# Syllabus selective component of VC

# Fundamentals of highway design

| Discipline name:              | Fundamentals of highway design                         |  |
|-------------------------------|--|--|
| Level of higher education:    | First (undergraduate)                                  |  |
| Course page in Moodle:        | https://dl2022.khadi.kharkov.ua/course/view.php?id=793 |  |
| The volume of the educational | 4 credits (120 hours)                                  |  |
| component                     |  |  |
| Form of final control         | Test   |  |
| Consultations:                | on schedule  |  |
| Name of the department:       | Department of Road Design, Geodesy and Land            |  |
|                               | Management   |  |
| Language of instruction:      | English  |  |
| Course leader:                | Anzhelika Hennadiivna Batrakova, Ph.D., professor      |  |
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## Brief content of the educational component:

**The goal is**the formation of theoretical knowledge about the principles, methods and tools of highway design, as well as the acquisition of practical skills and abilities regarding the use of a system approach in project activities; training students as future specialists in the field of transport construction to competently and creatively solve issues of analysis and justification of decisions made in highway projects.

Subject: methods and tools of highway design, system approach in project activity.

## The main tasks of studying an academic discipline are:

- studying the basics of highway and transport infrastructure design;

- acquisition of theoretical knowledge and practical skills of highway design;

- the ability to use and coordinate the results of geodetic measurements when developing projects for the construction, reconstruction and repair of highways.

#### Prerequisites for studying the educational component:

Higher mathematics; Informatics.

## Competencies acquired by the acquirer:

#### General competences:

Ability to apply knowledge in practical situations.

# Special (professional) competences:

Ability to apply regulatory and legal acts, regulatory and technical documents, reference materials in professional activities.

#### Learning outcomes:

Know and apply in professional activity regulatory and legal acts, regulatory and technical documents, reference materials in the field of highway design.

Know the peculiarities of highway design in different terrain conditions.

| Thematic plan |   |                 |                |  |
|---------------|---|-----------------|----------------|--|
| Topic         | Title of topics (IK IR PR S7 SR)  | Number of hours |                |  |
| number        |   | Full-<br>Time   | Correspondence |  |
| 1             | LK Motorway as a system. Types of design: system design (features), partial design. Practical application of the system approach to road design. General principles and criteria of technical, ergonomic, aesthetic, ecological and other types of design.  | 2               | 2              |  |
|               | PR Calculations of standards for highway design. Acquaintance with normative literature.  | 2               | 2              |  |
|               | SR Study of topic material 1. System design methodology and technique.  | 3               | 5              |  |
| 2             | LK Motion of a car on the road, supports of motion, equation of<br>motion of a car, dynamic factor and dynamic characteristics of a<br>car. Car movement on curvilinear sections of the road in plan and<br>longitudinal profile. Determination of road parameters (maximum<br>longitudinal slope, visibility distance, curve radii), lane width.           | 2               | -              |  |
|               | SR Studying the material of topic 2. Movement resistance forces, car motion equations, dynamic factor and dynamic characteristic. Determination of the maximum longitudinal slope.  | 3               | 8              |  |
|               | LC Requirements for the longitudinal profile of highways.<br>Definition. Elements. Control points. Types and methods of<br>longitudinal profile design. The sequence of drawing and<br>calculating the design line.   | 2               | 2              |  |
| 3             | PR Route of the road on the map. Definition of track elements.<br>Calculations of the information of straight lines and curves.<br>Breakdown of picketing.  | 2               | 2              |  |
|               | SR Studying the material of topic 3. Modern methods of longitudinal profile design.   | 5               | 5              |  |
| 4             | LK Requirements for the strength and stability of the ground<br>surface. Requirements for the type of soils, their location in the<br>subsoil. Regulation of the water-thermal regime of the subsoil<br>(elevation of the edge above the level of the earth's surface,<br>special layers and layers, etc.). Typical constructions of the<br>ground surface. | 2               | -              |  |
|               | SR Studying the material of topic 4. Strength and stability of the ground surface. The stability of the ground surface on a slope; on weak foundations.   | 3               | 8              |  |
| 5             | LK System of structures of surface and underground drainage.<br>Design principles. Road ditches: construction, types of ditch<br>reinforcement. Drains, types of drains, drainage design, location.   | 2               | -              |  |
|               | PR Designing the longitudinal profile. Control points. Determination of ground surface markings along the axis of the road.   | 2               | -              |  |
|               | SR Studying the material of topic 5. Location and construction of drains. Drainage calculations.  | 5               | 8              |  |
| 6             | LK Road clothing as a technical system. Designs of road clothes,<br>functional layers of road clothes. Classification. Transport load<br>and action of natural factors. Basic principles of designing non-<br>rigid road clothing.  | 2               | 2              |  |

|    | SR Studying the material of topic 6. Calculation load. Bringing the traffic flow to the calculated load.   | 3 | 5 |
|----|--|---|---|
|    | LK Constructions of road clothing. Calculations of non-rigid road  | 2 | - |
| 7  | PR Designing the project line using templates and the method of tangents.  | 2 | - |
|    | SR Study of topic material 7. Special calculations of layers from monolithic materials. Testing for frost resistance.  | 5 | 8 |
|    | LK Designs of rigid road clothing. Design of rigid road clothing.  | 2 | - |
| 8  | SR Studying the material of topic 8. Designs of rigid road clothing with a monolithic coating. Designs of plate joints, determination of plate length. Thin-layer coatings on a rigid base.                            | 5 | 8 |
|    | LK Transport hubs on highways.   | 2 | - |
| 9  | PR Structures of the earth bed in different conditions. Types of transverse profiles of the ground surface.  | 2 | - |
|    | SR Studying the material of topic 9. Transport hubs on highways, structural schemes.   | 5 | 8 |
|    | LK. Justification of road reconstruction. Reconstruction of roads.   | 2 | - |
| 10 | SR Studying the material of topic 10. The main measures that are performed during the reconstruction of roads  | 5 | 8 |
|    | LK Motor highways. Designing elements of arrangement of highways.  | 2 | - |
| 11 | PR Calculations of parameters of road ditches. Constructions of various types of drainage.   | 5 | - |
|    | SR Study of topic material 11. Design of transverse profiles on highways, roadway width, number of traffic lanes. Designs of road clothes.   | 5 | 8 |
| 10 | LK Designing of roads in marshy and wooded areas and in the karst spreading zone.  | 2 | - |
| 12 | SR Studying the material of topic 12. Designing transverse profiles of the earth bed in swamps   | 5 | 5 |
|    | LK Designing of highways in mountainous conditions and in the zone of the spread of ravines.   | 2 | - |
| 13 | PR Calculations of the design of non-rigid road clothing according to strength criteria. Reliability of road clothing, design load, use of nomograms.  | 5 | - |
|    | SR Study of topic material 13. Design of transverse profiles of the earth bed in mountainous terrain   | 5 | 5 |
|    | LK Road pipes. Small bridges.  | 2 | - |
| 14 | SR Studying the material of topic 14. Determination of flow volumes when calculating pipes and small bridges   | 5 | 8 |
|    | LK Bridge crossings. Bridge structures. Regulatory buildings.  | 2 | - |
| 15 | PR Structural schemes of various types of transport hubs.<br>Determination of conflict points. Analysis of traffic conditions.<br>Comparison of different types of transport nodes according to<br>traffic conditions. | 2 | - |
|    | SR Studying the material of topic 15. The main elements of the calculation of bridge crossings.  | 5 | 8 |
| 16 | LC Methods of technical and economic substantiation of project decisions.  | 2 | - |

| SR Study of topic material 16. Stages of technical and economic substantiation of project solutions. | 5   | 5   |
|--|-----|-----|
| In just one semester   | 120 | 120 |
| ALL by discipline  | 120 | 120 |

## Teaching methods:

verbal (lecture, explanation, story, conversation, discussion, work with a book), visual (the method of illustrations and demonstrations), practical tasks and independent work of the acquirer.

## Grading system and requirements:

## Current success

**1** The current success of applicants for the performance of educational types of work in training sessions and for the performance of tasks of independent work is assessed using a four-point scale of grades, followed by recalculation into a 100-point scale. During the assessment of current performance, all types of work provided for by the curriculum are taken into account.

**1.1** Lectures are evaluated by determining the quality of the specified tasks.

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

**1.3** Laboratory classes are assessed by the quality of the implementation of reports on the performance of laboratory work.

**1.4** Seminars are evaluated by the quality of the individual task / abstract.

**2** Evaluation of the current performance of applicants for higher education is carried out at each practical lesson (laboratory or seminar) on a four-point scale ("5", "4", "C", "2") and recorded in the journal of accounting for academic performance.

- "excellent": the applicant perfectly mastered the theoretical material, demonstrates deep knowledge of the relevant topic or academic discipline, the main provisions;

– "good": the applicant has well mastered the theoretical material, owns the main aspects from primary sources and recommended literature, reasonably teaches it; has practical skills, expresses his reasoning about certain problems, but assumes certain inaccuracies and errors in the logic of presenting theoretical content or in the analysis of practical;

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

- "unsatisfactory": the applicant has not mastered the educational material of the topic (discipline), does not know scientific facts, definitions, is almost not oriented in primary sources and recommended literature, there is no scientific thinking, practical skills are not formed.

**3** The final score for current activities is recognized as the arithmetic average sum of points for each lesson, for individual work, current tests according to the formula:

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

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

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

n – the number of measures of current control.

Scores are converted to points according to the recalculation scale (Table 1).

 Table 1 – Recalculation of the average score for current activities into a multi-point scale

| 4-point<br>Scale | 100-point<br>Scale | 4-point<br>Scale | 100-point<br>Scale | 4-point<br>Scale | 100-<br>point<br>Scale | 4-point Scale  | 100-point Scale |
|------------------|--------------------|------------------|--------------------|------------------|------------------------|----------------|-----------------|
| <u>5</u>         | <u>100</u>         | <u>4,45</u>      | <u>89</u>          | <u>3,90</u>      | <u>78</u>              | <u>3,35</u>    | <u>67</u>       |
| 4,95             | <u>99</u>          | <u>4,4</u>       | 88                 | <u>3,85</u>      | <u>77</u>              | <u>3,3</u>     | <u>66</u>       |
| <u>4,9</u>       | <u>98</u>          | <u>4,35</u>      | <u>87</u>          | <u>3,80</u>      | <u>76</u>              | <u>3,25</u>    | <u>65</u>       |
| 4,85             | <u>97</u>          | <u>4,3</u>       | <u>86</u>          | <u>3,75</u>      | <u>75</u>              | <u>3,2</u>     | <u>64</u>       |
| 4,8              | <u>96</u>          | <u>4,25</u>      | <u>85</u>          | <u>3,7</u>       | <u>74</u>              | <u>3,15</u>    | <u>63</u>       |
| 4,75             | <u>95</u>          | <u>4,20</u>      | <u>84</u>          | <u>3,65</u>      | <u>73</u>              | <u>3,1</u>     | <u>62</u>       |
| 4,7              | <u>94</u>          | <u>4,15</u>      | <u>83</u>          | <u>3,60</u>      | <u>72</u>              | <u>3,05</u>    | <u>61</u>       |
| 4,65             | <u>93</u>          | <u>4,10</u>      | <u>82</u>          | <u>3,55</u>      | <u>71</u>              | 3              | <u>60</u>       |
| <u>4,6</u>       | <u>92</u>          | <u>4,05</u>      | <u>81</u>          | <u>3,5</u>       | 70                     | from 1,78 to   | from 35 to 59   |
|                  |                    |                  |                    |                  |                        | 2,99           |                 |
|                  |                    |                  |                    |                  |                        | Reass          | embly           |
| <u>4,55</u>      | <u>91</u>          | <u>4,00</u>      | <u>80</u>          | <u>3,45</u>      | <u>69</u>              | from 0 to 1,77 | from 0 to 34    |
| 4,5              | <u>90</u>          | <u>3,95</u>      | <u>79</u>          | 3,4              | 68                     | Re-s           | tudy            |

#### Final assessment

**1** The applicant for higher education receives credit at the last lesson in he discipline based on the results of the current assessment. The average score for current activities is converted into points on a 100-point scale, according to the recalculation table (Table 1). Applicants for higher education who have an average current grade in a discipline lower than "3" (60 points) in the last lesson can increase their current score by passing tests in the discipline.

Assessment of knowledge of applicants by testing is carried out on a 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 the test is:
  - working out all missed classes;
  - the average current score in the discipline is not lower than "3" (60 points).

**3** For the implementation of individual independent work and participation in scientific events, applicants are awarded additional points.

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

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

- prizes in the discipline at the international / all-Ukrainian competition of scientific student works - 20 points;

- prizes 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 KhNADU in the discipline – 5 points;

– implementation of individual research (educational and research) tasks of increased complexity – 5 points.

**3.3** The number of additional points may not exceed 20 points.

**4** The result of training is evaluated (choose the right one):

- on a two-point scale (credited/not credited) according to table 2;

– on a 100-point scale (for differentiated standings) according to Table 3.

The final score, together with additional points, cannot exceed 100 points.

**Table 2** – Scale of transfer of points to the national grading system

| On a 100-point scale         | On a national scale |
|------------------------------|---------------------|
| from 60 points to 100 points | enrolled            |
| less than 60 points          | unaccounted for     |

 Table 3 – Scale of assessment of applicants' knowledge based on the results of the final control in the discipline

| Score      | National scale score |          | ECTS score |  |  |
|------------|----------------------|----------|------------|--|--|
| in         |                      |          | Score      | Criteria   |  |
| points     | Exam                 | Passed   |            |  |  |
| 90-<br>100 | Perfectly            | Enrolled | A          | The theoretical content of the course is<br>mastered entirely, without gaps, the necessary<br>practical skills of working with the mastered<br>material are formed, all the training tasks<br>provided by the training program have been<br>completed, the quality of their implementation<br>is estimated by the number of points close to<br>the maximum |  |

| 80–89 | el            | inrolled | В  | The theoretical content of the course is<br>mastered entirely, without gaps, the necessary<br>practical skills in working with the mastered<br>material are mainly formed, all the training<br>tasks provided by the training program have<br>been completed, the quality of most of them is<br>estimated by the number of points close to the<br>maximum  |
|-------|---------------|----------|----|--|
| 75-79 | - <b>3</b>    |          | С  | The theoretical content of the course is<br>mastered entirely, without gaps, some practical<br>skills of working with the mastered material are<br>not sufficiently formed, all the training tasks<br>provided by the training program have been<br>completed, the quality of none of them is<br>assessed by the minimum number of points,<br>some types of tasks are performed with errors  |
| 67-74 | actory        | ш        | D  | The theoretical content of the course is partially<br>mastered, but the gaps are not significant, the<br>necessary practical skills in working with the<br>mastered material are mainly formed, most of<br>the training tasks provided by the training<br>program have been completed, some of the<br>tasks performed may contain errors   |
| 60–66 | Satis         |          | E  | The theoretical content of the course is partially<br>mastered, some practical skills of work are not<br>formed, many of the training tasks provided by<br>the training program have not been completed,<br>or the quality of some of them is estimated by<br>the number of points close to the minimum.   |
| 35–59 | Disappointing | credited | FX | The theoretical content of the course is partially<br>mastered, the necessary practical skills of work<br>are not formed, most of the provided training<br>programs have not been completed, or the<br>quality of their implementation is estimated by<br>the number of points close to the<br>minimum; with additional independent work on<br>the course material, it is possible to improve<br>the quality of the training tasks (with the<br>possibility of re-compilation) |
| 0–34  | Unacceptable  | Not      | F  | The theoretical content of the course has not<br>been mastered, the necessary practical skills of<br>work are not formed, all completed training<br>tasks contain gross errors, additional<br>independent work on the course material will<br>not lead to any significant improvement in the<br>quality of the training tasks (with a mandatory<br>repeated course)  |

# **Course Policy:**

- the course involves teamwork, the environment in the audience is friendly, creative, open to constructive criticism;

- mastering the discipline involves the obligatory attendance of lectures and practical classes, as well as independent work;

- independent work involves the study of individual topics of the discipline, which are made in accordance with the program for independent study, or were considered briefly;

- all tasks envisaged by the program must be completed within the prescribed period;

- if the applicant for higher education is absent from the classroom for a good reason, he presents the completed tasks during the independent preparation and consultation of the teacher;

while studying the course, applicants for higher education must comply with the rules of academic integrity set forth in the following documents: "Rules of academic integrity of participants in the educational process of KhNADU" (<u>https://www.khadi.kharkov.ua/fileadmin/P\_Standart/pologeniya/stvnz\_67\_01\_dobroch\_1.p</u> df), "Academic integrity. Verification of the text of academic, scientific and qualification works 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 KhNADU (https://www.khadi.kharkov.ua/fileadmin/P\_Standart/pologeniya/stvnz\_67\_01\_MEK\_1.pdf).

- in case of detection of the fact of plagiarism, the applicant receives 0 points for the task and must re-complete the tasks provided for in the syllabus;

- write-offs during tests and exams are prohibited (including using mobile devices). Mobile devices are only allowed to be used during online testing.

## **Recommended Books:**

1. Batrakova A.G., Batrakov D.O., Kovalev M.M., Danielyan V.R., Urdzik S.M. Ground-penetrating and geodetic methods in the diagnosis of road wear. Scientific bulletin of construction - Kharkiv: KhNUBA, HOTV ABU, 2021. No. 2(104). P. 165-171.

2. Batrakova A.G., Sarkisyan G.S., Zakharova E.V. Improvement of the model for predicting the evenness of the non-rigid road surface. Communal management of cities: Scientific and technical collection. [Series: Technical sciences]. Kharkiv: XNUMG, 2021. Volume 4. Issue 164. P. 71-76.

3. Batrakova A.G. Analysis and substantiation of the regulatory support for the design of the earth bed in difficult engineering and geological conditions / E.V. Dorozhko, A.H. Batrakova, E.V. Zakharova // Communal management of cities: scientific and technical collection. Ser.: Technical sciences and architecture. 2021. Issue 6 (166). P. 81–87.

4. Fundamentals of system analysis: Study guide. / [O. Ya. Nikonov, A. I. Kudin, M. V. Kostikova, etc.] Kharkiv: Khnadu, 2013. 157 p.

5. Dmitry O. Batrakov, Angelika G. Batrakova, Mariya S. Antyufeyeva GPR and Geodetic Data Application in the Road Industry. Part I: Modern Georadar Technologies in Road Management. LAP LAMBERT Academic Publishing., 2019. - 180

6. Basics of system design and system analysis of complex objects: Basics of system approach and system analysis of objects of new technology. Study guide / Tymchenko A.A.; Under the editorship Yu.G. lie down K.: Lybid, 2004. 288 p.

7. Batrakova A.G. Methodical instructions for practical classes, course design and independent work of students from the discipline "Innovative methods of designing

transport facilities". for students of specialty 193 "Geodesy and land management" / A.H. Batrakova, T.A. Nalivaiko, I.V. Musienko. Kharkiv: Khnadu, 2019. 45 p.

## Additional sources:

 distance course: <u>https://dl2022.khadi.kharkov.ua/course/view.php?id=793</u>
 Public map of Ukraine: [Electronic resource]. - Access mode: <u>http://map.land.gov.ua/kadastrova-karta</u>
 <u>http://files.khadi.kharkov.ua</u>
 <u>http://files.khadi.kharkov.ua</u>
 <u>http://korolenko.kharkov.com</u>
 <u>http://library.univer.kharkov.ua</u>

Developer (developers) syllabus of the discipline

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