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TWO ENTROPY THEORY WINGS AS A NEW TREND FOR THE MODERN MEANS OF AIR TRANSPORT OPERATIONAL RELIABILITY MEASURE

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Abstract

The paper deals with the uncertainty of the operated system's possible states hybrid combined optional functions. Traditionally, the probabilities of the system's possible states are treated as the reliability measures. However, in the framework of the proposed doctrine, the optimality (for example, the maximal probability of the system's state) is determined based upon a plausible assumption of the intrinsic objectively existing parameters. The two entropy theory wings consider on one hand the subjective preferences functions in subjective analysis, concerning the multi-alternativeness of the operational situation at an individual's choice problems, and on the other hand the objectively existing characteristics used in theoretical physics. The discussed in the paper entropy paradigm proceeds with the objectively presented phenomena of the state's probability and the probability's maximum. The theoretical speculations and mathematical derivations are illustrated with the necessary plotted diagrams.

Keywords: entropy, preference, option, optimization, probability, maximum, alternative, functional, condition.

INTRODUCTION

The diversity of operational circumstances in air transport in conjunction with the multiplicity of the aircraft structures as well as the variety of the options for the aircraft and its components maintenance and repair [1], [2] induce the situations of uncertainty in regards with the modern means of air transport construction, application, and operation. The specifics of the air transport related issues undoubtedly lay within the reliability parameters ensuring and predictions [3], [4]. Scientific search for the new theoretical approaches even in such greatly developed to the tiniest details theories, likewise the reliability theory, probability will never stop; and that will definitely instigate the progress in knowledge.

Concerning the air transport problems uncertainty evaluation, there is a neatly elaborated approach named as Subjective Analysis [5] that deals with the subjective preferences of the available alternatives, which is an implementation of the other entropy paradigm wing initiated in the theoretical physics [6]-[8] for the purely objective phenomena description. Both entropy theory wings [5] and [6]-[8] are now, in the presented study, are proposed to be combined with the purpose of the important characteristic of the reliability measure determination.

A number of practical applications can be considered through the prism of the entropy paradigm [9]-[13]. The advantages and opportunities of such investigations are shown in references [14]-[30].

A SPECIAL CASE TRADITIONAL RELIABILITY APPROACH

If a simplified consideration, similar to the one in [16]-[19], which is demonstrated in the general view in Fig. 1, is taken into account, a special case shown in Fig. 2 is worth being analyzed.

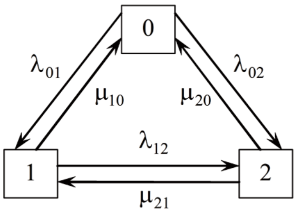

Fig. 1. General case of three states.

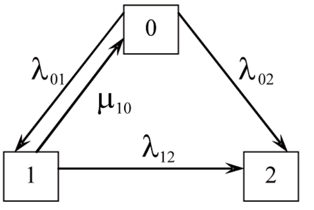

Fig. 2. Graph of three states with one without an exit.

Here, in Fig. 1 and Fig. 2, "0" designates the up state of the system; "1" − damage; "2" − failure. The corresponding values of the failure rates λ_{ij} and restoration rates μ_{ij}, deemed to be constant in time t, will determine the process going on in the system. For the substantiated reasons, for the state of "2" (see Fig. 1) to be a state without an "exit", it has to be satisfied the conditions of $\mu_{20} = \mu_{21} = 0$ (see and compare Fig. 1 and Fig. 2 correspondingly). Then, it, the state of "2", will be a real failure (see Fig. 2).

Probabilities of the corresponding states: "0", "1", "2" – P_0, P_1, and P_2 (see Fig. 1 and Fig. 2) can be found from the expressions of:

$$P_0(t) = \frac{b_1}{k_1 k_2} + \left(1 - \frac{k_2 + a_1 + \dfrac{b_1}{k_2}}{k_2 - k_1} - \frac{b_1}{k_1 k_2}\right) e^{k_1 t} + \left(\frac{k_2 + a_1 + \dfrac{b_1}{k_2}}{k_2 - k_1}\right) e^{k_2 t}, \quad (1)$$

where

$$k_1 = \frac{-e_1 + \sqrt{e_1^2 - 4 f_1 g_1}}{2 f_1}, \qquad k_2 = \frac{-e_1 - \sqrt{e_1^2 - 4 f_1 g_1}}{2 f_1}, \quad (2)$$

$$a_1 = \mu_{20} + \mu_{21} + \lambda_{12} + \mu_{10}, \qquad b_1 = \lambda_{12}\mu_{20} + \mu_{10}\mu_{20} + \mu_{10}\mu_{21}, \quad (3)$$

where

$$e_1 = \mu_{20} + \mu_{21} + \lambda_{12} + \mu_{10} + \lambda_{01} + \lambda_{02}, \qquad f_1 = 1, \qquad g_1 = b_1 + c_1 + d_1, \quad (4)$$

where

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

Or on the other hand:

$$P_0(t)=\frac{k_1e^{k_1t}-k_2e^{k_2t}}{k_1-k_2}+a_1\frac{e^{k_1t}-e^{k_2t}}{k_1-k_2}+\frac{b_1}{k_1k_2}+\left(-\frac{b_1}{k_2(k_2-k_1)}-\frac{b_1}{k_1k_2}\right)e^{k_1t}+\left(\frac{b_1}{k_2(k_2-k_1)}\right)e^{k_2t}. \quad (6)$$

The probabilities of two other states are:

$$P_1(t)=\lambda_{01}\frac{e^{k_1t}-e^{k_2t}}{k_1-k_2}+\frac{c_1}{k_1k_2}+\left(-\frac{c_1}{k_2(k_2-k_1)}-\frac{c_1}{k_1k_2}\right)e^{k_1t}+\left(\frac{c_1}{k_2(k_2-k_1)}\right)e^{k_2t}, \quad (7)$$

and

$$P_2(t)=\lambda_{02}\frac{e^{k_1t}-e^{k_2t}}{k_1-k_2}+\frac{d_1}{k_1k_2}+\left(-\frac{d_1}{k_2(k_2-k_1)}-\frac{d_1}{k_1k_2}\right)e^{k_1t}+\left(\frac{d_1}{k_2(k_2-k_1)}\right)e^{k_2t} \quad (8)$$

correspondingly.

Probabilities of (1) or (6) – (8) are the solutions of the system of the ordinary linear differential equations of the first order by Erlang for the general simplified case illustrated in Fig. 1; and that system will have the view of:

$$\left.\begin{aligned}\frac{dP_0}{dt}&=-(\lambda_{01}+\lambda_{02})P_0+\mu_{10}P_1+\mu_{20}P_2;\\ \frac{dP_1}{dt}&=\lambda_{01}P_0-(\lambda_{12}+\mu_{10})P_1+\mu_{21}P_2;\\ \frac{dP_2}{dt}&=\lambda_{02}P_0+\lambda_{12}P_1-(\mu_{20}+\mu_{21})P_2.\end{aligned}\right\} \quad (9)$$

Also, the solutions of (1) or (6) – (8) are found in the supposition of the initial conditions of:

$$P_0\big|_{t=t_0}=1,\quad P_1\big|_{t=t_0}=P_2\big|_{t=t_0}=0,\quad t_0=0. \quad (10)$$

For the data:

$$\lambda_{01}=5\cdot10^{-3},\quad \lambda_{02}=2\cdot10^{-4},\quad \lambda_{12}=1\cdot10^{-3},\quad \mu_{10}=1\cdot10^{-4},\quad \mu_{20}=\mu_{21}=0, \quad (11)$$

the diagrams plotted as both a numerical solution of system (9) and the analytical one by the equations of (1) and (6) – (8) are shown in Fig. 3.

The vertical axis in Fig. 3 is for the probabilities that were determined in a few different ways. Some of those probabilities were calculated by the different formulas, therefore designated with the different characters (letters, indexes) in order to be distinguished. Since for the same probabilities (although found in different ways) the values coincide (and that fact says about the correctness of suppositions, assumptions made, mathematical derivations), their curves are identical. Hence, these curves of the probabilities represent the same, they (and their designations) can be explained in the following way.

In Fig. 3, there used the designations of a_1, a_0, and a_2 as for the probabilities of $P_1(t)$, $P_0(t)$, and $P_2(t)$ obtained with the computer simulation for the differential equations system (9) with initial conditions of (10) and data of (11). The same probabilities $P_1(t)$, $P_0(t)$, and $P_2(t)$ are calculated by the analytical solutions of (1) and (6) – (8) and designated as $\mathrm{P_1(t)}$, $\mathrm{P_0(t)}$, $\mathrm{P_{00}(t)}$, and $\mathrm{P_2(t)}$

correspondingly for $P_1(t)$, $P_0(t)$, and $P_2(t)$. The curves for the expressions of (1) and (6): P_0(t), P_{00}(t), which is $P_0(t)$, coincide; as well as they both coincide with the numerical solution of a_0. The same corresponding coincidences in pairs are noticeable for two other probabilities of $P_1(t)$ and $P_2(t)$: a_1 coincides with P_1(t) and a_2 with P_2(t), which says about the correctness of the mathematical derivations and solutions, embodied in the procedures shown with the expressions of (1) – (11), and accuracy of calculations.

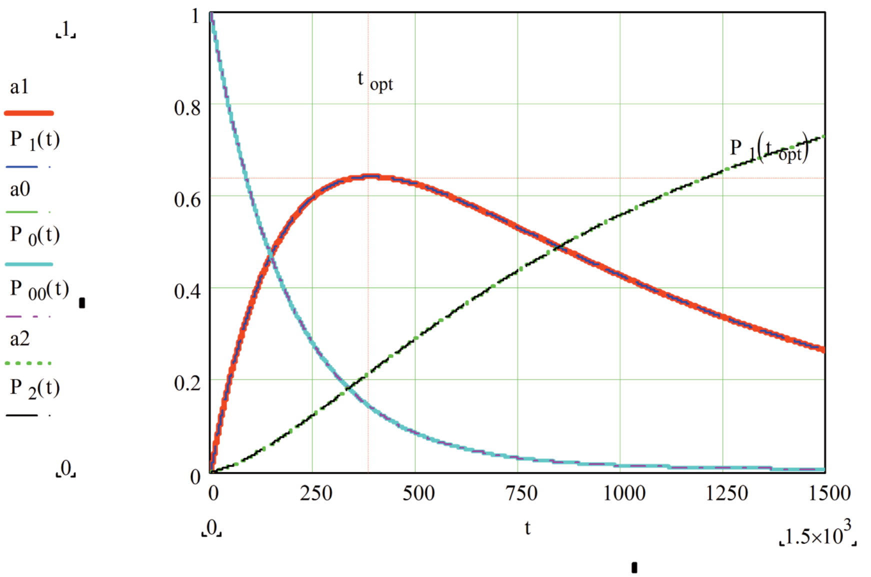

Fig. 3. Numerical and analytical solutions for the probabilities of states.

Now, the important parameter of the system's reliability, the maximal value of the probability $P_1(t)$ of the damaged "1", but not the ruined state "2", must be considered. This may be reckoned as an optimum for the timing of the system maintenance or repair if the probability of $P_2(t)$ does not exceed the boundary limits. Such timing is presumably deemed herewith as the optimal maintenance periodicity t_{opt} (also see Fig. 3). And the $P_1(t)$ probability maximum $P_1(t_{opt})$ is demonstrated in Fig. 3 too.

In order to get the analytical expression for the optimal maintenance periodicity, it has to be used the necessary conditions for an extremum existence:

$$\frac{dP_1(t)}{dt} = 0. \tag{12}$$

Condition (12) being applied to equation (7) yield:

$$\frac{dP_1(t)}{dt} = \frac{\lambda_{01}}{k_1 - k_2}\left(k_1 e^{k_1 t} - k_2 e^{k_2 t}\right) + k_1\left(-\frac{c_1}{k_2\left(k_2 - k_1\right)} - \frac{c_1}{k_1 k_2}\right)e^{k_1 t} + k_2\left(\frac{c_1}{k_2\left(k_2 - k_1\right)}\right)e^{k_2 t}. \tag{13}$$

After equalizing (13) to zero, the optimal maintenance periodicity:

$$t_p^* = \frac{\ln\left(\lambda_{01}k_1 + c_1\right) - \ln\left(\lambda_{01}k_2 + c_1\right)}{k_2 - k_1} \tag{14}$$

can be obtained.

ENTROPY DOCTRINE TREND

Here is an attempt to demonstrate the entropy paradigm approach. Generally speaking, this branch of the entropy application theory is named *the Hybrid-Optional Combined Effectiveness Functions Entropy Conditional Optimization (Extremization) Doctrine* so far.

Imagine that the processes illustrated with the graphs pictured in Fig. 1 and Fig. 2 have three optional states of the system (object) considered; and the multi-optional uncertainty of the processes has the cumulative effect transferring the system from state to state. The probabilities of the system to be in one or another states are stipulated with the characteristics of the failure and restoration intensities or rates (if a simplest Poisson flow of events driving the system from one state into another is considered). The objective measures of reliability such as probabilities of the system's states in some circumstances may have the extremums existed.

In such problem statement, it is not already a problem of Subjective Analysis [5] in the sense of the subjective preferences of the available alternatives conditional optimal distribution due to the entropy measure of the subjective preferences functions uncertainty. It is rather objectively existing, versus subjectively preferred by someone, situation; therefore, there must be a theoretical explanation based on the conditions of the multi-optionality (objective characteristics) rather than (versus) the multi-alternativeness (subjective characteristics). However, this objective consideration should also take into account its own uncertainty (entropy) measure concerning the objectively existing multi-optionality.

The stated above contemplations result in the objective (purpose) functional:

$$\Phi_h = -\sum_{i=1}^{3}\left[xF_1^{(i)}\right]\ln\left[xF_1^{(i)}\right] - \frac{t_p^*}{\lambda_{01}}\sum_{i=1}^{3}\left[xF_1^{(i)}\right]\left(M_{12}^{(i)}\right) + \gamma\left[\sum_{i=1}^{3}\left[xF_1^{(i)}\right]-1\right], \tag{15}$$

where x is an unknown parameter so far;

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

$$\Delta(\mathbf{M}) = p\left(p^2+pe_1+b_1+c_1+d_1\right) \ , \tag{16}$$

where p is complex parameter (variable) of the Laplace transformation for the system of equations (9); then, in (15), t_p^* is unknown parameter which has to be determined, its ratio of t_p^*/λ_{01} is an analogue to β parameter in Subjective Analysis [5], γ is the parameter, coefficient, function (uncertain Lagrange multiplier, weight coefficient) for the normalizing condition.

In the developed hereinafter concept of (15) with (16):

$$h_i = xF_1^{(i)}. \tag{17}$$

And the entropy of such combinations of (17), figuring in the purpose (objective) functional (15):

$$H_h = -\sum_{i=1}^{3}\left[xF_1^{(i)}\right]\ln\left[xF_1^{(i)}\right], \tag{18}$$

related to the process' options (see Fig. 1), is taken into consideration for the entropy (uncertainty degree of the situation) conditional extremization (optimization).

Here, bypassing the purely probabilistic approach of (1) – (8), for (9) – (11), with (12) – (14), and implementing the hybrid-optional functions entropy conditional optimization doctrine in the view expressed with the formulas of (15) – (18) (with the objectively existing measures of reliability rather than subjectively preferred functions of alternatives [5]), the correct objective result (14) is obtained much easier.

Indeed, using the condition of the objective functional (15) possible extremum existence:

$$\frac{\partial \Phi_h}{\partial h_i} = \frac{\partial \Phi_h}{\partial \left[x F_1^{(i)} \right]} = 0, \qquad \forall i \in \overline{1,3}, \tag{19}$$

it can be found that:

$$t_p^* = \frac{\ln\left[F_1^{(1)}(\cdot)\right] - \ln\left[F_1^{(2)}(\cdot)\right]}{k_2(\cdot) - k_1(\cdot)}. \tag{20}$$

And finally, the concept of (19) and (20) yields the optimal solution of (14), with taking into account (16).

DISCUSSION

Comparing both methods (1) – (14) and (15) – (20), leading to the same result of (14), one can notice that for the (1) – (14) approach it is necessary to solve the system of the differential equations of (9).

There are analytical means of the *characteristic equation:*

$$\begin{vmatrix} -(\lambda_{01} + \lambda_{02}) - k & \mu_{10} & \mu_{20} \\ \lambda_{01} & -(\lambda_{12} + \mu_{10}) - k & \mu_{21} \\ \lambda_{02} & \lambda_{12} & -(\mu_{20} + \mu_{21}) - k \end{vmatrix} = 0, \tag{21}$$

where k is root, and the *Laplace transformations* in the *operational calculus:*

$$F(p) = \int_0^{+\infty} e^{-pt} f(t)\, dt, \tag{22}$$

where p is the complex parameter of the transformation, that can be used for that purpose.

Concerning the first mentioned *characteristic equation* method (21) it is required finding the determinant of (21):

$$\begin{gathered} \left[-(\lambda_{01} + \lambda_{02}) - k\right]\left[-(\lambda_{12} + \mu_{10}) - k\right]\left[-(\mu_{20} + \mu_{21}) - k\right] + \lambda_{01}\lambda_{12}\mu_{20} + \\ + \lambda_{02}\mu_{10}\mu_{21} - \left\{\lambda_{02}\left[-(\lambda_{12} + \mu_{10}) - k\right]\mu_{20}\right\} - \left\{\lambda_{01}\mu_{10}\left[-(\mu_{20} + \mu_{21}) - k\right]\right\} - \\ - \left\{\left[-(\lambda_{01} + \lambda_{02}) - k\right]\lambda_{12}\mu_{21}\right\} = 0. \end{gathered} \tag{23}$$

From (23) it can be found the roots of $k_{1,2,3}$. For each root k_i of Eq. (21) and (23), namely k_1, k_2, k_3 one will write down the system of linear uniform (homogenous) algebraic equations with respect to their coefficients $\alpha_1^{(i)}$, $\alpha_2^{(i)}$, $\alpha_3^{(i)}$:

$$\left.\begin{array}{llll} \left[-(\lambda_{01} + \lambda_{02}) - k\right]\alpha_1 & + \mu_{10}\alpha_2 & + \mu_{20}\alpha_3 & = 0; \\ \lambda_{01}\alpha_1 & + \left[-(\lambda_{12} + \mu_{10}) - k\right]\alpha_2 & + \mu_{21}\alpha_3 & = 0; \\ \lambda_{02}\alpha_1 & + \lambda_{12}\alpha_2 & + \left[-(\mu_{20} + \mu_{21}) - k\right]\alpha_3 & = 0. \end{array}\right\} \tag{24}$$

The system (24) derives from an assumption of a partial solution existence in the view of:

$$P_0 = \alpha_1 e^{kt}; \qquad P_1 = \alpha_2 e^{kt}; \qquad P_2 = \alpha_3 e^{kt}; \tag{25}$$

for the system of Eq. (9).

Since having three roots in the stated problem setting, one obtains partial solutions for the general solution of the system of Eq. (9):

– for the root of k_1:

$$P_0^{(1)} = \alpha_1^{(1)} e^{k_1 t}; \qquad P_1^{(1)} = \alpha_2^{(1)} e^{k_1 t}; \qquad P_2^{(1)} = \alpha_3^{(1)} e^{k_1 t}; \tag{26}$$

– for the root of k_2:

$$P_0^{(2)} = \alpha_1^{(2)} e^{k_2 t}; \qquad P_1^{(2)} = \alpha_2^{(2)} e^{k_2 t}; \qquad P_2^{(2)} = \alpha_3^{(2)} e^{k_2 t}; \tag{27}$$

– for the root of k_3:

$$P_0^{(3)} = \alpha_1^{(3)} e^{k_3 t}; \qquad P_1^{(3)} = \alpha_2^{(3)} e^{k_3 t}; \qquad P_2^{(3)} = \alpha_3^{(3)} e^{k_3 t}. \tag{28}$$

Since getting the linearly independent partial solutions as the equations of (26) – (28), the general integral will have the view of:

$$\left.\begin{aligned} P_0 &= C_1 P_0^{(1)} + C_2 P_0^{(2)} + C_3 P_0^{(3)} = C_1 \alpha_1^{(1)} e^{k_1 t} + C_2 \alpha_1^{(2)} e^{k_2 t} + C_3 \alpha_1^{(3)} e^{k_3 t};\\ P_1 &= C_1 P_1^{(1)} + C_2 P_1^{(2)} + C_3 P_1^{(3)} = C_1 \alpha_2^{(1)} e^{k_1 t} + C_2 \alpha_2^{(2)} e^{k_2 t} + C_3 \alpha_2^{(3)} e^{k_3 t};\\ P_2 &= C_1 P_2^{(1)} + C_2 P_2^{(2)} + C_3 P_2^{(3)} = C_1 \alpha_3^{(1)} e^{k_1 t} + C_2 \alpha_3^{(2)} e^{k_2 t} + C_3 \alpha_3^{(3)} e^{k_3 t}; \end{aligned}\right\} \tag{29}$$

where C_1; C_2; C_3 – arbitrary constants.

Determining these constants and coefficients $\alpha_1^{(i)}$, $\alpha_2^{(i)}$, $\alpha_3^{(i)}$: based upon the initial conditions of equations of (10), the solutions of (1) or (6) – (8) can be obtained.

As for the *Laplace transformations* (22), The function $F(p)$ is called the *Laplace transformant* (*image*) of the function $f(t)$, which is called the *initial function*, or *original*. The indication is:

$$L\{f(t)\} = F(p). \tag{30}$$

In accordance with the theorem for the transformants of derivatives, the system of Eq. (9), taking into account the initial conditions of the problem that is for the probabilities of the system's possible states: (10), will have the corresponding algebraic system:

$$\left.\begin{aligned} &\left(pF_0(p) - \left[P_0\big|_{t_0=0} = 1\right] = L\left\{\frac{dP_0}{dt}\right\}\right) = -(\lambda_{01} + \lambda_{02})\left[F_0(p) = L\{P_0\}\right] +\\ &+\mu_{10}\left[F_1(p) = L\{P_1\}\right] + \mu_{20}\left[F_2(p) = L\{P_2\}\right];\\ &\left(pF_1(p) - \left[P_1\big|_{t_0=0} = 0\right] = L\left\{\frac{dP_1}{dt}\right\}\right) = \lambda_{01}\left[F_0(p) = L\{P_0\}\right] -\\ &-(\lambda_{12} + \mu_{10})\left[F_1(p) = L\{P_1\}\right] + \mu_{21}\left[F_2(p) = L\{P_2\}\right];\\ &\left(pF_2(p) - \left[P_2\big|_{t_0=0} = 0\right] = L\left\{\frac{dP_2}{dt}\right\}\right) = \lambda_{02}\left[F_0(p) = L\{P_0\}\right] +\\ &+\lambda_{12}\left[F_1(p) = L\{P_1\}\right] - (\mu_{20} + \mu_{21})\left[F_2(p) = L\{P_2\}\right]. \end{aligned}\right\} \tag{31}$$

The system of equations (31) compact working view is:

$$\left.\begin{aligned} pF_0(p)-1&=-(\lambda_{01}+\lambda_{02})F_0(p)+\mu_{10}F_1(p)+\mu_{20}F_2(p);\\ pF_1(p)-0&=\lambda_{01}F_0(p)-(\lambda_{12}+\mu_{10})F_1(p)+\mu_{21}F_2(p);\\ pF_2(p)-0&=\lambda_{02}F_0(p)+\lambda_{12}F_1(p)-(\mu_{20}+\mu_{21})F_2(p).\end{aligned}\right\} \tag{32}$$

The obtained algebraic equations system, Eq. (32), solving is possible in different ways. One of them is a matrix-vector.

It yields for the transformants:

$$F_0=\frac{M_{11}}{\Delta(\mathbf{M})}=\frac{p^2+pa_1+b_1}{p\left(p^2+pe_1+b_1+c_1+d_1\right)}, \tag{33}$$

$$F_1=\frac{M_{12}}{\Delta(\mathbf{M})}=\frac{p\lambda_{01}+\lambda_{01}\mu_{20}+\lambda_{01}\mu_{21}+\lambda_{02}\mu_{21}}{p\left(p^2+pe_1+b_1+c_1+d_1\right)}, \tag{34}$$

$$F_2=\frac{M_{13}}{\Delta(\mathbf{M})}=\frac{p\lambda_{02}+\lambda_{01}\lambda_{12}+\lambda_{02}\lambda_{12}+\lambda_{02}\mu_{10}}{p\left(p^2+pe_1+b_1+c_1+d_1\right)}. \tag{35}$$

Applying the same designations as of the expressions of (5) to the nominators of the fractions of Eq. (34) and (35) one obtains:

$$F_1=\frac{p\lambda_{01}+c_1}{p\left(p^2+pe_1+b_1+c_1+d_1\right)}, \tag{36}$$

$$F_2=\frac{p\lambda_{02}+d_1}{p\left(p^2+pe_1+b_1+c_1+d_1\right)}. \tag{37}$$

Using the roots for the parameter of *p*, which will be the same as (2) – (5), and after the images (transformants) of (33), (36) and (37) decompositions and transformations to the tabulated fractions, it is possible to find the sought probabilities of (1) or (6) – (8).

Then, both traditional methods, described with the procedures of (21) – (29) for *characteristic equation* and (30) – (37) for the *Laplace transformants*, are being proceeded with the concept of (12) and (13) search, which results in optimal solution (14).

Instead, the proposed doctrine approach (15) – (20), gives (14) bypassing the probabilities determination and extremization.

CONCLUSIONS

The developed approach, conventionally named the hybrid-optional combined effectiveness functions entropy conditional optimization (extremization) doctrine, allowed avoiding the probabilities of states finding for their further optimization. On its part the doctrine proposes the conditional optimization of the uncertainty of the specified functions related with the considered options of the going on process. Thus, the discussed concept delivers the optimal solution, likewise the maximum of the probability of the system's state, based upon a different theoretical background.

The Jaynes' formalism [6]-[8] adopted by Subjective Analysis [5] has got an evolution into the application presented herewith the paper.

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DWA KIERUNKI W TEORII ENTROPII JAKO NOWY TREND BADAŃ NIEZAWODNOŚCI OPERACYJNEJ WSPÓŁCZESNYCH ŚRODKÓW TRANSPORTU LOTNICZEGO

Abstrakt

Artykuł dotyczy niepewności możliwych stanów eksploatowanego systemu hybrydowych połączonych funkcji opcjonalnych. Tradycyjnie jako miary niezawodności traktuje się prawdopodobieństwa możliwych stanów systemu. Jednak w ramach proponowanej doktryny optymalność (na przykład maksymalne prawdopodobieństwo stanu systemu) jest określana na podstawie wiarygodnego założenia o obiektywnie istniejących parametrach wewnętrznych. Dwa kierunki w teorii entropii uwzględniają z jednej strony subiektywne funkcje preferencji w analizie subiektywnej, dotyczące wielowariantowości sytuacji operacyjnej przy indywidualnych problemach wyboru, a z drugiej strony obiektywnie istniejące cechy stosowane w fizyce teoretycznej. Omawiany w artykule paradygmat entropii kontynuuje obiektywnie przedstawione zjawiska prawdopodobieństwa stanu i maksimum prawdopodobieństwa. Spekulacje teoretyczne i wyprowadzenia matematyczne zilustrowano za pomocą niezbędnych wykresów.

Słowa kluczowe: entropia, preferencja, optymalizacja, prawdopodobieństwo, alternatywa, funkcjonalność, warunek.