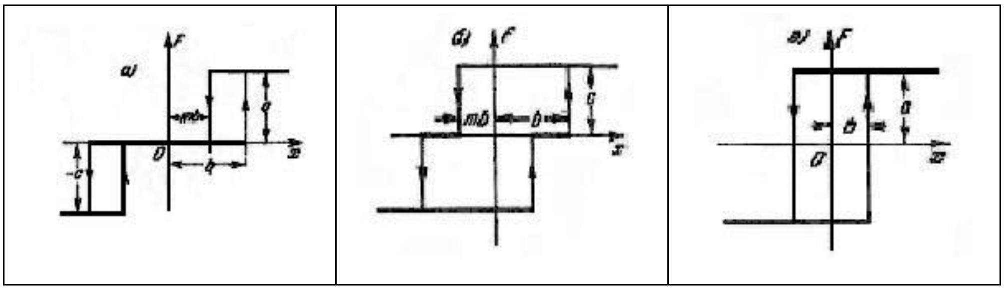
USE OF RELAY CHARACTERISTICS FOR FORMING THE SERVICEABILITY PARAMETERS OF TECHNICAL OBJECTS

Anatol Popescu, Anatol Besetea, Iurie Balan

Technical University of Moldova

It is known, that in the practice of forming the dynamic models for the analysis of serviceability of technical objects it is widely and successfully used the theory of linear systems. [1]

In such cases, for serviceability estimation there are used, for instance, restrictions on displacement of roots in a complex plane, characteristic parameters of transient processes etc. However, the technical object, except for the linear ones, may contain one or more nonlinear elements. In these cases, linear methods cannot be applied; otherwise big errors will be received when estimating the parameters. But it is not acceptable to use exact methods of calculation for the analysis of nonlinear parts. Except for other lacks, this way is unacceptable also because still and consequently, that it should to use two different mathematical devices, that not always allow to pick up features of dynamic phenomena in the investigated object. A more rational way in this case, is the linearization of nonlinear parts with a further analysis of the technical object movement, using linear methods. From the known methods of linearization the most acceptable is the method of harmonious linearization (MHL). One of the main advantages of this method is that it allows linearization of essential - nonlinear parts. We will cite some forms of relay static characteristics which are most frequently met. (figure 1). They are used for the description - changes of voltage U_m enclosed to the motor, depending on the managing current I_m of relay; conditions of the two-position polarized relay; the step dependence which displays the functioning of lamellar potentiometer etc.



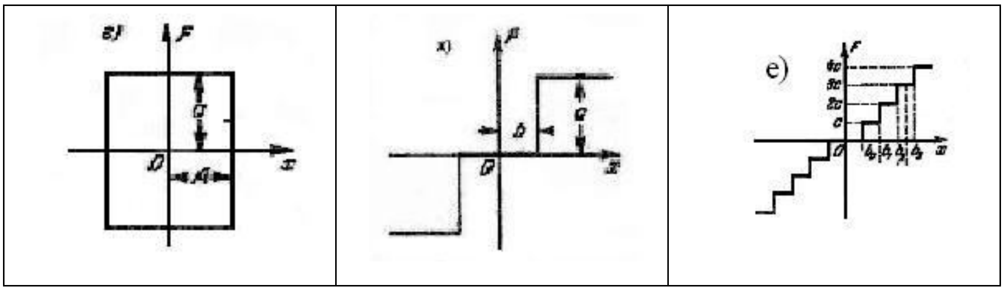


Figure 1. Versions of relay static characteristics:
(1, a - general view characteristic; 1,б- with hysteresis loop; 1, в - characteristic at displaced hysteresis loop; 1, г - with hysteresis loop of variable width; 1, д-with the zone of tolerance; 1, e - a step kind).

Parameters of these characteristics, may, for example, designate, в – operate current, ($в_1$, $в_2$..., $в_n$ - step change of a current), m-factor of return, with - a level of a switched voltage (c_1, c_2..., c_n – graded change of the voltage). The change of properties of nonlinear parts will be reflected by the change of loop parameters. It enables to use the given parameters in order to estimate the change of part serviceability.

It is known [2] that MHL allows to present the part with nonlinear static characteristic (NSC) as a linear part with some function F (x), where x – represents an entrance sine wave signal of nonlinear link with amplitude A. The influence character of this function on movement of newly received linear link is determined by some constant q and q^1. Analytical expressions of these factors for above mentioned relay characteristics are resulted below.

For general view characteristics (see fig. 1-a)

$$q(A) = \frac{2c}{\pi A}(\sqrt{1-\frac{b^2}{A^2}}) + \sqrt{1-\frac{m^2 b^2}{A^2}}), \ at\ A \geq b \quad (1)$$

$$q^1(A) = -\frac{2cb}{\pi A^2}(1-m), \ at\ A \geq b \quad (2)$$

Factors of the characteristic with hysteresis loop (see fig. 1-б)

$$q(A) = \frac{4c}{\pi A}\sqrt{1-\frac{b^2}{A^2}}, \ at\ A \geq b \quad (3)$$

$$q^1(A) = -\frac{4cb}{\pi A^2}\ , at\ A \geq b \quad (4)$$

At displaced hysteresis loop (see fig. 1-в)

$$q(A) = \frac{2c}{\pi A}(\sqrt{1-\frac{b^2}{A^2}}) + \sqrt{1-\frac{m^2 b^2}{A^2}})\ , at\ A \geq b \quad (5)$$

$$q^1(A) = -\frac{2cb}{\pi A^2}(1 + \mathrm{I}m\mathrm{I}),\ \ at\ A \geq b \qquad (6$$

For hysteresis loops with variable width (see fig. 1-г)

$$q(A) = 0\ ,\ at\ A \geq b \qquad (7)$$

$$q^1(A) = -\frac{4cb}{\pi A}\ ,\ at\ A \geq b \qquad (8)$$

Factors of the characteristic with an inactivity zone (see rice 1-д)

$$q(A) = \frac{4c}{\pi A}\sqrt{1 - \frac{b^2}{A^2}})\ ,\ at\ A \geq b \qquad (9)$$

$$q^1(A) = 0\ ,\ at\ A \geq b \qquad (10)$$

At grade characteristic (see fig. 1-e)

$$q(A) = \frac{4c}{\pi A}\sum_{\gamma=0}^{m}\sqrt{1 - \frac{b^2}{A^2}}\ ,\ at\ \ b_n \leq A \leq b \qquad (11)$$

Let's remind that for the definition of technical objects serviceability, including nonlinear dynamic parts, it is necessary to carry out a choice of estimated parameters. The static characteristic is described by parameters c, в and m. The change of object condition (occurrence of defect) will be reflected by the change of characteristic parameters. To estimate a changed condition of technical object it is necessary to learn to receive parameters of above mentioned characteristics.

Literature

1.Глазунов Л. П., Смирнов А. Н. Проектирование технических систем диагностирования. Л.: Энергоатомиздат, 1982, 168 с.

2.Бесекерский В.А., Попов Е. П. Теория систем автоматического регулирования. М.: Наука, 1975, 767 с.