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Optimal optional-hybrid functions distribution for a reliability problem within the "multi-optionality" uncertainty degree evaluation doctrine

The sixth part of the generalization for the degrading state maximal probability determination in the framework of the hybrid-optional functions entropy conditional optimality doctrine initiated in the preceding reports was presented in the given report. The issue will be continued with a following sequence of reports.

Introduction. Continuing the previous research dedicated to optimal periodicity of aeronautical engineering units' maintenance, it is an important issue to formulate the own concept (idea, problem, hypotheses), some original theoretical and practically applicable approaches [1-34].

State of the problem. Having considered the situation when the probability of state "2" $P_2(t)$ undergoes the extremum instead of the probability of state "1" $P_1(t)$ presented with the graph in Figure 1 [10, p. 24, Fig. 1, p. 37, Fig. 3], the problem, **due to the symmetry**, has a symmetrical solution [8-10, p. 36, (64)], [11, p. 91, (17)]:

$$t_p^* = \frac{\ln(\lambda_{02}k_1 + d_1) - \ln(\lambda_{02}k_2 + d_1)}{k_2 - k_1}, \qquad (1)$$

compared with the case when vise versa the probability of state "1" $P_1(t)$ has a maximum on the contrary to the probability of state "2" $P_2(t)$, [8-10, p. 36, (63)], [11, p. 91, (16)]:

$$t_p^* = \frac{\ln(k_1\lambda_{01} + c_1) - \ln(k_2\lambda_{01} + c_1)}{k_2(\cdot) - k_1(\cdot)}, \qquad (2)$$

where t_p^* – optimal (to the probability) time of the maintenance periodicity;

$$k_{1,2} = \frac{-e_1 \pm \sqrt{e_1^2 - 4 f_1 g_1}}{2 f_1}, \quad e_1 = \mu_{20} + \mu_{21} + \lambda_{12} + \mu_{10} + \lambda_{01} + \lambda_{02}, \qquad (3)$$

$$f_1 = 1, \quad g_1 = b_1 + c_1 + d_1, \quad b_1 = \lambda_{12}\mu_{20} + \mu_{10}\mu_{20} + \mu_{10}\mu_{21}, \qquad (4)$$

$$c_1 = \lambda_{01}\mu_{20} + \lambda_{01}\mu_{21} + \lambda_{02}\mu_{21}, \quad d_1 = \lambda_{01}\lambda_{12} + \lambda_{02}\lambda_{12} + \lambda_{02}\mu_{10}, \qquad (5)$$

and the meaning of the intensities λ_{ij} and μ_{ji} determining the process going on in the system is clear from the graph (see the marked arrows in Fig. 1).

Here, in Figure 1, "0" designates the initial up state of the system. That is the system according to the developing stationary Poison flow process has the possible states optimal options related with either the system of parameters $\{k_i, \lambda_{02}, d_1\}$ or $\{k_i, \lambda_{01}, c_1\}$ values for the initial moment probability of the state "0" being equaled to "1".

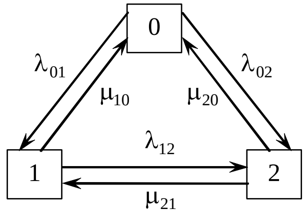

Fig. 1. Graph of the three states of an aeronautical engineering unit

Purpose of the paper. It is to prolong the proposed approach (doctrine) likewise in [8-16] considering the possibility of the optimal optional-hybrid functions distribution for a reliability problem within the “multi-optionality” uncertainty degree evaluation doctrine situation depicted in Figure 1.

Problem setting. Objective functionals for obtaining equations of (1) or (2) are similar. Like proposed in references [8-16], and for a distinguishing ability, let us decide it would be in the case of (2), such objective functional is as follows [8-10, p. 35, (55)], [11, p. 90, (11)]:

$$\Phi_h = -\sum_{i=1}^{3}\left[xF_1^{(i)}\right]\ln\left[xF_1^{(i)}\right] - \frac{t_p^*}{\lambda_{01}}\sum_{i=1}^{3}\left[xF_1^{(i)}\right]\left(M_{12}^{(i)}\right) + \gamma\left[\sum_{i=1}^{3}\left[xF_1^{(i)}\right] - 1\right], \quad (6)$$

where x is an unknown parameter; $h_i = xF_1^{(i)}$ is the multi-optional hybrid functions depending upon the options effectiveness functions of $F_1^{(i)}$; t_p^*/λ_{01} is the intrinsic parameter of the system and the process, it is unknown yet for such problem formulation and the time of t_p^* is going to be determined as a solution, i.e. it is not the equation obtained on the basis of the absolutely probabilistic methods so far, however it will be, to the flow intensity λ_{01}; $M_{12}^{(i)}$, is the algebraic addition of the initial elementary intensities matrix $\mathbf{M}$, formed in the style of the Erlang’s system [24], element of m_{12}; γ is the parameter for the normalizing condition.

The multiplier of x in such a case is expressed with [10, p. 37, (66)]:

$$\sum_{i=1}^{3}\left[xF_1^{(i)}\right] = 1. \quad (7)$$

With respect to the [8-10, p. 35, (55)] second and third conditions:

$$F_1^{(i)} = \frac{M_{12}^{(i)}}{\Delta(\mathbf{M})} = \frac{k_i\lambda_{01} + c_1}{p\left(p^2 + pe_1 + b_1 + c_1 + d_1\right)}, \quad (8)$$

and where p is the complex parameter of the Laplace transformation [10, p. 38, (67)]:

$$x = \frac{p\left(p^2 + pe_1 + b_1 + c_1 + d_1\right)}{\lambda_{01}(k_1 + k_2) + 3c_1}. \quad (9)$$

The optimal optional-hybrid functions are found from [10, p. 38, (68), (69)]:

$$\frac{\partial \Phi_h}{\partial h_i[\cdot]} = 0\,, \quad h_i\left[x, F_1^{(i)}(\cdot)\right] = xF_1^{(i)}\,, \quad \forall i \in \overline{1,3}\,. \qquad (10)$$

Using, the normalizing condition (7) for (6), we obtain the analogue to the known canonical distribution of preferences, [7], [10, p. 39, (74)], [11, p. 91, (18)]:

$$h_i[\cdot] = \frac{e^{-\frac{t_p^*}{\lambda_{01}}\left[M_{12}^{(i)}(\cdot)\right]}}{\sum_{j=1}^{3} e^{-\frac{t_p^*}{\lambda_{01}}\left[M_{12}^{(j)}(\cdot)\right]}}\,. \qquad (11)$$

However in this work we interpret it, Eq. (11), as the optional hybrid functions distribution since we do not consider any active elements or subjects (persons, individuals, or human beings) in the system. Instead we deal with (1)-(11), the objectively existing optimal quality of the system, corresponding with the system intrinsic nature, rather than subjectively preferred (although might be also essential, indispensable) matter [8-10, p. 39].

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