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STUDY OF THE DYNAMIC COMPLIANCE CURVES OBTAINED BY MEASURING THE SPECTRAL DENSITY

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Abstract – One uses the spectres of spectral density for setting the dynamic compliance curves; the elastic structure of the tool-machine is investigated experimentally under real conditions of functioning obtaining data in a much more reduced interval of investigation.

The transfer function that describes the functional dependency (in the functional field) between input and output signals of an invariable linear transfer system in time is the ratio of the Fourier transformed equations of the input and output signals: [1], [2], [4].

$$F_{xy}(it) = \frac{F\{y(t)\}}{F\{x(t)\}} = \frac{Y(it)}{X(it)} \qquad (1)$$

or

$$F_{xy} = (it) = \frac{R_e\{F_{xy}(it)\}}{E_{xx}(t)} + j\frac{I_m\{E_{xy}(it)\}}{E_{xx}(t)} \qquad (2)$$

The module of the Fourier transformation of a signal, $|X|$ is called the spectre of the amplitude density or the spectre of signal frequency. [2], [4]

As characteristic statistical size, one chooses in practices the spectral power density which describes in each moment the average frequential contents of a process. [12], [4]

The spectral power density, respectively the inter-spectral size of power is defined as limit value of the ratio between the energy spectre, respectively of inter-correlated energy and the time of analysis *T*. [2], [4]

With the four data of the analyser $S_{xx}(t), S_{yy}(t)\, R_e \text{ si } I_m\left[S_{xy}(t)\right]$ a standard figure may be defined (coherence factor). [2], [4]

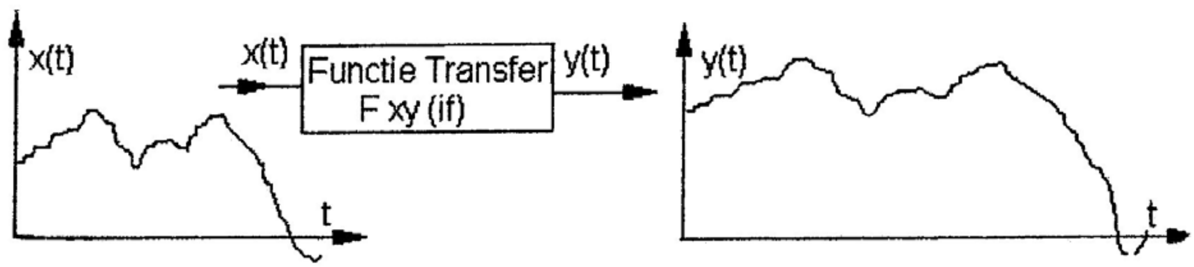
The analysis of the system by measuring the spectral density.

From the analysis of the relation (1), the transfer function which describes the correlation between the input and output signals for a linear mechanical system, invariable in time, in a specific frequency field, is true as in the case of exciting the elastic structure of the mechanical system with the help of some stochastic signals.

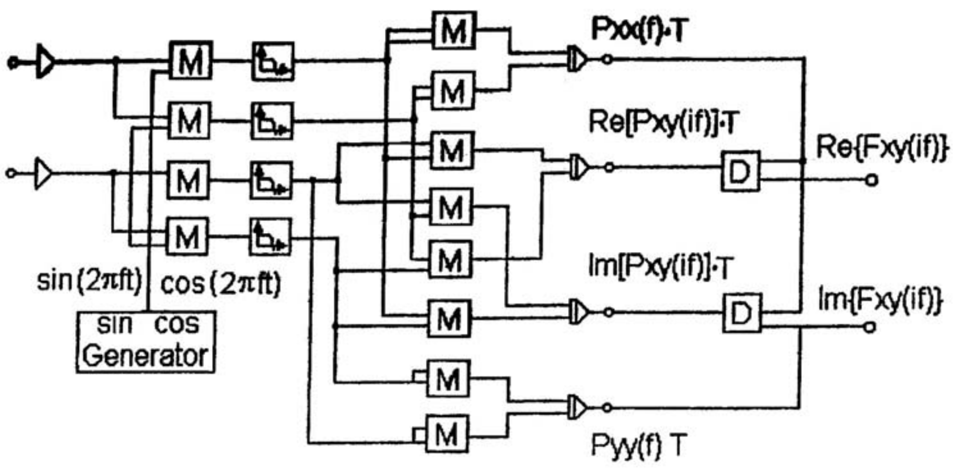
For the use of an analyser of spectral density, we have:

- the distinctive signals of input output will be modulated through sin-cos signals, supplied by a frequency modulator; (picture 1);
- the procedure of integration implied by the Fourier transformation will be modelled with the help of a fine advancement filter;
- before integration, the Fourier transformed equations are Multiplied (picture 2), and at an established observation time T, the following values are supplied: the real power

of the input spectre $P_{xx}(t)$, analogue for the input signal $P_{yy}(t)$ and real and imaginary components of transversal power of the spectre $P_{xxy}(t)$. [2], [4]



Picture 1. Statistical signals of input and output. [2], [4]



Picture 2. Logical scheme of Multiplying the
Fourier transformed equations of the signals [2], [4]

The desired values of the transfer function [2], [4] results from:

$$F_{xy}(it) = \frac{P_{xy}(it)}{P_{xx}(t)} \qquad (3)$$

From the four groups of data supplied by the analyser of spectral density (picture 1) one can deduct the coherence function given by the relation: [2], [4].

$$X_{xy}^2 = \frac{\left|P_{xy}(it)\right|^2}{P_{XX}(t)\cdot P_{YY}(t)} = \frac{P_{xy}(it)}{P_{XX}(t)}\cdot\frac{P_{yx}(it)}{P_{YY}(t)} = F_{xy}(it)\cdot F_{yx}(it) \qquad (4)$$

The coherence function X_{xy}^2 may take the maximum value 1,00 if and only if there is a dependency of an output signal towards the input signal that generated it. So the mutual relation: [2], [4] is also valid

$$F_{xu}(it) = \frac{1}{F_{yx}(it)} \qquad (5)$$

In the general case, we shall have $X_{xy}^2 \in [0,1]$, value $X_{xy}^2 = 0$ corresponding to the situation when the input and respectively the output signals are independent.

For $X_{xy}^2 \in (0,1)$, the significance may be that the output signal in influenced by several input signals, some unidentified or that the elastic structure of the tool machine TM (STF has a non-linear behaviour). [2], [4]

In conclusion, the experimental investigation of the dynamic behaviour of the elastic structure of a tool-machine is proper to deploy under real conditions of functioning of that machine or of that study.

If the reminded investigation of the dynamic behaviour is performed with the tool-machine, in state of non-functionality then the diagrams of dynamic stability may show a less relevant correspondence in relation to the experimental data obtained in real time. A means of investigation under real conditions of functioning of the stability performances of a tool-machine is represented by the analysis of the system through its excitation, with the help of some stochastic signals, by measuring the spectral density admitting that the elastic structure of the tool-machine is a linear system. [1], [4]

The stochastic input signals are generated in the current case by the splintering of some "random" standard pieces. Thus one generates force signals of "random" splintering obtained with the help of the random variation of the splinter's width caused by a supplementary movement of the tool or in the case of the seismic excitation, of the dynamic structure of TM with the help of some special devices of overtaxing. [2], [4]

One sets the diagram of dynamic stability, constructed in coordinates $b_{\lim} - t$, using force translators $B\&k$ and some seismic translators for displacement $B\&k$. After recording the primary data on a port – program, these were processed with the help of an analyser of spectral density assisted by computer. The responses to the frequency are represented by dynamic compliance curves presented in complex frame (I_m, R_e), used in order to quantify the influence of the various technological or constructive parameters upon the performances of dynamic stability of the TM system.

In comparison with the methods of raising the of the TM structure by sinusoid excitation, the deduction of the compliance curves by measuring the spectral density has the advantage of simulating closer to truth the dynamic behaviour in a much more reduced time interval of investigation. [2], [4]

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