Ministry of Education and Science of Ukraine
National Aviation University

TRANSPORT VEHICLES OPERATION PART VI: THE SIMPLEST SYSTEM RELIABILITY

SELF-STUDY METHOD GUIDE

Part VI

For the Students of the
Field of Study 27 “Transport”
Specialty 275 “Transport Technologies”

Kyiv 2023

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А992

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Містять декілька рекомендацій для самостійної роботи щодо застосування знань отриманих при проходженні дисципліни «Експлуатація транспортних засобів», що є необхідним для виконання робіт індивідуального завдання, підготовки до складання заключних видів контролю.

Для студентів 2-го курсу галузі знань 27 «Транспорт», спеціальності 275 «Транспортні технології (на авіаційному транспорті)».

А992 **Transport Vehicles Operation. Part VI : The Simplest System Reliability** : Self-Study Method Guide . Part VI / compiler: A. V. Goncharenko. – K. : NAU, 2023. – 55 p.

The **METHOD GUIDE** contains a few recommendations on the Self-Study in regards with the application of the knowledge acquired at the study of the Academic Subject “Transport Vehicles Operation” carrying out, which is indispensable to complete the works of the individual task, get ready for passing the final kinds of the check.

Designed for the 2nd year students of the Field of Study 27 “Transport”, Specialty 275 “Transport Technologies (by Air Transport)”.

CONTENTS

INTRODUCTION

This **METHOD GUIDE ON THE SELF-STUDY** (SS) is contemplated as an ideological continuation of **PART I-V:**

[263]: **"Transport** Vehicles Operation. Part I : Number of Transport Vehicles : Self-Study Method Guide . Part I . Number of Transport Vehicles . Optimal Choice Dilemma / compiler: A. V. Goncharenko. – K. : NAU, Electronic Repository. – 2022. – 48 p. https://er.nau.edu.ua/handle/NAU/56234, Method_Guide.pdf."

[275]: **"Transport** Vehicles Operation. Part II: Elementary Supply Chain Optimization : Self-Study Method Guide . Part II / compiler: A. V. Goncharenko. – K. : NAU, Electronic Repository. – 2023. – 53 p. https://er.nau.edu.ua/handle/NAU/62062, II_TVO_SSG.pdf."

[276]: **"Transport** Vehicles Operation. Part III : Elementary Optimal Supply Speed : Self-Study Method Guide . Part III / compiler: A. V. Goncharenko. – K. : NAU, Electronic Repository. – 2023. – 53 p. https://er.nau.edu.ua/handle/NAU/62139, III_TVO_SSG.pdf."

[277]: **"Transport** Vehicles Operation. Part IV : Optimal Number of Transport Vehicles : Self-Study Method Guide . Part IV / compiler: A. V. Goncharenko. – K. : NAU, Electronic Repository. – 2023. – 57 p. https://er.nau.edu.ua/handle/NAU/62141, IV_TVO_SSG.pdf."

[278]: **"Transport** Vehicles Operation. Part V: The Simplest Problem of the Probability of a Choice : Self-Study Method Guide . Part V / compiler: A. V. Goncharenko. – K. : NAU, Electronic Repository. – 2023. – 54 p. https://er.nau.edu.ua/handle/NAU/62159, V_TVO_SSG.pdf."

in response to the needs of our students in more detailed elaborations concerning the **TRANSPORT VEHICLES OPERATION** (TVO) tasks stated, set, or given for the students' independent work on this **ACADEMIC SUBJECT** for the specified **CALCULATION AND GRAPHIC PAPER** (CGP), possibly used in their further educational works, such as their **TERM PAPERING** (TP), **COURSE PROJECTING** (CP), further **GRADUATION PAPERS** or even **PH.D. STUDIES.** The whole material is split into portions. Each portion is intended to cover a fraction of the probable applications aimed at the **TRANSPORT TECHNOLOGIES** (TT) (by **AIR TRANSPORT** (AT)), particularly dealing with the **TRANSPORTATION ORGANIZATION AND MANAGEMENT ON TRANSPORT** (TOMT) for AT. It means AT management in operation possibly including some **AIRCRAFT** (A/C) technical operation issues in regards with the **AERONAUTICAL ENGINEERING** (AE) **MAINTENANCE** (M/T), as for example, in aviation business.

The presented in the sixth part, **PART VI,** of the **METHOD GUIDE ON THE** SS assignments are dedicated, and a special attention is drawn here,

to the general aspects of the SS work for the TVO practical works, individual task, final kinds of the check, future students' prospective research and scientific publications as well as conference reports and presentations.

The scientific component of the SS work is very important. That is why, specifically, the objectives of the **PART VI** material are to help students cope with the challenging problems relating to the studied **ACADEMIC SUBJECT** of TVO on the AT management in operation, for instance, A/C technical operation in regards with the aeronautical engineering M/T as well as the **AIRCRAFT AIRWORTHINESS** support measures.

The set of the considered issues is based upon the **RECOMMENDED LITERATURE SOURCES** (the list is presented, but not limited to it). The **LIST OF LITERATURE** at the end of the **METHOD GUIDE** is basic (major) and compiled partially not only in the alphabetic order, but mainly with respect to the matter of supposed (assumed) importance.

The **REFERENCES LIST** is selected, set in the order [1-278], does not pretend for completeness, but instead it is aimed at developing the students' abilities of thinking and to analyze, contemplate in the specified directory rather than their abilities to know and memorize. However, these are very significant too. Actually, in the contemporary informative boom world, the needed or required data can be easily retrieved from the internet, found in multiple references, guidance materials [1-23], studies, dictionaries, comprehensive books, publications and scientific papers like [24-278] amongst those monographs [9, 90, 108, 121, 198, 201, 206] etc. The **METHOD GUIDE** is designed for the 2nd year students (**BACHELOR'S DEGREE** contenders) in the Field of Study: 27 "Transport", Specialty: 275 "Transport technologies (by air transport)", Specialization: 05 "Air Transportation Management". The considered studied academic subject of TVO finalizes the previous education in the Field of Study: 27 "Transport", Specialty: 275 "Transport technologies (by air transport)", (**BACHELOR'S DEGREE** contenders); plus of the 1st year students (**BACHELOR'S DEGREE** contenders) in the Field of Study: 27 "Transport", Specialty: 275 "Transport technologies (by air transport)", Specialization: 05 "Air Transportation Management". There are a lot of the planned academic subjects in the **BACHELOR'S** and **MASTER'S**

DEGREE CURRICULA (CURRICULUMS) related to the considered studied academic subject of TVO.

This very special sixth part, **PART VI,** of the studied academic subject of TVO is aimed at the **MATHEMATICAL SETTING OF THE PROBLEMS** considered in the CGP on TVO, with the possibilities of the further development to education work, such as, course projects, even up to the graduation papers, **BACHELOR'S** and **MASTER'S DEGREE GRADUATION WORK,** or even Ph.D. studies. Therefore it is strongly suggested for the students to agree their own envisaged course projects, **BACHELOR'S** and **MASTER'S DEGREE GRADUATION WORK THEMES** and prospective research areas with their **SUPERVISORS**.

The scientific portion of the students' SS work might prolong the initiated at the preceding stages of the **BACHELOR'S DEGREE** contending study. It includes the **students' SS research results publication in scientific journals and scientific conferences proceedings**. In the prospect such kinds of the students' activity may lead to a successful defense of the **GRADUATION WORK** or a successful passing the **FINAL STATE EXAMINATION;** as well that may lead to a successful passing of the **UNIVERSITY PH.D.'S DEGREE PROGRAM ENTRANCE EXAMINATION.** The other benefit of the research results publication may be, for example, in the detailed solutions for obtaining the optimal distributions of transportation means: [263, 277], their combinations, optimization of the supply chain links: [275], and supply speeds: [276], probability of a choice: [278], reliability objective measures allowing assessing the improvements of the A/C functional system M/T process considered in references [138-140].

Herewith it is proposed to continue the search for the detailed solutions for the examples considered in the references of:

[194]: **"Goncharenko A. V.** Multi-optional hybridization for UAV maintenance purposes / A. V. Goncharenko // 2019 IEEE 5th International Conference "Actual Problems of Unmanned Aerial Vehicles Developments (APUAVD)" Proceedings. – October, 22-24, 2019, Kyiv, Ukraine. – 2019. – pp. 48-51."

[182]: **"Goncharenko A. V.** Relative Pseudo-Entropy Functions and Variation Model Theoretically Adjusted to an Activity Splitting / A. V. Goncharenko // 2019 9th International Conference on Advanced Computer Information Technologies (ACIT'2019). – June 5-7, 2019. – Ceske Budejovice, Czech Republic, 2019. – pp. 52-55."

[71]: **"Goncharenko A. V.** Measures for estimating transport vessels operators' subjective preferences uncertainty / A. V. Goncharenko // Scientific Bulletin of Kherson State Maritime Academy. – 2012. – № 1(6). – pp. 59-69."

Completion of CGP is an independent / individual student's work of a creativeness.

The essential sections of the student's report of the CGP completion are:

Introduction;
Literature survey;
Theoretical background;
Major dependencies;
Statistical data;
Student's own contribution;
Derivations;
Findings;
Calculations;
Plotting diagrams;
Analysis;
Discussion;
Conclusion;
References;
Other necessary parts (significant results).

The time required for CGP completion is about 10 academic hours.

The length of the report for the about 10 academic hours completion work is up to 5 pages.

For the **PANDEMIC QUARANTINE PERIOD,** especially **MARTIAL LAW,** it possibly might have the corrections in the **ORDER** of the SS on TVO carrying out.

The general control for the SS on TVO performance is realized (amongst others) through the corresponding **GOOGLE CLASS ROOM.**

Thus, dear students, get down to this challenge to demonstrate your own creativity!

GENERAL PROVISIONS

The principal theoretical provisions can be found out in references [1-23].

1. Planned hours

According to the **TRAINING PROGRAM** on the **ACADEMIC SUBJECT** of the considered TVO and depending upon the particular academic hours specified for the training and study, the entire **SUBJECT** may contain up to many hours.

According with the **TIME TABLE, PROGRAM,** and **CURRICULUM,** regularly approved by the **UNIVERSITY RECTOR'S ORDER,** it figures out like following:

17-19 (optionally 18) weeks of the **SEMESTER WORK,** including some days for the **MODULE TESTS** or the **CGP DEFENSE,** final **GRADED TEST CHECK.**

Thus, it all usually makes a **SEMESTER** weeks **PERIOD.**

Regularly, there might be **2 SHIFTS** that are planned for the **STUDENTS.**

Namely:
The **1ST SHIFT** starts at 8:00;
The **2ND SHIFT** starts at 15:20.

For the **SOPHOMORIC STUDENTS** it is usually the **1ST SHIFT;** and for the not large groups it is just **COMMON LABORATORY CLASSES**, without dividing the groups into **HALVES (SUBGROUPS).**

Therefore, duration is 2 (4) academic hours a week for each **STUDENT** of a group on the day of the **LECTURE DELIVERY** and **LABORATORY CLASS CONDUCTION.** Totally it makes up to 30-40 academic hours of **AUDITORIUM WORK** for the entire considered studied academic subject of TVO. Then, it is plus about up to two thirds

of SS (up to 100 academic hours) including up to 30 academic hours for CGP. As whole it may have variations.

As a rule, the information on the **TIME TABLE, PROGRAM,** and **CURRICULUM,** and **TOPICS** are provided at the **AIR TRANSPORTATION MANAGEMENT DEPARTMENT** on the **INFORMATION BOARD (DESK)**; as well as, it can be displaced at the corresponding **GOOGLE CLASS ROOM** and/or the **DEPARTMENT WEBSITE (PAGE), UNIVERSITY REPOSITORY PAGE** etc.

For the **PANDEMIC QUARANTINE PERIOD,** especially **MARTIAL LAW,** the general control for the CGP performance is possible (amongst others) through the corresponding **GOOGLE CLASS ROOM.**

2. Subject content

This step is very important too.

The mentioned above 18 (16) weeks of the Semester study **STUDENTS' WORK** (accordingly with the **TIME TABLE)** are, or might be, subdivided into **COMMON AND INDIVIDUAL TOPICS**:

1.1. Organizational meeting. Instruction on labour protection and fire safety.
1.2. Common aspects of the General Approaches.
1.3. Individual Tasks relations to the chosen research areas.
1.4. Correspondence with the Final Work theme.
1.5. Appropriate methods of the research.
1.6. Mathematical Apparatus for the objectives.
1.7. Mathematical formulation of the conceptual provisions.
1.8. Experimentations.
1.9. Statistical Data processing.
1.10. Analysis of the obtained preliminary results.
1.11. Choice of the corrective methods and ideas.
1.12. Analysis of the use of the corrected methods research results.
1.13. Implementation into the Final Work.
1.14. Prospects of the research results application.
1.15. Publication of the research results.

These **TOPICS** might also be provided at the **AIR TRANSPORTATION MANAGEMENT DEPARTMENT** on the **INFORMATION BOARD (DESK)**; as well as, they can be displaced at the corresponding **GOOGLE CLASS ROOM** and/or **UNIVERSITY REPOSITORY PAGE.**

There is one major document that the student must prepare: CGP **REPORT**. The **REPORT** of the CGP is discussed at the corresponding following **SECTIONS** of this SS **METHOD GUIDE.**

After this **PROGRAM** on CGP completion, and having done and submitted the own **REPORT,** every **STUDENT (AUTHOR)** is supposed attempting to pass the

DEFENSE AND GRADED TEST

The ***DEFENSE*** is going to be discussed further on in this SS **METHOD GUIDE.**

And the best way of the CGP completion is the **SCIENTIFIC PUBLICATION,** which also will be instructed down here in the presented SS **METHOD GUIDE.**

Theoretical material for the CGP tasks is based upon references [1-278]. The idea is traced from the comparatively newest (latest) books [4, 5, 9, 13-17], **NATIONAL PROVISIONS** for aviation business in compliance with the **IATA, EASA,** continental, normative documents, and **ICAO** requirements like in [14]. Some convenient aspects of the subject learning are in the TOMT for AT, TT (by AT), **DIRECTIVES ON TECHNICAL OPERATION,** A/C and AE M/T, referred to in [14].

For the **PANDEMIC QUARANTINE PERIOD,** especially **MARTIAL LAW,** the general control for the CGP performance is possible (amongst others) through the corresponding **GOOGLE CLASS ROOM.**

RELIABILITY OF THE SIMPLEST SYSTEMS

The principal theoretical provisions can be found out in the references [1-23] and other literature sources and informational resources. Especially [23].

The directions of the CGP work and their completion are reflected in the series of problems offered to be considered, set, and solved.

1. Basic theoretical provisions

Consider the simplest system consisting out of the elementary subsystems. The task is to determine the reliability measures.

The simplest system scheme for the reliability measures prediction is represented in Fig. 5.1.

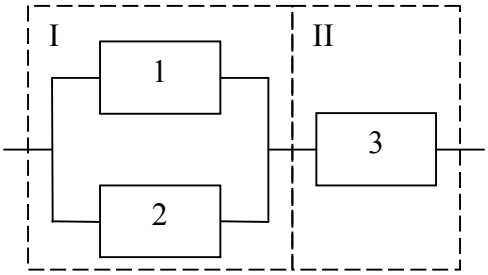

Fig. 5.1 – The simplest system reliability measures prediction scheme

The simplest system shown in Fig. 5.1 consists of three elements.

The elements of "1" and "2" are working in parallel (duplicate each other). Such redundancy means that subsystem "I" fails only if both elements of "1" and "2" fail.

Subsystem "II" consists of just one element "3" (without reserve) functioning in a sequential manner with the subsystem "I" which implies that the whole system fails when at least just one of the two subsystems fails (either "I" or "II" or both).

As to the reliability of the system, subsystems, and depending upon the elements failure-free operation, it should be noted that the whole system is

reliable only if both subsystem (when “I” and “II” necessarily both) are in the up state. This is stipulated by the subsystems sequential connection.

The redundancy of the elements of “1” and “2” ensures the failure-free operation for the subsystem “I” in case when at least just one of the two elements is in up state (either “1” or “2” or both).

Supposedly, in the limits of the given operating time, the reliabilities and probabilities of failures for the elements of “1”, “2”, and “3” are as follows:

$$R_1(t),\quad R_2(t),\quad R_3(t),\quad Q_1(t),\quad Q_2(t),\quad Q_3(t), \tag{5.1}$$

where $R_i(t)$ is the reliability function (survival function) of the "i"$^{\text{th}}$ element during the given operating time t; $Q_i(t)$ is the unreliability function of the "i"$^{\text{th}}$ element during the given operating time t.

In the probabilistic terms, $R_i(t)$ is the probability of the up state (failure-free state); and $Q_i(t)$ is the probability of the failure (down state) of the "i"$^{\text{th}}$ element during the given operating time t.

From the probabilistic point of view

$$R_i(t)+Q_i(t)=1, \tag{5.2}$$

at any moment of time (it implies either up or down state only) for any element, subsystem or the whole system.

To determine the reliability of the system is possible in a few ways.

The one way is to compile the complete group of the non-conjoint events; their probabilities lead to the normalizing condition of the equation of (4.22). The total number of all possible outcomes is likewise the one of the equation of (4.21), i.e.

$$m^n, \tag{5.3}$$

where m is the number of the possible non-conjoint states of each of the system’s elements; n is the number of the elements each of which can be in either up or down state only.

Thus, for the system schematically portrayed at Fig. 5.1, the probabilities of the complete group of the possible non-conjoint outcomes, which are the

elementary occurrences, will be, likewise in the previous problem above, (4.13)-(4.20):

$$1.\ P_{1,2,3}(t) = R_1(t)R_2(t)R_3(t). \tag{5.4}$$

$$2.\ P_{1,2,\bar{3}}(t) = R_1(t)R_2(t)Q_3(t). \tag{5.5}$$

$$3.\ P_{1,\bar{2},3}(t) = R_1(t)Q_2(t)R_3(t). \tag{5.6}$$

$$4.\ P_{\bar{1},2,3}(t) = Q_1(t)R_2(t)R_3(t). \tag{5.7}$$

$$5.\ P_{\bar{1},\bar{2},3}(t) = Q_1(t)Q_2(t)R_3(t). \tag{5.8}$$

$$6.\ P_{\bar{1},2,\bar{3}}(t) = Q_1(t)R_2(t)Q_3(t). \tag{5.9}$$

$$7.\ P_{1,\bar{2},\bar{3}}(t) = R_1(t)Q_2(t)Q_3(t). \tag{5.10}$$

$$8.\ P_{\bar{1},\bar{2},\bar{3}}(t) = Q_1(t)Q_2(t)Q_3(t). \tag{5.11}$$

In the mentioned equations above, (5.4)-(5.11), $P_{\bullet,\bullet,\bullet}(t)$ are the probabilities of the corresponding elementary events; the probabilities' subscripts in the style of 1, $\bar{1}$, 2, $\bar{2}$, 3, and $\bar{3}$ symbolize the elements up and down state in respect.

Since the probabilities of (5.4)-(5.11) are the probabilities of the complete group of the non-conjoint events, like in the previous **PART V:** [278], problem (4.13)-(4.20), their sum will be the normalizing condition identical to the equation of (4.22), i.e.

$$\sum_{i=1}^{8} P_i = 1, \tag{5.12}$$

where i is the subscript depicting each of the all eight possible elementary occurrences variants of (5.4)-(5.11).

In such terms and according to the considered functioning system scheme presented at Fig. 5.1, the reliability state of the system's work is characterized by

$$R_S(t) = P_{1,2,3}(t) + P_{1,\bar{2},3}(t) + P_{\bar{1},2,3}(t), \tag{5.13}$$

where $R_S(t)$ is the reliability function (survival function) of the system, that is the probability of the system's up state (failure-free state).

In fact, reliability (5.13) takes into account # 1, 3, and 4 variants of (5.4), (5.6), and (5.7) out of (5.4)-(5.11).

The system's unreliability function: $Q_S(t)$, the probability of the system's failure (down state) can be determined in an analogous way, i.e.

$$Q_S(t) = P_{\bar{1},\bar{2},\bar{3}}(t) + P_{1,2,\bar{3}}(t) + P_{\bar{1},2,\bar{3}}(t) + P_{1,\bar{2},\bar{3}}(t) + P_{\bar{1},\bar{2},3}(t). \tag{5.14}$$

The probability of the system's failure: $Q_S(t)$, (5.14), takes into account # 2 and 5-8 variants of (5.5) and (5.8)-(5.11) out of (5.4)-(5.11).

It can be found more simply from the normalizing conditions of (5.2) or (5.12), i.e.

$$Q_S(t) = 1 - R_S(t). \tag{5.15}$$

2. The system's subsystems approach

The other way of solving the problem is to consider the structure of the system in the terms of the system's subsystems consisting of either parallel or sequential connections of the elements; and the subsystems are also considered like new elements connected in either parallel or sequential way in the original entire system. This more rational approach decreases the number the considered variants as well as reducing the amount of calculations for complex and complicated systems.

For the presented example (see Fig. 5.1), there are two subsystems: "I" and "II".

For the first subsystem it is easier to find the probability of the subsystem's failure:

$$Q_I(t) = P_{\bar{1},\bar{2}}(t) = Q_1(t)Q_2(t). \tag{5.16}$$

And for the entire original system it is easier to find the probability of the system's failure-free operation:

$$R_S(t) = P_{I,II}(t) = R_I(t)R_{II}(t) = [1 - Q_I(t)]R_2(t). \tag{5.17}$$

Or, expressing in (5.17) via elements' states probabilities of (5.16)

$$R_S(t) = \{1 - [Q_1(t)Q_2(t)]\}R_2(t). \tag{5.18}$$

As a whole, the approach of (5.16)-(5.18) implements the general dependencies: For parallel connection

$$Q_{Par}(t) = \prod_{i=1}^{n} Q_i(t), \tag{5.19}$$

where n is the number of the paralleled elements.

And for sequential connection

$$R_{Seq}(t) = \prod_{j=1}^{m} R_j(t), \tag{5.20}$$

where m is the number of the sequentially connected elements.

From (5.1)-(5.20) one can analyze the reliability optimal solution. It depends upon some parameters. Their values are up to the students.

3. Numerical simulation

The illustration to the graphical representation is based upon the Mathcad calculation platform.

The magnitudes of the values have a certain conventional (some conditional) measurement units (dimensions).

The students are supposed to set the correspondence.

Suppose for the system, the scheme of which is shown in Fig. 5.1, the reliability functions: (5.1), for some operational time would be as they are represented in Fig. 5.2.

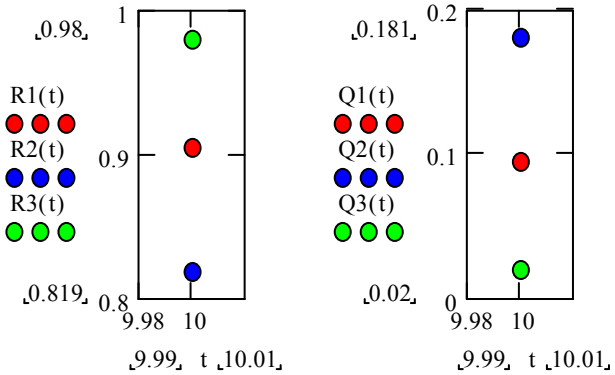

Fig. 5.2 – Reliability functions values

Elementary outcomes probabilities, obtained by of (5.4)-(5.11), and the system's failure-free operation functions, determined by calculations with the formulas of (5.1)-(5.20), are shown in Fig. 5.3.

In Fig. 5.3 RsP(t) is found by (5.16)-(5.20).

Dynamics of the system's reliability is modeled with the relation

$$R_i(t) = e^{-\lambda_i t}, \qquad (5.21)$$

where λ_i is the failure rate (in some circumstances it is the same as the failure intensity) of the "i"th element.

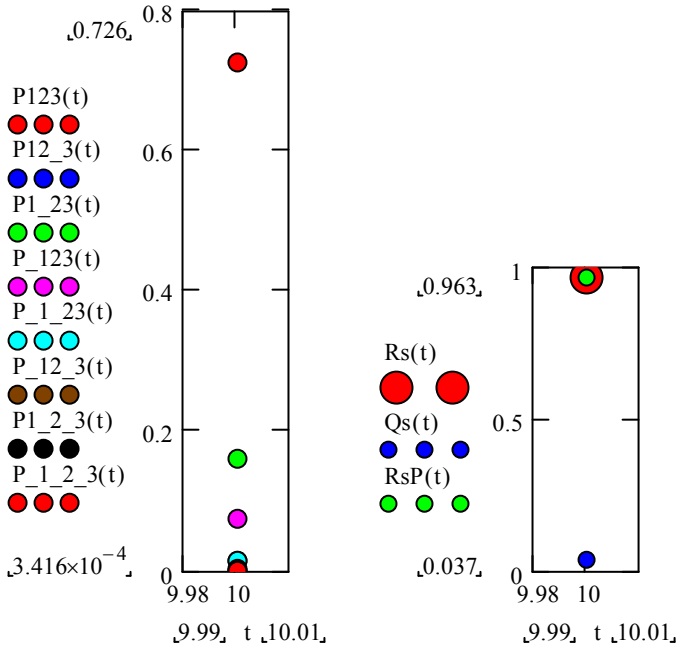

Fig. 5.3 – Elementary outcomes probabilities and system reliability functions

Simulation results in regards with the operational time variation, found by the calculations with the formulas of (5.1)-(5.21), are illustrated in Fig. 5.4-Fig. 5.7.

The approach (5.1)-(5.21) allows researching the influence of other parameters.

There are some developments of the problem; in the number of the elements and their interconnections, models of the probabilistic values, "good" and "bad" aircraft, optimization, different aircraft fleets varying in the aircraft numbers, aircraft types, trajectories, distances, speeds, other random (stochastic, probability) values, cost and other economical issues, dynamics, subject to additional conditions or constraints and so on.

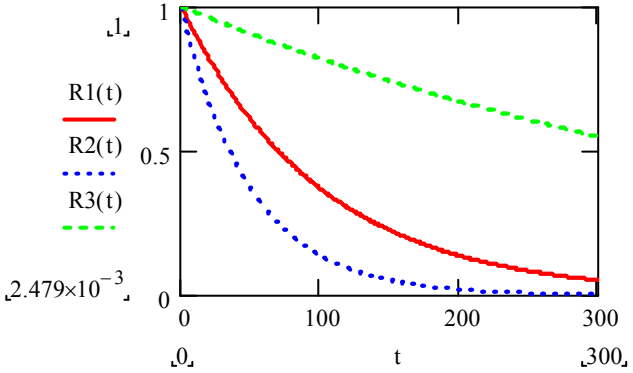

Fig. 5.4 – Reliability functions values

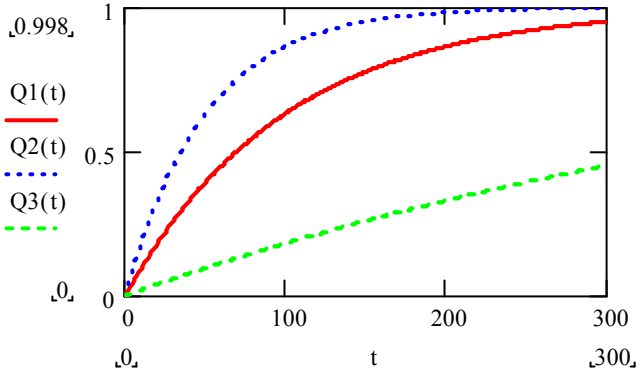

Fig. 5.5 – Failure functions values

It is possible to plot three-dimensional surfaces and graphically find solutions upon them.

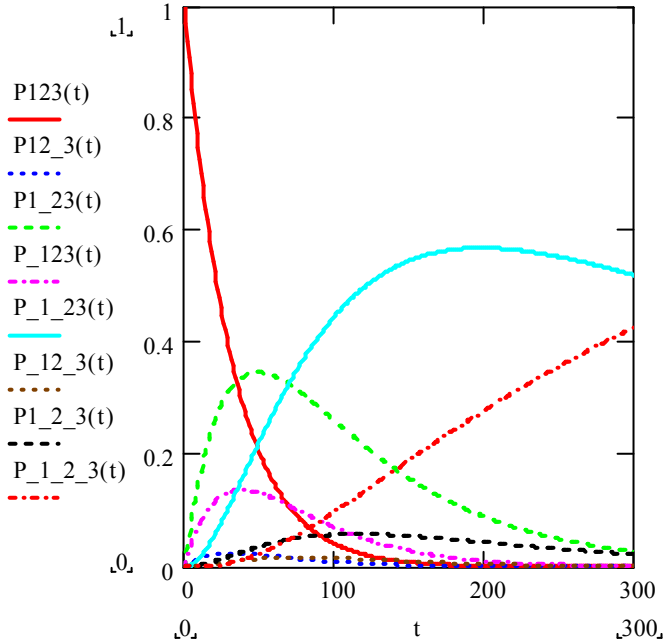

Fig. 5.6 – Elementary outcomes probabilities

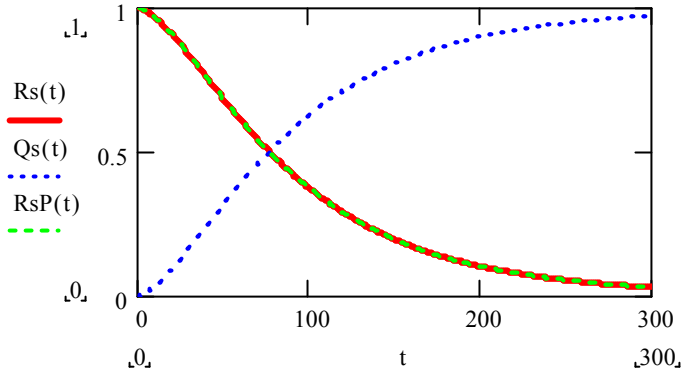

Fig. 5.7 – System reliability functions

REPORT PREPARATION

The CGP stages are aimed at the effective CGP time management and results estimation control in the field of TOMT for AT, TT (by AT), A/C and AE M/T.

The best way is when it leads to the **SCIENTIFIC FORMALIZATION** of the **RESEARCHED MATTER.** For this purpose the **SCIENTIFIC PUBLICATIONS** suit the best.

The CGP **REPORT** is usually prepared in accordance with the **REPORT TEMPLATE.** As a rule it is provided at the corresponding **GOOGLE CLASS ROOM** and/or **UNIVERSITY REPOSITORY PAGE.**

The **REPORT** must contain the materials connected with CGP, especially with the **REPORT SECTIONS** characteristic, **INTRODUCTION, IMPORTANCE, TOPICS** etc.

The CGP work completion **REPORT** reflects the student's own achievements in acquiring the practical knowledge and skills of work in the **SCIENTIFIC FORMALIZATION** of the **RESEARCHED ISSUES.** For this purpose the **SCIENTIFIC PUBLICATIONS** suit the best.

The **REPORT** must contain the materials connected with CGP, especially with the researched object characteristic, student's own achievements etc.

The **REPORT** must be **SIGNED** (amongst the others) by the **AUTHOR (STUDENT),** with pointing the **NAMES** and **POSITIONS;** also **DATED.**

The **AUTHOR (STUDENT);** should characterize generally the topic; and He/She should emphasize the strong and weak points of the CGP work.

Finally, the **AUTHOR (STUDENT)** should evaluate the CGP work with the own reasonable and own rational **GENERAL ESTIMATION.**

After the CGP work completion (all is **SIGNED, DATED, AND SO ON**) it **(**CGP **REPORT)** must be, along with the CGP author's own **SCIENTIFIC PUBLICATIONS** (if there are any **RELEVANT**), submitted to the **DEPARTMENT COMMISSION** for the **DEFENSE**.

DEFENSE

The principal theoretical provisions can be found out in the references [1-23].

The **DEFENSE** of the CGP **REPORT,** along with the CGP **RELEVANT SCIENTIFIC PUBLICATIONS** (if there are any) on the CGP works completion takes place in the **AIR TRANSPORTATION MANAGEMENT DEPARTMENT COMMISSION** on the corresponding CGP.

The process of the **DEFENSE** is held at the specified period of time.

The **AIR TRANSPORTATION MANAGEMENT DEPARTMENT COMMISSION** on the corresponding CGP is to put the contending **STUDENT** the **FINAL ESTIMATION MARK.**

PUBLICATIONS

The principal theoretical provisions can be found out in the lecture notes of the students who have been attended the lectures, completed practical and laboratory works, finished course projects and homework etc., have some scientific inclinations and in the references [1-278].

For nowadays, it is incredibly important for the students to take part in some scientific activity. Results of such deeds as scientific research must be duly presented to the scientific community. The most popular forms of such presentation are the publications in:

1. Scientific Journals
2. Proceedings of the Scientific Conferences

In any case it is up to the students what and how to do, but relevant **PUBLICATIONS** will definitely help enter the **NEXT STAGE OF EDUCATION** and defend **EDUCATIONAL GRADUATION** and **SCIENTIFIC QUALIFICATION WORKS,** theses, dissertations etc.

Generally speaking the move toward the **PUBLICATIONS** actions may be reduced to a few indispensable steps. Perhaps, the first and apparently the most important is the choice of the scientific supervisor. It has to relate with the general theme of the research and the contender preferences. After finding such field of the creative potential application, it is reasonable to distinguish the specific direction, formulate the problem, propose the solution, and demonstrate verification of the approach and scientific findings.

All the students' findings, including made at the CGP, may be implemented into further students' achievements.

For nowadays the most valuable **PUBLICATIONS** are those indexed in the **SCOPUS** and **WEB OF SCIENCE SCIENTIFIC DATABASES.**

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Навчальне видання

ЕКСПЛУАТАЦІЯ ТРАНСПОРТНИХ ЗАСОБІВ

Частина VI

НАДІЙНІСТЬ НАЙПРОСТІШОЇ СИСТЕМИ

Методичні рекомендації
до виконання самостійної роботи
для студентів 2-го курсу галузі знань 27 «Транспорт»,
спеціальності 275 «Транспортні технології
(на авіаційному транспорті)»,
спеціалізації 05 «Організація авіаційних перевезень».

(Англійською мовою)

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