

Syllabus educational component

Structural strength and methods of its increase

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| Subjects: | Structural strength and methods of its increase |
| Level of higher education: | the first (bachelor's) |
| Course page in Moodle: | https://dl2022.khadi-kh.com/course/view.php?id=1569 |
| The scope of the educational component | 3 credits (90 hours) |
| Final control form | examination |
| Consultations: | on schedule |
| Name of the department: | department of Metal Technology and Materials Science |
| Teaching language: | English |
| Course leader: | Iryna Vasylyvna Doshchechkina, professor, candidate of technical sciences, associate professor |
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Brief content of the educational component:

The goal is the formation of a set of knowledge, abilities and skills in students to solve problems in materials science in the field of mechanical engineering at the stage of improving the quality of the material and increasing the structural strength of products of various purposes, which would ensure an increase in the resource due to more reliable and durable operation.

Subject: theoretical and methodological foundations material processing processes for obtaining a complex of high service characteristics in the absence of its brittleness, which are in the greatest correlation with the operating conditions of a specific product made of this material and ensure its reliability and durability.

The main tasks of studying an academic discipline are:

The ability to solve complex specialized tasks and practical problems of premature failure of products and provides for an increase in structural strength - a necessary set of properties of this product to ensure its reliability and durability in specific operating conditions, which requires knowledge of the current state of existing new materials and their processing technologies with the implementation of strengthening mechanisms without embrittlement of products during operation; the ability of the future specialist to correctly use the main methods of managing the structural strength of materials and to carry out in practice their justified rational selection for products taking into account operational and economic requirements.

Prerequisites for studying the educational component:

the discipline is studied after mastering the courses "Physics", "Materials Science", "Alloyed Steels and Alloys". "Progressive construction materials", "Theoretical foundations and equipment of heat treatment"; "Technology of coating", " «Alloy steels and alloys".

Competencies acquired by the acquirer:

General competences:

Ability to find and use information from domestic and foreign sources (ZK4).

Ability to make informed decisions in production conditions (ZK5).

Knowledge and understanding of one's specialty (ZK8).

Ability and readiness to implement modern technological processes of obtaining, processing materials, technologies for improving properties and restoring products in order to meet their production requirements(ZK9).

The ability to analyze violations of the established technological process and the reasons for failure of parts and structures (ZK10).

Special (professional) competences:

The ability to use in practice modern ideas about the influence of micro-macro- and nanostructure on the properties of materials, their interaction with the environment (FK4).

Ability to master professional terminology, including one of the foreign languages (FK6).

Willingness to participate in the development of technological processes of heat treatment of materials, various methods of surface strengthening and coating(FK7).

The ability to use normative and methodical materials during the preparation and execution of technical tasks for the performance of tests and measurements, research and experimental design works (FK10).

The ability to perform a literary search of sources, including foreign ones, in the professional sphere and to use them in one's professional activity (FK13).

Knowledge of patterns of phase transformations in metals and alloys (FK14).

Knowledge of the main groups of materials and the ability to justify their selection for specific operating conditions (FK15).

Knowledge of basic technologies of manufacturing, processing, testing of materials and products(FK17).

Learning outcomes according to the educational program:

Know the main types of modern metallic and non-metallic materials and the principles of their selection for specific products, taking into account the operating conditions (PRN3).

To know the classification, marking, regimes of strengthening heat treatment, mechanical properties and fields of use of steels - the main material of industry (PRN4).

Know the regularities and practical methods of controlling the mechanical properties of metal alloys by changing their chemical composition and structure (PRN6).

Use the understanding of the principles and regularities of phase transformations in metals and alloys under the influence of external factors (PRN13).

To acquire the judgments of a practical engineer in materials science (PRN18).

PRN21. Have a judgment about the rational and economical use of equipment and devices for processing and quality control of materials and products (PRN21).

Themaic plan

| Topic No | Title of topics (LC, LW, PW, SS, InW) | Number of hours |
|----------|--|-----------------|
| | | intramural |
| 1 | LK. Mechanical properties of metals and alloys. Durability and reliability, their criteria, factors affecting them. Structural strength. | 2 |
| | PW Mechanical properties of products. Durability and reliability, their criteria, factors, factors affecting them. Structural strength. | 2 |
| | InW.Reliability of the product and reliability of the material. The difference between these concepts. | 4 |
| 2 | LK. Product properties. Threshold of cold brittleness and factors affecting it. Crack resistance of the material, its indicators. | 2 |
| | PW. Types of destruction of metals and alloys, nature of fractures. | 2 |
| | InW. Durability and the main reasons for the failure of parts in operation. Durability. Wear-free effect. Corrosion | 4 |

| | | |
|----------------------|---|----|
| 3 | LK.The influence of strengthening mechanisms on the structural strength of metals and alloys. | 2 |
| | PW. Methods of strengthening metals and alloys. | 2 |
| | InW.Theoretical and real strength of metals. Explain why it is difficult to achieve a simultaneous increase in strength, plasticity and crack resistance in real metals and alloys. | 4 |
| 4 | LK.Strengthening of structural traditional steels. | 2 |
| | PW. Effect of grain size on structural strength of metals and alloys. | 2 |
| | InW.Methods of processing steel for the purpose of grinding grain and increasing structural strength. | 4 |
| 5 | LK. Modern trends in increasing the structural strength of steels. | 2 |
| | PR. Methods of strengthening metals and alloys. | 2 |
| | SR.The latest methods of processing steel for denial of structural strength. | 4 |
| 6 | LK. Amorphous and nanomaterials, structural features, unique functional properties, high structural strength. | 2 |
| | PW.Types of nanocrystalline materials, their applications. | 2 |
| | InW. Nanocomposite and nanoporous materials. | 4 |
| 7 | LK. The influence of the state of the surface of the product on its deformation behavior and properties. | 2 |
| | PR. The influence of the surface layer on the mechanical properties of products under different loads. | 2 |
| | SR. The surface as a special state of the object and the reasons for its influence on the properties of the product as a whole. | 2 |
| 8 | LK. Various methods of surface modification to increase the structural strength of products. | 2 |
| | PW. The effect of surface modification on the technological properties of the material and the quality of its products. | 2 |
| | InW. Design methods of increasing the structural strength of products. | 2 |
| Toget her | LK. | 16 |
| | PW. | 16 |
| | InW. | 28 |
| | Exam preparation, exam | 30 |

Individual educational and research task(if available):

Teaching methods:

1) verbal:

1.1 traditional: lectures, explanations.

1.2 non-traditional: electronic version, remote.

2) visual: method of illustrations, method of demonstrations

3) practical:

3.1 traditional classes

3.2 non-traditional stations: role-playing games, dialogical discussions. the creation of a problematic situation and the selection of a heuristic method of supply.

Evaluation system and requirements:

Current performance

1. The current success rate of applicants for the performance of educational types of work in training classes and for the performance of independent work tasks is evaluated using a four-point rating scale with subsequent transfer to a 100-point scale. During the evaluation

of the current academic performance, all types of work provided by the educational program are taken into account.

1.1. Lecture classes are evaluated by determining the quality of performance of specified tasks.

1.2. Practical classes are evaluated by the quality of performance of a control or individual task, performance and design of practical work.

1.3. Laboratory classes are evaluated by the quality of reports on the performance of laboratory work.

1.4. Seminar classes are evaluated by the quality of the performance of an individual task/abstract.

2. Evaluation of the current performance of students of higher education is carried out at each practical session (laboratory or seminar) on a four-point scale ("5", "4", "3", "2") and entered in the journal of academic performance.

– "excellent": the winner mastered the theoretical material flawlessly, demonstrates deep knowledge of the relevant topic or academic discipline, the main provisions;

– "good": the applicant has mastered the theoretical material well, has the main aspects from primary sources and recommended literature, presents it in an argumentative manner; has practical skills, expresses his thoughts on certain problems, but certain inaccuracies and errors are assumed in the logic of the presentation of theoretical content or in the analysis of practical ones;

– "satisfactory": the applicant has basically mastered the theoretical knowledge of the educational topic or discipline, orients himself in primary sources and recommended literature, but answers unconvincingly, confuses concepts, answers additional questions uncertainly, does not have stable knowledge; when answering questions of a practical nature, reveals inaccuracy in knowledge, does not know how to evaluate facts and phenomena, connect them with the future profession;

– "unsatisfactory": the applicant has not mastered the educational material of the topic (discipline), does not know scientific facts, definitions, hardly orients himself in primary sources and recommended literature, lacks scientific thinking, practical skills are not formed.

3. The final score for the current activity is recognized as the arithmetic mean sum of points for each lesson, for individual work, current control works according to the formula:

$$K^{nomoy} = \frac{K1 + K2 + \dots + Kn}{n},$$

where K^{nomoy} – final assessment of success based on the results of current control;

$K1, K2, \dots, Kn$ – assessment of the success of the n-th measure of current control;

n – number of ongoing control measures.

Assessments are converted into points according to the calculation scale (table 1).

Table 1 – Recalculation of the average grade for the current activity into a multi-point scale

| 4-point scale | 100-point scale | 4-point scale | 100-point scale | 4-point scale | 100-point scale | 4-point scale | 100-point scale |
|---------------|-----------------|---------------|-----------------|---------------|-----------------|-------------------|-----------------|
| 5 | 100 | 4,45 | 89 | 3,90 | 78 | 3,35 | 67 |
| 4,95 | 99 | 4,4 | 88 | 3,85 | 77 | 3,3 | 66 |
| 4,9 | 98 | 4,35 | 87 | 3,80 | 76 | 3,25 | 65 |
| 4,85 | 97 | 4,3 | 86 | 3,75 | 75 | 3,2 | 64 |
| 4,8 | 96 | 4,25 | 85 | 3,7 | 74 | 3,15 | 63 |
| 4,75 | 95 | 4,20 | 84 | 3,65 | 73 | 3,1 | 62 |
| 4,7 | 94 | 4,15 | 83 | 3,60 | 72 | 3,05 | 61 |
| 4,65 | 93 | 4,10 | 82 | 3,55 | 71 | 3 | 60 |
| 4,6 | 92 | 4,05 | 81 | 3,5 | 70 | from 1.78 to 2.99 | from 35 to 59 |
| | | | | | | reassembly | |
| 4,55 | 91 | 4,00 | 80 | 3,45 | 69 | from 0 to 1.77 | from 0 to 34 |
| 4,5 | 90 | 3,95 | 79 | 3,4 | 68 | repeated study | |

Final assessment

1. The student of higher education receives a credit in the last lesson in the discipline based on the results of the current assessment. The average score for the current activity is converted into points on a 100-point scale, according to the conversion table (table 1). Applicants for higher education who have a current grade point average in the discipline lower than "3" (60 points) can increase their current grade by taking tests in the discipline in the last session.

Assessment of the knowledge of applicants through testing is carried out according to the following scale:

- "Excellent": at least 90% of correct answers;
- "Very good": from 82% to 89% of correct answers;
- "Good": from 74% to 81% of correct answers;
- "Satisfactory": from 67% to 73% of correct answers;
- "Satisfactory enough": from 60% to 66% of correct answers;
- "Unsatisfactory": less than 60% of correct answers.

2. The condition for obtaining credit is:

- making up for all missed classes;
- the average current grade in the discipline is not lower than "3" (60 points).

3. Winners are awarded additional points for individual independent work and participation in scientific events.

3.1. Additional points are added to the sum of points scored by the student of higher education for the current educational activity (for disciplines, for which the final form of control is a test), or to the final grade in the discipline, for which the final form of control is an exam.

3.2. The number of additional points awarded for different types of individual tasks depends on their volume and importance:

- prizes in the discipline at the international / all-Ukrainian competition of scientific student works – 20 points;
- prize places in the discipline at the All-Ukrainian Olympiads – 20 points;
- participation in the international / all-Ukrainian competition of scientific student works – 15 points
- participation in international / all-Ukrainian scientific conferences of students and young scientists – 12 points;

- participation in all-Ukrainian Olympiads in the discipline – 10 points
- participation in Olympiads and scientific conferences of the Khnadu in the discipline – 5 points;
- performance of individual scientific and research (educational and research) tasks of increased complexity – 5 points.

3.3. The number of additional points cannot exceed 20 points.

4. The learning result is evaluated (select required):

- on a two-point scale (passed/failed) according to table 2;
- on a 100-point scale (for differentiated assessment) according to table 3.

The final grade together with additional points cannot exceed 100 points.

Table 2 – The scale for transferring points to the national evaluation system

| On a 100-point scale | On a national scale |
|------------------------------|---------------------|
| from 60 points to 100 points | counted |
| less than 60 points | not counted |

Table 3 – The scale for evaluating the knowledge of students based on the results of the final control of the academic discipline

| Score in points | Evaluation on a national scale | | Evaluation according to the ECTS scale | |
|-----------------|--------------------------------|----------------|--|--|
| | | | Estimate | Criteria |
| 90-100 | Perfectly | Counted | A | The theoretical content of the course has been mastered in its entirety, without gaps, the necessary practical skills for working with the mastered material have been formed, all educational tasks provided for in the training program have been completed, the quality of their performance has been assessed with a number of points close to the maximum |
| 80-89 | Fine | Counted | B | The theoretical content of the course has been mastered in its entirety, without gaps, the necessary practical skills for working with the mastered material have mainly been formed, all educational tasks provided for by the training program have been completed, the quality of most of them has been assessed with a number of points close to the maximum |
| 75-79 | | | C | The theoretical content of the course has been mastered in its entirety, without gaps, some practical skills of working with the mastered material have not been formed enough, all educational tasks provided for by the training program have been completed, the quality of none of them has been assessed with a minimum number of points, some types of tasks have been completed with errors |

| Score in points | Evaluation on a national scale | | Evaluation according to the ECTS scale | |
|-----------------|--------------------------------|-------------|--|--|
| | | | Estimate | Criteria |
| | exam | test | | |
| 67-74 | Satisfactory | | D | The theoretical content of the course is partially mastered, but the gaps are not of a significant nature, the necessary practical skills for working with the mastered material are basically formed, most of the educational tasks provided by the training program have been completed, some of the completed tasks may contain errors |
| 60-66 | | | E | The theoretical content of the course has been partially mastered, some practical work skills have not been formed, many educational tasks provided by the training program have not been completed, or the quality of some of them has been assessed with a number of points close to the minimum. |
| 35-59 | Unsatisfactory | Not counted | FX | The theoretical content of the course has been partially mastered, the necessary practical work skills have not been formed, most of the prescribed training programs of educational tasks have not been completed, or the quality of their implementation has been assessed with a number of points close to the minimum; with additional independent work on the course material, it is possible to improve the quality of the performance of educational tasks (with the possibility of retaking) |
| 0-34 | Unacceptable | | F | The theoretical content of the course has not been mastered, the necessary practical work skills have not been formed, all completed educational tasks contain gross errors, additional independent work on the course material will not lead to any significant improvement in the quality of the performance of educational tasks (with a mandatory repeat course). |

Course policy:

- the course involves working in a team, the environment in the classroom is friendly, creative, open to constructive criticism;
- mastering the discipline involves mandatory attendance of lectures and practical classes, as well as independent work;
- independent work involves the study of individual topics of the academic discipline, which are presented in accordance with the program for independent study, or were considered briefly;
- all tasks provided by the program must be completed within the set time;
- if the student of higher education is absent from classes for a good reason, he presents the completed tasks during independent preparation and consultation of the teacher;

- the coursework must be protected no later than a week before the beginning of the examination session (indicated if available);
- while studying the course, students of higher education must adhere to the rules of academic integrity set forth in the following documents: "Rules of academic integrity of participants in the educational process of KhNAHU" (https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_67_01_dobroch_1.pdf), "Academic integrity. Checking the text of academic, scientific and qualification papers for plagiarism" (https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_85_1_01.pdf), "Moral and ethical code of participants in the educational process of KhNAHU" (https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_67_01_MEK_1.pdf)
- in case of detection of plagiarism, the applicant receives 0 points for the task and must repeat the tasks provided for in the syllabus;
- writing off during tests and exams is prohibited (including using mobile devices). Mobile devices are allowed to be used only during online testing.

Recommended Books: *(literature no later than 10 years old, except for 1 fundamental classic textbook or monograph)*

1. Basic literature

- 1.1. Dyachenko S.S. Materials science: textbook / S. S. Dyachenko, I. V. Doshchechkina, A. O. Movlyan, E. I. Pleshakov. - Kharkiv: Khnadu Publishing House, 2007. - 440 p.
- 1.2. Dyachenko S.S. Materials for various purposes, their processing and properties: education manual / S.S. Dyachenko, I.V. Doshchechkina, I.V. Ponomarenko, S.I. Bondarenko. - Kharkiv: KHNADU, 2016. - 348 p.
- 1.3. Pchelintsev V. O. Mechanical properties and structural strength of materials: education manual / V. O. Pchelintsev, A. I. Degula. – Sumy: CumD, 2012 - 247 p.
- 1.4. Azarenkov M.O. Nanomaterials and nanotechnologies: Study guide / M. O. Azaryenkov, I. M. Neklyudov, V. M. Beresnev, V. M. Voevodin and others. – Kh.: KhNU named after V. N. Karazin, 2014. - 316 p
- 1.5. Doshchechkina I. V. Directions for improving the quality of materials: laboratory workshop - Kharkiv: Khnadu Publishing House, 2021. - 144 p.

2. Supporting literature

- 2.1. Kholiyavko V.V. Physical foundations of strength and destruction: lecture notes / V.V. Kholiyavko - K.: NTUU "KPI", 2015. - 100 p
- 2.2. Azarenkov M.O. Functional materials and cover: heading help / M.O. Azarenkov, V.M. Beresnev, S.V. Litovchenko et al. – H. : KhNU named after V. N. Karazin, 2013. - 208 p.
- 2.3. Doshchechkina I.V. Increasing technological plasticity while maintaining the strength of cold-rolled thin-sheet low-carbon steel // Bulletin of KHNADU. 2020. - Issue 91. – P. 165-171.
- 2.4. Doshchechkina, I.V. The influence of the surface condition on the deformation behavior of products and improvement of the stamping of rolled sheet metal / Doshchechkina I.V., Tatarkina I.S., Ozarkiv V.V. // Bulletin of KHNADU Vol.82. - Kharkiv, 2018.– P. 20 – 26.
- 2.5. I. V. Doshchechkina Surface epilation as a method of plasticizing cold-rolled low-carbon steels / I. V. Doshchechkina, I. S. Tatarkina // Bulletin of KHNADU.– Issue 88,– Kharkiv, 2020 – P. 17-22.

3. Information resources

- 3.1. <https://dl2022.khadi-kh.com/course/view.php?id=1569> distance course
- 3.2. <https://uadoc.zavantag.com/text/26157/index-1.html> Methods of increasing the structural strength of metal.

- 3.3.<https://studfile.net/preview/9269637/page:13/> Theoretical and real strength of metals and ways to increase it
- 3.4.http://www.fhotm.kpi.ua/sworks/06/prach_article_2011.pdf Amorphous alloys. Review.
- 3.5.http://gen.phys.univ.kiev.ua/files/nanomaterials_nanotech.pdf. Nanomaterials, nanotechnologies, nanodevices

Developer(s)
syllabus of the educational
discipline



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