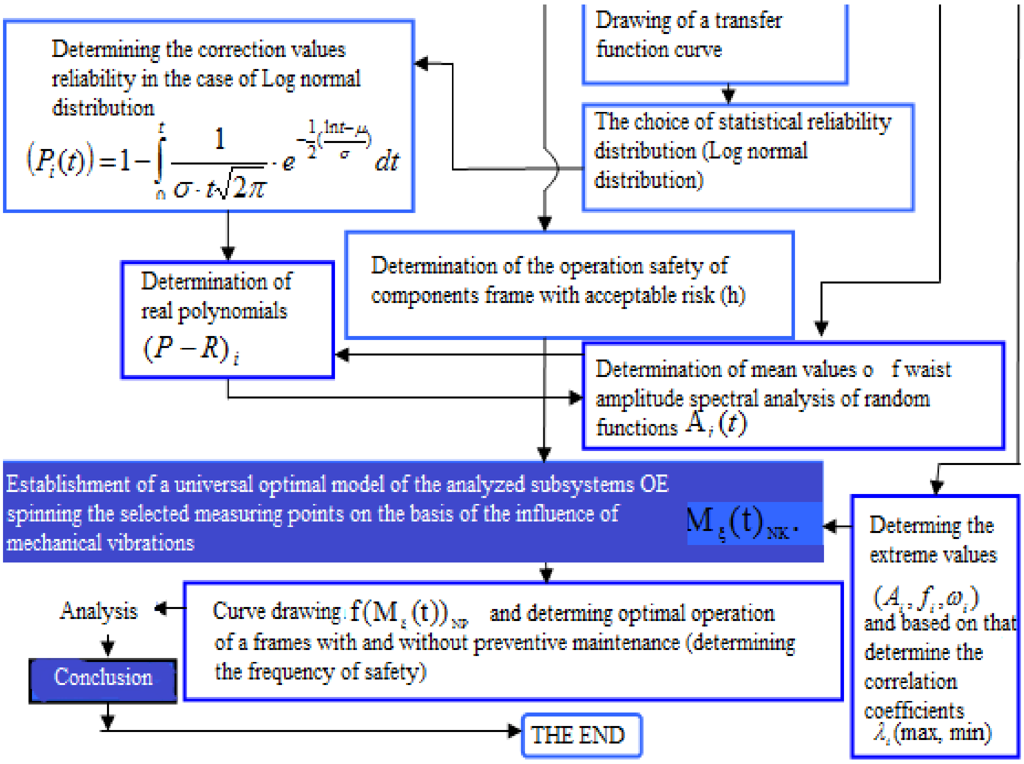



Figure (3). Monitoring system (algorithm) methodology of determing certitude functioning of the analyzed frames - OE spinning machines

***NOTE: In the formation of this model started from the block diagram that are different from the block diagram in determining the reliability of the transfer function. The reason is that the measuring point 6 includes the impact of the tensioner and lifter (F3) while another part that makes this subgroup of a brake coils (F4) belongs to the measuring point 7, so it is necessary to distinguish their effects. In determining the reliability of the transfer function that was not of great importance, and models for determining the optimal assembly for winding coils the finished yarn is of great importance, because it determines the measuring points and the influence of each component of the heat caused by the occurrence of mechanical oscillations.***
With the introduced labels measuring points (M6 and M7) transformation of the structure of the block diagram is as follows (Figure 5.):

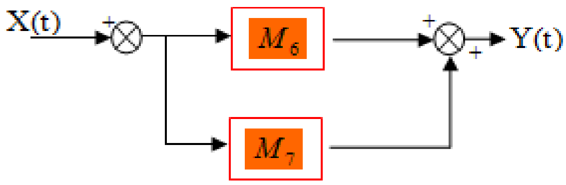



Figure (5). The transformation of the structure of the block diagram of transfer to sub-models for winding coils with the finished yarn

Model analysis was carried out and stepping to determine the sub-models according to selected measuring points for determining the mechanical oscillation (vibration), and then made srtuktura block diagram linking sub-models of transportation mode input processing yarn yarn (thread guide) to the output (cross the road) ie. the final stage (the final winding yarn around a spool).
**Note:** This block diagram structure will be further used to determine the general form of the transfer function of the optimal model $M_\xi(t)_{NK}$ **to be defined as the frequency of the safety assembly for winding coils the finished yarn.**
To carry out the general form of the transfer function of the optimal model, it is necessary to determine the terms of sub-models $(M_i)$ that are included locations of measuring the level of vibration.

**6. Measuring point 6, includes components – threas guide (F1) and spool tensioner/lifter (F3).**

Thread quide moving in a straight line - the axial direction and with 60 cycles in one minute (30 cycles in an axial direction, and so in the other) in a way that leads spun yarn from one end to the other end of the coil winding is being carried out. As the authoritative speed takes the speed of one cycle of movement guide:

$\vartheta_{VODI\check{C}\cdot NITI}(t) = \omega_{F_1}(t) = f\left(A_6(t)_{F_1}\right) \neq \omega_6$.

Spool tensioner/lifter is activated when the process begins winding the yarn on the bobbin ready and then when fully wound bobbin yarn, which frees it from the rollers to rotate the coil winding is raising up. The relevant angular velocity is the speed of the roller rotation coil (roll is the same shape as the coil and act on it in pairs)

$\omega_{VALJKA}(t) \neq \omega_6(t)$.

$\omega_6(t)$ - The angular velocity circular assembly at the measuring point 6, as a function of the oscillation amplitude $A_6(t)_{F_1}$, $A_6(t)_{F_3}$.

Equation 6 is a sub-models:

$$\mathrm{M}_6 = \mathrm{M}_6^{'} \cdot \mathrm{M}^{''}_6 = \frac{R_{F1}(t)\cdot \mathrm{A}_6(t)_{F1}}{\omega_{F1} = f(\omega_6)} \cdot t_{13} \cdot \frac{R_{F3}(t)\cdot \mathrm{A}_6(t)_{F3}}{\omega_{F3} = f(\omega_6)} \cdot t_{14} = \frac{(P-R)_{F_1}(t)}{\omega_6} \cdot t \cdot \frac{(P-R)_{F_3}(t)}{\omega_6} \cdot t$$

$$\mathrm{M}_6 = \frac{t^2}{\omega_6^2}\left((P-R)_{F_1}(t)\cdot (P-R)_{F_3}(t)\right) \quad (1)$$

$R_{F1}(t)$ - The reliability of the guide or the useful period of work;

$R_{F3}(t)$ - The reliability of the belt / pickup coil in a useful period of work;

$\mathrm{A}_6(t)_{F_1}$ $\left[{}^{m}\!/\!{}_{s^2}\right]$ - The amplitude of oscillation in a helpful guide or period of the measuring point 6;

$\mathrm{A}_6(t)_{F_3}$ $\left[{}^{m}\!/\!{}_{s^2}\right]$ - Amplitude of oscillation belt / pickup coil in a useful period of the measuring point 6;

$t_{13}, t_{14}[s]$ - Uptime components at the measuring point 6;

$(P-R)_{F_1}(t)$ - A polynomial with real coefficients, which gives the dependence of reliability of the component guides in the function or value of the level of mechanical vibrations at the measuring point 6

$(P-R)_{F_3}(t)$ - A polynomial with real coefficients, which gives the dependence of the component reliability tensioner/lifter operational level values of mechanical vibrations at the measuring point 6.

7. Measuring point 7., includes components: coil holder (F2) and the brake coil (F4).

Coil holder has a circular motion and turning over the rolling bearing, over which sits in firmly. Longitudinal rotation speed $(\omega_{LE\check{Z}AJA}(t))$, is the speed bearing that is different from the circular velocity at the measuring point 7.

$\omega_{F_2} = \omega_{LE\check{Z}AJA}(t) \neq \omega_{F4}(t) = f\left(A_7(t)_{F_2,F_4}\right) \neq \omega_7$.

$\omega_7(t)$ - The angular velocity circular assembly at the measuring point 7, as a function of the oscillation amplitude $A_7(t)_{F_2}$, $A_7(t)_{F_4}$.

Equation of a sub-models 7 is:

$$\mathrm{M}_7 = \mathrm{M}_7^{'} \cdot \mathrm{M}^{''}_7 = \frac{R_{F2}(t)\cdot \mathrm{A}_7(t)_{F2}}{\omega_{F2} = f(\omega_7)} \cdot t_{15} \cdot \frac{R_{F4}(t)\cdot \mathrm{A}_7(t)_{F4}}{\omega_{F4} = f(\omega_7)} \cdot t_{16} = \frac{(P-R)_{F_2}(t)}{\omega_7} \cdot t \cdot \frac{(P-R)_{F_4}(t)}{\omega_7} \cdot t$$

$$\mathrm{M}_7 = \frac{t^2}{\omega_7^2}\left((P-R)_{F_2}(t)\cdot (P-R)_{F_4}(t)\right) \quad (2)$$

$R_{F2}(t)$ - The reliability of the coil holder in a useful period of work;
$R_{F4}(t)$ - The reliability of the brake coil in a useful period of work;
$A_7(t)_{F_2}\left[{}^{m}\!/\!{}_{s^2}\right]$ - The amplitude of the oscillation coil holder in a useful period of the measuring point 7;
$A_7(t)_{F_4}\left[{}^{m}\!/\!{}_{s^2}\right]$ - Amplitude of oscillation brake coil in a useful period of the measuring point 7;
$t_{15}, t_{16}[s]$ - Uptime components at the measuring point 7;
$(P-R)_{F_2}(t)$ - A polynomial with real coefficients, which gives the dependence of reliability of the component holder coil operational level values of mechanical vibrations at the measuring point 7;
$(P-R)_{F_4}(t)$ - A polynomial with real coefficients, which gives the dependence of the reliability of components brake coil operational level values of mechanical vibrations at the measuring point 7;

## V. CONCLUSION

The general form of the universal equation of the optimal model assembly for winding coils the finished yarn is obtained by entering all prior specific factors (the transfer function of the optimal model $M_{\xi}(t)_{NK}$, **which is defined as the frequency of the safety assembly for winding coils the finished yarn**) so that:

$$M_{\xi}(t)_{NK} = M_6 + M_7 = \left(\frac{t^2}{\omega_6{}^2}(P-R)_{F1}(t)\cdot(P-R)_{F3}(t)\right) + \left(\frac{t^2}{\omega_7{}^2}(P-R)_{F2}(t)\cdot(P-R)_{F4}(t)\right). \quad (3)$$

The introduction of shift:

$$\begin{aligned}(P-R)_{F1}(t)\cdot(P-R)_{F3}(t) &= \xi_{10};\\ (P-R)_{F2}(t)\cdot(P-R)_{F4}(t) &= \xi_{11}.\end{aligned} \quad (4)$$

it is obtained universal equations of the optimal model for the security of the complex coil winding the finished yarn:

$$\boxed{M_{\xi}(t)_{NK} = \frac{Y(t)}{X(t)} = t^4\left(\left(\frac{\xi_{10}}{\omega_6{}^2}\right) + \left(\frac{\xi_{11}}{\omega_7{}^2}\right)\right).} \quad (5)$$

This equation is a universal equation of the transfer function of the optimal model of assembly of the finished coil winding yarn by selected sampling points from the effect of mechanical oscillations, and it gives the frequency dependence of the safety of operations.

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