

**National University of Life and Environmental Sciences of  
Ukraine**

**Department of Engineering Reliability**

Methodical instructions for laboratory work: "Machine reliability"

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The methodical instructions contain information about the structure of studying the discipline "Reliability of machines", which includes the following sections: basic terms and definitions; backtrack physics; mathematical theory of reliability; testing of machines for reliability; methods of ensuring the reliability of machines.

The guidelines also provide a form and procedure for the execution of laboratory work, control questions.

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Educational edition

## METHODICAL INSTRUCTIONS

before laboratory work:

### "RELIABILITY OF MACHINES"

for undergraduate students on disciplines "Reliability of agricultural machines" and "Reliability of machines and equipment"

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For students studying in the field of preparation 6.050503 - "Machine-building", 6.100102 - "Processes of machinery and equipment of agro-industrial production".

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The purpose and tasks of studying the discipline, knowledge and skills acquired during the study of discipline, the importance and place of the course in the system of training engineer-mechanics. The role of discipline in the reliability of machines in the formation of a culture of engineering thinking in order to develop the capabilities of ensuring the efficiency and repair of machines in the process of developing and creating new technology.

#### 1. Purpose and tasks of the discipline.

The purpose of studying the discipline is to train future engineers to ensure the working capacity of machinery and equipment of the forest complex for a given time with minimal time, material and labor resources for design, production, operation, maintenance and repair.

#### 2. Requirements for the knowledge and skills acquired as a result of studying the discipline.

On the basis of studying the discipline student must

##### 2.1 Know:

- basic concepts, terms and definitions of the theory of machine reliability;
- engineering and physical bases of reliability;
- mathematical methods for determination of reliability indices;
- methods of calculation and forecasting of indicators of reliability;
- methodological bases of system of planning and conducting of tests, collection and analysis of information on reliability;
- methods of providing and improving the reliability of machinery and equipment;

##### 2.2 Be able to:

- Identify and analyze the causes of failures;
- to assess the technical condition of parts, assemblies, machines and equipment;
- to test the machines for reliability;

- to possess methods of calculation and forecasting of indicators of reliability;
- to possess the methods of substantiation of the limits and admissible at repair of the sizes of details and their conjugations;
- to have methods of processing information on reliability.

literature

1. Grankin S.G. The goodness of agricultural machinery / SG Grankin, VS Malakhov, MI Chernovol, V.Yu. Cherkun - K., Harvest. - 1998 - 208 p.
2. Ermolov L.S. Fundamentals of reliability of agricultural machinery / Л.С. Ermolov, V.M. Kryazhkov, V.E. Cherkun - M., Kolos. -1982. - 247.
3. Kanarchuk VE VE Reliability of Machines: Textbook / V. Y. Kanarchuk, S. K. Polyansky, M. M. Dmitriev. - K.: Lybid, 2003. - 424 pp. - ISBN966-06-0215-4.

### **1. Basic terms, concepts and definitions**

The concept of the quality and reliability of machines. The value of reliability in the efficient use of machines and equipment of the forest complex. Basic terms, concepts and definitions in the field of reliability: reliability, durability, efficiency and safety.

### **2. Engineering and physical bases of reliability**

Reasons that disrupt performance and reduce the reliability of machines. Dynamics of damage formation. Damage as random probabilistic processes. Physics of failures. Their species and classification.

Wear. Types, characteristics and patterns of wear. Deformation and destruction. Types, characteristics and patterns of wear.

#### **Fatigue of materials. Types, characteristics and patterns of wear.**

Corrosion and its species. Types, characteristics and patterns of wear. Aging materials. Types, characteristics and patterns of wear. Creation of growths and pollution. Types, characteristics and patterns of wear.

### 3. Mathematical methods for determination of reliability indicators

Stochastic nature of reliability indicators. Discrete and continuous random variables in the theory of reliability. The laws of their distribution. Numerical distribution characteristics.

Reliability indicators: the probability of failure-free operation, average failure rate, failure parameter, gamma percentage rejection, failure rate, average refusal duration, average life expectancy. Complex reliability indicators: readiness coefficient, coefficient of technical use, coefficient of readiness, specific cost of reliability.

Graphic methods of information processing. Using a computer to process information.

### **4. Reliability of machines as complex forecasting systems**

Retirement

System analysis of machines reliability. The probability of failure-free operation of systems with sequential, parallel and mixed elements of elements. Dependence of system reliability (machine) on its structure. Types of reservations and their classification. Analysis of the effectiveness of various backup methods.

Prediction of machine reliability. Stages and forecasting methods. Reliability and effectiveness of the forecast. Forecasting at the stage of designing (designing) machines.

### **5. Reliability test**

Collection and processing of statistical information on the reliability of objects. Test plan. Complete and trimmed sample. Appointment tests for reliability. Types and test classification. Value of tests in the process of completion and production of machines. Organization and planning of tests. Methods and methods of accelerating tests. Imitation, compressed and forced tests. Reliability tests. Tests for labor, fatigue, corrosion. Methods of non-destructive parametric control. Use of technical diagnostics at maintenance and repair of machines.

## **6. Methods of ensuring the reliability of machines**

Problems of reliability in the "life cycle" of machines. Design and technological methods of reliability assurance. Principles of designing highly reliable parts and units. Forms of natural wear. Methods of tribology when selecting friction pairs and conditions of operation. Modern methods of finishing the surfaces of parts, their role in increasing the reliability and durability of machines. Examples of practical developments of highly reliable nodes.

Technological methods of strengthening the working surfaces of parts. Electrolytic coatings, surfacing, thermodiffusion saturation of surfaces. Plasma and laser treatment.

Ensuring reliability in maintenance and repair of machines.

### **Question for performing the test work**

On given questions numbers give full answers with examples, diagrams, drawings and explanations to them.

1. Quality and reliability of machines. The main properties of the machines.
2. Historical development of machine reliability as a science.
3. Machine reliability as a science.
4. Define and characterize the basic properties of reliability: reliability, durability, maintainability, maintainability.
5. General concepts that are used in reliability: good condition, faulty state, working condition, incapacitated condition, limit state.
6. What are the reasons for the failure of the equipment. Common concepts that are used in reliability: failure, damage, defect, malfunction.
7. What is gamma-interest resource, its practical value, graphic dependencies.
8. Give definitions, specify the units of their measurements and describe: failure to work, lifetime, assigned resource, shelf-life.
9. Describe the main types of failures of technical objects.

10. What is the physical nature of the emergence of gradual and sudden. Specify Graphic Dependencies.

11. Types of failures. Breakdown of failures depending on complexity group.

12. Describe the internal and external factors that affect the reliability of the technical objects.

13. Conduct the classification of the main types of friction in cars, describe the effect of friction on the wear process.

14. Wear and wear. Describe the classification of the main types of wear.

15. The concept of mechanical wear parts. Measures to combat this type of wear. Explain on the example of the parts of the agricultural machinery.

16. Abrasive and hydroabrasive (gas-abrasive) wear parts. The essence of the process and the conditions of leakage. Measures to combat these types of wear. Explain on the example of the parts of the agricultural machinery.

17. Erosion, hydro-erosion (gas-erosion). The essence of processes and conditions of leakage .. Measures to combat these types of wear. Explain on the example of the parts of the agricultural machinery.

18. Corrosion-mechanical deterioration of parts: oxidizing wear and wear when friction-corrosion. Essence of processes and conditions of leakage. Measures to combat these types of wear. Explain on the example of the parts of the agricultural machinery.

19. Wear and durability of machine parts. Explain on the example of the parts of the agricultural machinery Specify the formulas.

20. Cavitation wear, wear from wear and tear. Essence of processes and conditions of leakage. Measures to combat these types of wear. Explain on the example of the parts of the agricultural machinery.

21. Wear and electrodeposition wear. Essence of processes and conditions of leakage. Explain on the example of the parts of the agricultural machinery.

22. What are the reasons for the formation of a scum? How do they affect the work of the machine? What are the methods to combat this phenomenon?

23. What are the reasons for the formation of scum? How do they affect the work of the machine? What are the methods to combat this phenomenon?

24. Give definitions and describe the processes: diffusion, adhesion, cogenesis, adsorption.

25. What are the main indicators and characteristics of wear?

26. When and how are the basic laws of wear and tear of parts used (during operation, during construction and during repair)?

How does the macro- and microgeometry of surfaces affect the wear of machine parts? Optimum Micro Geometry of Surfaces?

28. What are the methods of determining the wear of parts of machines. Indicate the scope of their use?

29. What is the limiting condition (wear) of machine parts and parts connections. Describe the criteria for the limiting state of the parts. Give examples.

30. Permissible and limit values of wear of parts. Dependence between them.

31. Loss of robotic ability of parts due to fatigue

32. Corrosive damage to parts of machines, conditions for corrosion and measures to combat it. Give examples.

33. Chemical corrosion of metals. Classification and conditions of leakage. Give examples of parts.

34. Electrochemical corrosion of metals. Classification and conditions of leakage. Give examples of parts.

35. Objective and subjective factors acting on agricultural machinery.

36. Give the concept of indicators of product quality.

37. The concept of indicators of product reliability. Single and complex reliability indicators.

38. What indicators are characterized by failure of technical objects?

39. What indicators are characterized by the durability of technical facilities?

40. Uniform performance indicators of agricultural machinery.

41. Indicators of safety of technical objects and their essence.



42. Coefficient of availability of technical facilities. Properties that are characterized by these indicators.

43. The coefficient of technical use. Properties that are characterized by these indicators.

44. Specific cost of machine reliability. Make an explanation of the compound formula.

45. Complex indicator operational coefficient of technical facilities.

46. List additional indicators of agricultural machinery maintenance.

47. What is the purpose, purpose and features of the testing of agricultural machinery on reliability.

48. Present the classification of test methods and control of agricultural machinery reliability.

49. Describe the types of testing of agricultural machinery.

50. The essence of bench and field tests.

51. Accelerated reliability tests.

52. Technical means of accelerated reliability testing.

53. Describe performance testing.

54. Present a method for processing statistics on reliability.

55. List the main constructive methods of improving the reliability of machines.

56. List the main technological methods to improve the reliability of machines.

57. List the main methods of improving the reliability of machines during maintenance.

58. List the main methods for improving the reliability of machinery and equipment during operation.

59. List the main methods of improving the reliability of machines during repair.

60. List the main methods of improving the reliability of machines in the restoration of parts.

61. Describe the basic theoretical reliability laws that are used in reliability.
62. Deformation and destruction of machine parts.
63. Describe the aging of polymeric materials.
64. Describe the aging of operating materials.
65. Describe the aging properties of steels and cast iron.
66. Scale of parts of internal combustion engines.
67. Nagar details of internal combustion engines.
68. Test plans for reliability.