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**Federal State Autonomous Educational Institution
Higher Education "Peoples' Friendship University of Russia named after Patrice
Lumumba"**

Academy of Engineering

(name of the main educational unit (MEU) – developer of the educational program of higher education)

STATE FINAL CERTIFICATION PROGRAM

Recommended by the ICSC for the field of study/specialty:

27.03.04 Control in Technical Systems

(code and name of the training area/specialty)

**The state final certification is carried out within the framework of the implementation of
the main professional educational program of higher education (EP HE):**

Data Science and Space Systems / Data Science and Space Systems

(name (profile/specialization) of the educational institution of higher education)

1. PURPOSE AND OBJECTIVES OF THE STATE FINAL CERTIFICATION (SFC)

The goal of conducting the State Final Attestation within the framework of the implementation of the educational program of higher education “Data Science and Space Systems / Data Science and Space Systems” is to determine the compliance of the results of mastering the educational program of higher education by students with the relevant requirements of the RUDN University Educational Standards.

The following are the criteria for state final certification:

- checking the quality of teaching an individual basic humanitarian knowledge, natural scientific laws and phenomena necessary in professional activities;
- determining the level of theoretical and practical preparedness of the graduate to perform professional tasks in accordance with the qualification received;
- establishing the degree of an individual’s desire for self-development, improving their qualifications and skills;
- checking the formation of a graduate’s sustainable motivation for professional activity in accordance with the types of professional activity tasks provided by the RUDN University Educational System;
- assessment of the level of ability of graduates to find organizational and managerial solutions in non-standard situations and their readiness to take responsibility for them;
- ensuring the integration of education and scientific and technical activities, increasing the efficiency of using scientific and technical achievements, reforming the scientific sphere and stimulating innovative activities;
- ensuring the quality of training of specialists in accordance with the requirements of the RUDN University Educational Standards Board.

2. REQUIREMENTS TO THE RESULTS OF MASTERING THE OP HE

A student who has no academic debt and has fully completed the curriculum or individual curriculum of the educational program of higher education is admitted to the State Final Attestation.

Upon completion of the EP HE, the graduate must have the following universal competencies (UC):

Code and name of the UC
UC-1. Capable of searching, critically analyzing and synthesizing information, and applying a systematic approach to solving assigned tasks.
UC-2. Capable of defining a range of tasks within the framework of a set goal and choosing the best ways to solve them, based on current legal norms, available resources and limitations
UC-3. Capable of social interaction and fulfilling his/her role in a team
UC-4. Capable of communication in interpersonal and intercultural interaction in Russian (as a foreign language) and foreign language(s) based on proficiency in interconnected and interdependent types of reproductive and productive foreign language speech activity, such as listening, speaking, reading, writing and translation in everyday, socio-cultural, educational and professional, official business and scientific spheres of communication.
UC-5. Able to perceive the intercultural diversity of society in socio-historical, ethical and philosophical contexts.
UC-6. Able to manage their time, build and implement a trajectory of self-development based on the principles of lifelong education
UC-7. Able to maintain the proper level of physical fitness to ensure full social and professional activity
UC-8. Capable of creating and maintaining safe living conditions in everyday life and professional

Code and name of the UC
activities to preserve the natural environment, ensure sustainable development of society, including in the event of a threat or occurrence of emergency situations and military conflicts
UC-9. Able to use basic defectological knowledge in social and professional spheres
UC-10. Capable of making informed economic decisions in various areas of life
UC-11. Capable of forming an intolerant attitude towards manifestations of extremism, terrorism, corrupt behavior and counteracting them in professional activities
UC-12. Capable of: searching for the necessary sources of information and data, perceiving, analyzing, memorizing and transmitting information using digital means, as well as using algorithms when working with data obtained from various sources in order to effectively use the information obtained to solve problems; evaluating information, its reliability, building logical conclusions based on incoming information and data

- general professional competencies (GPC):

Code and name of the GPC
GPC-1 Capable of analyzing the tasks of professional activity based on provisions, laws and methods in the field of natural sciences and mathematics
GPC-2 Capable of formulating tasks of professional activity based on knowledge, specialized sections of mathematical and natural science disciplines (modules)
GPC-3 Capable of using fundamental knowledge to solve basic control problems in technical systems in order to improve professional activities
GPC-4 is capable of assessing the effectiveness of control systems developed on the basis of mathematical methods
GPC-5 Capable of solving problems of development of science, engineering and technology in the field of control in technical systems taking into account legal regulation in the field of intellectual property
GPC-6 Capable of developing and using algorithms and programs, modern information technologies, methods and means of control, diagnostics and management, suitable for practical application in the field of their professional activity
GPC-7 is capable of performing the necessary calculations of individual units and devices of control, automation and management systems, selecting standard automation, measuring and computing equipment when designing automation and management systems
GPC-8 Capable of adjusting measuring and control equipment and complexes, and performing their routine maintenance
GPC-9 is capable of performing experiments according to specified methods and processing the results using modern information technologies and technical means.
GPC-10 Capable of developing (based on current standards) technical documentation (including in electronic form) for routine maintenance of control, automation and control systems and equipment
GPC-11 Able to understand the principles of operation of modern information technologies and use them to solve problems of professional activity

- professional competencies(PC):

PC code and name
PC-1 Capable of collecting, processing and interpreting modern scientific research data necessary for drawing conclusions on relevant scientific research, including Earth remote sensing data
PC-2 Capable of participating in the development of schematic documentation for the flight control system of launch vehicles and spacecraft, in the preparation of publications based on the results of research and development
PC-3 Capable of carrying out work on processing and analyzing information in the field of application of mathematical methods and information technologies in the field of application of remote sensing data of the Earth from space
PC-4 Able to formulate, analyze and solve engineering problems in the field of ballistics, motion mechanics and spacecraft motion control based on professional knowledge

PC code and name
PC-5 Able to develop, debug, test performance, modify software; apply software design methods and tools, develop and coordinate software documentation

3. STRUCTURE OF THE SFC

The State Final Attestation can be conducted either in person (students and the state examination committee are at RUDN during the State Final Attestation) or using distance learning technologies (DET) available in the RUDN Electronic Information and Educational Environment (EIEE).

The procedure for conducting the State Final Attestation in person or using (DOT) is regulated by the relevant local regulatory act of RUDN.

State Final Attestation for the EP HE "Data Science and Space Systems / Data Science and Space Systems» includes:

- state exam (SE);
- defense of the final qualifying work (FQW).

4. PROGRAM OF THE GE

The state examination is conducted in one or several disciplines and (modules) of the educational program of higher education, the results of mastering which are of decisive importance for the professional activities of graduates.

The volume of the state examination for the OP HE is 3 credit units.

The state exam is conducted in two stages:

First stage– assessment of the level of theoretical training of a graduate in the form of computer testing using the tools available in the RUDN University Electronic Information and Educational Environment (EIEE);

Second stage– assessment of the graduate’s practical preparation for future professional activity in written form.

In order to prepare students for passing the State Examination, the head of the higher education institution (no later than one calendar month before the start of the State Examination) is obliged to familiarize the final-year students with this State Examination program, an exhaustive list of theoretical questions included in the State Examination, examples of industrial situational tasks (cases) that will need to be solved in the process of passing the certification test, as well as with the procedure for conducting each stage of the State Examination and the methodology for assessing its results (with assessment materials).

Before the State Examination, mandatory consultations are held for students on issues and tasks included in the State Examination program (pre-examination consultation).

Procedure for conducting computer testing within the framework of the State Final Attestation the following:

The test task contains 50 questions, randomly selected from the question bank. The student has 100 minutes to complete the test task. 2 points are awarded for a correctly answered question, 0 points for an incorrect one.

The procedure for conducting the second stage of the State Examination next:

1) A written test of knowledge is conducted using examination tickets, each examination ticket contains three questions and a task. The questions and tasks included in the examination ticket are interdisciplinary in nature and are aimed at determining the level of theoretical and practical preparedness of the graduate to solve professional problems defined by the

educational standard of RUDN in accordance with the research type of professional activity tasks to which the educational program is focused.

2) The total number of examination tickets is determined by the number of students admitted to the state examination. The student is given 90 minutes to prepare and defend a written answer on the ticket.

3) During the state examination, members of the State Examination Commission may ask the student additional questions in the area of professional activity of the graduate, as provided for by the educational standard.

The assessment of the results of the State Examination is carried out in accordance with the methodology set out in the assessment materials presented in the Appendix to this State Final Attestation program.

5. REQUIREMENTS FOR THE FINAL QUALIFICATION WORK AND THE PROCEDURE FOR ITS DEFENSE

A final qualifying work is a work completed by a student (or several students together) that demonstrates the level of readiness of the graduate for independent professional activity.

The list of topics for final qualifying papers offered to students for completion is approved by the order of the head of the educational program implementing the educational program of higher education, and is communicated by the program head to the students of the final year no later than 6 months before the start date of the State Final Attestation.

Preparation and defense of a final qualifying work on a topic proposed by the student (students) is permitted in accordance with the established procedure.

A student who has passed the state examination is allowed to defend the final qualifying work.

Only a fully completed thesis, signed by the graduate(s) who completed it, the supervisor, consultant (if any), the supervisor of the issuing BUP and OUP, which has undergone the external review procedure (mandatory for Master's and Specialist's programs) and a check for the volume of borrowings (in the Antiplagiat system) is allowed to be defended. A supervisor's review of the graduate's work in preparing the thesis is mandatory attached to the thesis admitted to defense.

In order to identify and promptly eliminate deficiencies in the structure, content and design of the final qualifying work, no later than 14 days before the date of its defense, a rehearsal of the defense of the students' work (pre-defense) is held in the presence of the head of the final qualifying work and other teachers of the graduating BUP.

The defense of the final qualifying work is carried out at an open meeting of the state examination commission (SEC).

The certification test is conducted in the form of an oral report by students with a mandatory multimedia (graphic) presentation reflecting the main content of the final qualifying work.

Upon completion of the report, the defenders give oral answers to questions raised by the members of the State Examination Commission on the subject matter, structure, content or design of the final qualifying work and the profile of the educational program of higher education. The report and/or answers to questions from the members of the State Examination Commission may be in a foreign language.

The stages of completing the final qualifying work, requirements for the structure, volume, content and design, as well as the list of mandatory and recommended documents submitted for defense are specified in the relevant methodological guidelines.

The assessment of the results of the defense of the final qualifying work is carried out in accordance with the methodology set out in the assessment materials presented in the Appendix to this State Final Attestation program.

6. LOGISTICS AND TECHNICAL SUPPORT FOR CONDUCTING THE SFC

To prepare for the state exam and defend their final qualifying work, students use rooms for independent work.

To conduct the test part of the state exam, a classroom equipped with workstations with personal computers (at least 12) equipped with the necessary software and an Internet connection is required.

To conduct the main part of the state examination and the defense of the final qualifying work, a room with a capacity of 12 or more people is required, in which workplaces are equipped for all members of the State Examination Commission, with the ability to listen to reports, view public presentations of speakers, keep records and protocols, there are places for listeners who wish to attend the procedure for the defense of the final qualifying work. The necessary equipment of the room includes:

- equipment for public presentations of the results of the final qualifying work, including a multimedia screen, projector, and audio equipment.
- a board for illustrating answers to questions.

The student may notify the issuing department of any requests for additional material and technical equipment (if necessary) for the audience assigned for the defense of the final qualifying work by submitting a written statement no later than one week before the defense procedure.

7. EDUCATIONAL, METHODOLOGICAL AND INFORMATIONAL SUPPORT FOR THE GIA

Basic literature for preparation for the State Examination and/or completion and defense of the final qualifying work:

1. Tolpegin, O. A. Methods of Optimal Control: Textbook and Workshop for Universities / O. A. Tolpegin. - 2nd ed., corrected. and additional. - Moscow: Publishing House Yurait, 2021. - 234 p. - (Higher education). - ISBN 978-5-534-13534-3. - Text: electronic // EBS Yurait [site]. - URL: <https://urait.ru/bcode/465342>.

2. Beklaryan L. A., Flerova A. Yu., ZhUCova A. A. Optimal Control Methods: Tutorial. MIPT, 2018.

3. Aleksandrov V.V., Zlochevsky S.I., Lemak S.S., Parusnikov N.A. Introduction to the dynamics of controlled systems. M, Moscow State University, 1993.

4. Alekseev V.M., Tikhomirov V.M., Fomin S.V. Optimal control. Moscow, NaUCa, 1979;

5. Alekseev V.M., Galeev E.M., Tikhomirov V.M. Collection of optimization problems. M., NaUCa, 1984.

6. Atans M., Falb P. Optimal control. Moscow, Mechanical Engineering, 1968.

7. Bliss G.A. Lectures on the calculus of variations. Moscow, Foreign Literature, 1950.

8. Boltyansky V.G. Mathematical methods of optimal control. Moscow, NaUCa, 1969.

9. Gnoensky L.S., Kamensky G.A., Elsgolts L.E. Mathematical foundations of the theory of controlled systems. Moscow, NaUCa, 1969.

10. Pontryagin L.S., Boltyansky V.G., Gamkrelidze V.R., Mishchenko E.F. Mathematical theory of optimal processes. Moscow, Fizmatgiz, 1961.

11. Roytenberg Ya.N. Automatic control. Moscow, NaUCa, 1992.
12. Solodovnikov V.V., Plotnikov V.N., Yakovlev A.V. Theory of automatic control of technical systems. Moscow, Publishing House of Moscow State Technical University, 1993.
13. Methods of classical and modern theory of automatic control: Textbook in 5 volumes. Volume 1: Mathematical models, dynamic characteristics and analysis of automatic control systems / Under the general editorship of K.A.Pupkov. - 2nd ed., revised and enlarged. - Moscow: Publishing house of Moscow State Technical University, 2004. - 656 p.
14. Collection of problems for the course "Theory of Automatic Control": educational and methodological manual / K. A. Pupkov, D. A. Andrikov; Russian Peoples' Friendship University. - Moscow: RUDN University, 2014 (Moscow: RUDN University). - 107 p.
15. Nefedov V.N., Osipova V.A. Course of discrete mathematics: Textbook. – M.: MAI Publishing House, 1992.
16. Kuznetsov O.P., Adelson-Velsky G.M. Discrete Mathematics for an Engineer. – M.: Energoatomizdat, 1988.
17. Gurov V.V., ChUCanov V.O. Fundamentals of the Theory and Organization of Computers - Internet University of Information Technologies - INTUIT.ru”, 2006 - 280 p.
18. Cormen Thomas H., Leiserson Charles I., Rivest Ronald L., Stein Clifford Algorithms. Construction and Analysis, 2nd edition – Moscow: Williams Publishing House, 2007. - 1296 p.
19. Knuth Donald E. The Art of Computer Programming in 3 volumes – M.: Williams Publishing House, 2008. – T.1 – 720, T.2 – 832 p., T.3 - 824 p.
20. Aho Alfred V., Hopcroft John, Ullman Jeffrey D., Data structures and algorithms - – M.: Williams Publishing House, 2000. – 384 p.
21. Bakhvalov N.S., Zhidkov N.P., Kobelkov G.M. Numerical methods. – Moscow: NaUCa, 1987.
22. Samarskii A.A., Gulin A.V. Numerical methods. – Moscow: NaUCa, 1989.
23. Amosov A.A., Dubinsky Yu.A., Kopchenova N.V. Computational methods for engineers. – M.: Higher. school, 1994.
24. Plis A.I., Slivina N.A. Laboratory practical training in higher mathematics. – M.: Higher. school, 1994.
25. Collection of problems on computational methods / Ed. P.I. Monastyrny. – M.: NaUCa: 1994.
26. Glovatskaya A.P. Methods and algorithms of computational mathematics. M. Radio and communication, 1999. 408 p.
27. MalyUC A.A., Pazizin S.V., Pogozhin N.S. Introduction to information security in automated systems – M.: Goryachaya Liniya-Telecom, 2001, 148 p.
28. Belov E.B., Los V.P., Meshcheryakov R.V., Shelupanov A.A. Fundamentals of information security. Textbook for universities, Moscow: Hotline – Telecom, 2006. - 544 p.
29. Besekersky Tikhonov V.A., Reich V.V. Information security: conceptual, legal, organizational and technical aspects: textbook. manual. – M.: Helios ARV, 2006.- 528 p.
30. Shan'gin V.F. Information security of computer systems and networks: textbook. Manual. - M.: ID "FORUM": INFRA-M, 2008.-416 p.
31. Moore T., Pym D., Ioannidis C., Economics of Information Security and Privacy, Springer, 2010, - 320 pp.
32. Ensuring information security of business, Edited by Kurilo A.P., Alpina Publishers, 2011, - 392 p.
33. Bondarev V.V. Introduction to information security of automated systems (2nd edition). - M.: Bauman Moscow State Technical University. 2018. - 252 p.

34. Organizational and legal support of information security. edited by A.A. Alexandrov, M.P. Sychev – M.: Bauman Moscow State Technical University. 2018. – 292s.
35. MalyUC A.A. Fundamentals of security policy for critical information infrastructure systems. - M.: Hotline - Telecom, 2018. - 314 p.
36. Methods of classical and modern theory of automatic control: Textbook in 5 volumes / edited by K.A. Pupkov. – M.: Publishing house of Bauman Moscow State Technical University, 2004.
37. Dorf R., Bishop R. Modern control systems – M.: Publishing house Laboratory of basic knowledge, 2004. – 832 p.
38. Besekersky V.A., Popov E.P. Theory of automatic control systems. – M.: Publishing house Profession, 2004. – 747 p.
39. Xu D., Meyer A. Modern theory of automatic control and its application. – M.: Mashinostroenie, 1972.
40. Popov E.P. Theory of linear systems of automatic regulation and control. – M.: NaUCa, 1978.
41. Popov E.P. Theory of nonlinear systems of automatic regulation and control. – M.: NaUCa, 1988.
42. Solodovnikov V.V., Plotnikov V.N., Yakovlev A.V. Fundamentals of the theory and elements of automatic control systems. Textbook for universities. – M.: Mashinostroenie, 1985.
43. Theory of automatic control. In 2 parts / A.A.Voronov, D.P.Kim, V.M.Lokhin, et al.; Ed. by A.A.Voronov. –M.: Higher. school, 1986.
44. Pervozvansky A.A. Course in the Theory of Automatic Control. – M.: NaUCa, 1986.
45. Afanasyev V.N., Kolmanovsky V.B., Nosov V.R. Mathematical theory of control systems design. – M.: Higher. school, 1989, 1998.
46. Topcheev Yu.I., Tsyplyakov A.P. Problem book on the theory of automatic control. Textbook for universities – Moscow: Mechanical Engineering, 1977.
47. Collection of problems in the theory of automatic regulation and control / Ed. V.A. Besekersky. - M.: NaUCa, 1978.
48. Merkin D.R. Introduction to the Theory of Stability of Motion. – M.: NaUCa, 1987.
49. Afanasyev V.N., Kolmanovsky V.B., Nosov V.R. Mathematical theory of control systems design. – M.: Higher School, 2003. 615 p.
50. Afanasyev V.N. Analytical design of continuous control systems. Textbook – RUDN, 2005. 148 p.
51. Afanasyev V.N. Optimal control systems. Analytical design. Textbook – RUDN, 2007. 260 p.
52. Panteleev A.V., Letova T.A. Optimization methods in examples and problems: Textbook – M.: Higher School, 2005. – 544 p.
53. Vanko V.I., Ermoshina O.V., Kuvyrkin G.N. Calculus of variations and optimal control – Moscow: Bauman Moscow State Technical University; 2002. – 488 p.
54. Andreeva E.A., Tsiruleva V.M. Calculus of variations and optimization methods. Moscow: Higher School. 2006. – 584 p.
55. Elsgolts L.E. Calculus of variations. Moscow: LKI Publishing House, 2008. – 208 p.
56. Attetkov A.V., Galkin S.V., Zarubin V.S. Optimization Methods – Moscow: Bauman Moscow State Technical University, 2003 – 440 p.
57. Callan R. Basic concepts of neural networks – M.: Williams Publishing House, 2001. – 288 p.

Additional literature for preparation for the State Examination and/or completion and defense of the final qualifying work:

1. Matthews J.G., Fink K.D. Numerical Methods. Using Matlab. – M., St. Petersburg, Kyiv: Williams Publishing House, 714 p.
2. Demidovich B.P., Maron I.A., Shuvalova E.Z. Fundamentals of computational mathematics. – St. Petersburg: Lan Publishing House, 2006.
3. Kopchenova N.V., Maron I.A. Computational Mathematics in Examples and Problems. – Moscow: NaUCa, 1972.
4. Samarskii A.A. Introduction to numerical methods. – M.: NaUCa, 1997.
5. Voevodin V.V., Kuznetsov Yu.A. Matrices and calculations. – M.: NaUCa, 1984.
6. Ortega J., Poole W. Introduction to Numerical Methods for Solving Differential Equations. – Moscow: NaUCa, 1986.
7. Zadeh L., Desoer C. Theory of linear systems. (State space method). – Moscow: NaUCa, 1970.
8. Moroz A.I. Course in systems theory. – M.: Higher. school, 1987.
9. Wonham M. Linear Multidimensional Control Systems: Geometric Approach. – Moscow: NaUCa, 1980.
10. Topcheev Yu.I. Atlas for designing automatic control systems. – M.: Mashinostroenie, 1989.
11. Torokin A.A. Fundamentals of engineering and technical protection of information. – M.: Os'-89, 1998.-336 p.
12. Devyanin P.N., Mikhalsky O.O., Pravikov D.I., Shcherbakov A.Yu., Theoretical foundations of computer security, – M: Radio and communication, 2000. -192 p.
13. Pyarin V.A., Kuzmin A.S., Smirnov S.N. Security of electronic business. – M.: Helios ARB, 2002. – 432 p.
14. Snytnikov A.A. Licensing and certification in the field of information security. – M.: Gelios ARV, 2003.- 192 p.
15. Sobolev A.N., Kirillov V.M. Physical foundations of technical means of ensuring information security: Textbook. – M.: Helios ARV, 2004.- 144 p.
16. Streltsov A.A. Legal support of information security of Russia: theoretical and methodological foundations. – Minsk.: BELLITFOND, 2005.-304 p.
17. Shumsky A.A., Shelupanov A.A. Systems analysis in information security: Textbook. – M.: Helios ARV, 2005.- 224 p.
18. Semkin S.N., Belyakov E.V., Grebenev S.V., Kozachok V.I. Fundamentals of organizational support for information security of information technology objects: Textbook. manual. – M.: Helios ARV, 2005.- 192 p.

Resources of the information and telecommunications network "Internet":

1. RUDN University Electronic Library System and third-party electronic library systems to which university students have access on the basis of concluded agreements:
 - Electronic library system of RUDN - ELS RUDN <http://lib.rudn.ru/MegaPro/Web>
 - Electronic library system "University library online" <http://www.biblioclub.ru>
 - EBS Yurait <http://www.biblio-online.ru>
 - Electronic Library System "Student Consultant" www.studentlibrary.ru
 - EBS "Lan" <http://e.lanbook.com/>
 - EBS "Troitsky Bridge"
2. Databases and search engines:
 - electronic fund of legal and normative-technical documentation <http://docs.cntd.ru/>
 - Yandex search engine <https://www.yandex.ru/>

- Google search engine <https://www.google.ru/>
- SCOPUS abstract database <http://www.elsevierscience.ru/products/scopus/>

*Educational and methodological materials for independent work of students in preparation for passing the State Examination and/or completing the final qualifying work and preparing the work for defense *:*

1. Methodological guidelines for the implementation and design of the final qualifying work on the educational program Data Science and Space Systems / Data Science and Space Systems
2. The procedure for checking the final qualifying work for the volume of borrowings in the Antiplagiat system.
3. The procedure for conducting the State Final Attestation on the educational program of higher education “Data Science and Space Systems / Data Science and Space Systems” using DOT, including the procedure for identifying the graduate’s identity.

* - all educational and methodological materials for independent work of students are posted in accordance with the current procedure on the GIA page in TUIS!

8. EVALUATION MATERIALS AND SCORE-RATING SYSTEM FOR ASSESSING THE LEVEL OF DEVELOPMENT OF COMPETENCIES IN GRADUATES

The assessment materials and the scoring and rating system* for assessing the level of development of competencies based on the results of mastering the discipline of the educational program of higher education “Data Science and Space Systems” are presented in the Appendix to this State Final Attestation program.

* - OM and BRS are formed on the basis of the requirements of the relevant local regulatory act of RUDN (regulations/procedures).

HEAD OF THE DEPARTMENT:

Head of the Department of

Mechanics and Control Processes

Razumny Yu.N

Name of the Department

Signature

Surname I.O.

HEAD OF THE EP HE:

Professor of the Department of

Mechanics and Control Processes

Razumny Yu.N

Position, Department

Signature

Surname I.O.