

Ministry of Education and Science of Ukraine
Sumy National Agrarian University
Faculty of Economics and Management
Department of Cybernetics and Informatics

Work program (syllabus) of the educational component
Economic and mathematical methods and models

| | |
|----------------------------------|---------------------------|
| Specialty | 073 «Management» |
| Educational program | «Management» |
| Level of Higher Education | First (Bachelor's) |

SUMY

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Department

(academic degree and title, position)

Module syllabus agreed at the
Cybernetics and Informatics

Minutes dated June 12, 2024 № 16

Department meeting

(name of the department)

Head of Department



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Guarantor of the educational program

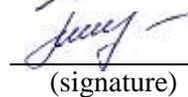


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Syllabus review (attached) is provided by:

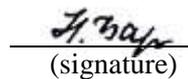


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06.08.2024

(date)

1 GENERAL INFORMATION

| | | | | | |
|------|--|---|-------------------|------------|------------------|
| 1. | Name EC | Economic and mathematical methods and models | | | |
| 2. | Faculty / Department | Faculty of Economics and Management / Department of Cybernetics and Informatics | | | |
| 3. | Status EC | mandatory | | | |
| 4. | Program / specialty that includes EC | EC « Management » Specialty: 073 « Management » (2024 recruitment year) | | | |
| 5. | EC can be proposed for | – | | | |
| 6. | Semester and duration of study | full-time: 4 semesters, 1-15 weeks part-time: /1 semester | | | |
| 7. | Number of credits | 5 | | | |
| 8. | Total hours and their distribution | Contact work (classes) | | | Independent work |
| | | Lectures | Practical/seminar | Laboratory | |
| | | 30/12 | – | 30/10 | 90/128 |
| 9. | Language | Ukrainian | | | |
| 10. | Teacher / Educational Component Coordinator | Candidate of Economic Sciences, Associate Professor of the Department of Cybernetics and Informatics, Dolgikh Yana Volodymyrivna | | | |
| 10.1 | Contact information | 308 e. Email address: yana.dolgikh@snau.edu.ua | | | |
| 11. | General description of the educational component | Economic and mathematical methods and models is an educational component that studies methods for solving optimization problems. The objectives of the educational component are to provide students with knowledge about the essence of optimization problems, the basic principles and techniques for building economic and mathematical models of optimization problems, the principles of using mathematical tools and software for their practical implementation. The professional significance of studying the educational component is to form in future specialists the ability to make optimal decisions, plan, forecast, and design the activities of socio-economic systems. | | | |
| 12. | Purpose of the educational component | The purpose of the educational component is to form in future specialists the knowledge and skills of creating economic and mathematical models of optimization problems, finding the extremum of functions, using modern methods and algorithms of optimization in applied research. As a result of studying the educational component, the applicant must know: – formulation and methods of solving optimization problems; – algorithms for solving optimization problems in Ms Excel; and be able to: – identify optimization problems in professional activities, formulate them; – use mathematical apparatus to build economic and mathematical models of optimization problems; – possess modern methods and algorithms for solving optimization problems, use Ms Excel for their solution; – find optimal solutions under conditions of uncertainty; – analyze the optimal solutions obtained, justify decision-making in professional activities. | | | |

| | | |
|-----|--|---|
| 13. | Prerequisites for studying EC, connection with other educational components EP | 1. EC is based on the study of the discipline “Higher Mathematics and Probability Theory”; 2. EC is the basis for the disciplines: “Analysis of Economic Activity”, “Personnel Management”, “Self-Management”, “Innovation Management” |
| 14. | Academic Integrity Policy | When performing laboratory work, defending it, testing for current control, and taking an exam, the applicant must comply with the rules of academic integrity. To prevent academic dishonesty, the following is carried out: – familiarization with the general principles and fundamental values of academic integrity of participants in the educational process at Sumy NAU; – providing tasks for laboratory work, examination tickets according to options; – carrying out public defense of laboratory work, conducting exams. If facts of cheating or academic dishonesty are detected, the completed laboratory work and answers to the examination ticket are canceled. |
| 15. | Keywords | economic and mathematical methods, decision making, modeling, optimization, economic and mathematical model, mathematical programming |
| 16. | Link to the course in Moodle | https://cdn.snau.edu.ua/moodle/course/view.php?id=1734 |

2 LEARNING OUTCOMES BY EDUCATIONAL COMPONENT AND THEIR RELATIONSHIP WITH PROGRAM LEARNING OUTCOMES

| Learning outcomes for EC: | Program learning outcomes that the EC aims to achieve | | | How is it rated? |
|---|---|---|---|---|
| | PLO ₇ Demonstrate organizational design skills | PLO ₁₂ Assess the legal, social and economic consequences of the organization's operations | PLO ₁₉ Be able to use modern information technologies, blockchain technologies in resource and database management to justify management decisions regarding the choice of innovative technologies in agricultural enterprises | |
| After studying EC, the student is expected to be able to... | | | | |
| ALO 1. Formulate optimization problems, build optimization economic and mathematical models | X | | | Conducting modular control, independent work testing, calculation tasks |
| ALO 2. Solve economic optimization problems using mathematical tools and software | X | | X | Conducting modular control, independent work testing, calculation tasks |
| ALO 3. Conduct post-optimization analysis | X | X | | Conducting modular control, independent |

| | | | | |
|--|---|--|--|---|
| | | | | work testing, calculation tasks |
| ALO 4. Provide practical recommendations for making management decisions | X | | | Conducting modular control, independent work testing, calculation tasks |

3 CONTENT OF THE EDUCATIONAL COMPONENT (COURSE PROGRAM)

| Topic. List of issues to be considered within the topic | Distribution within the overall time budget | | | | Educational resources |
|---|---|-----------------------|-----------------------|-----------------------|---|
| | Classroom work | | | independent work | |
| | Lectures | Practical / seminar | laboratory | | |
| Full-time / part-time | Full-time / part-time | Full-time / part-time | Full-time / part-time | Full-time / part-time | |
| Topic 1. <i>Economic and mathematical modeling.</i> Mathematical model of the process. Economic and mathematical model, the principle of optimality in economics. | 1/1 | | | /1 | Basic: 1, 2 Methodical: 1 Additional: 1-3 |
| Topic 2. <i>Linear programming problems.</i> Examples of linear programming problems: production planning, feed ration compilation, raw material supply, investment distribution. Formulation of a linear programming problem. Standard, canonical linear programming problem. Admissible, optimal plans. Reduction of a linear programming problem to canonical form. | 3/1 | | | /3 | Basic: 1, 2 Methodical: 1 Additional: 1-3 |
| Topic 3. <i>Graphical method of solving linear programming problems.</i> Geometric interpretation of linear programming problems: convex sets of points, geometric meaning of solving linear inequalities and systems of inequalities. Graphical method of solving linear programming problems. | 2/2 | | 4 | /2 | Basic: 2 Methodical: 1 Others: 1 |
| Topic 4. <i>Simplex method.</i> Geometric content of the simplex method. Solving linear programming problems using the simplex method in Ms Excel. | 4/4 | | 4/2 | /6 | Basic: 2 Methodical: 1 Others: 2, 5 |
| Topic 5. <i>Dual estimates.</i> Formulation of a dual linear programming problem. Duality theory. First duality theorem. Second duality theorem. Economic interpretation of the duality theory: economic interpretation of the problem, which is the dual of the production planning problem, economic content of the first duality theorem, objectively determined estimates and their content, analysis of the stability of dual estimates, feasibility of including new products in the plan. | 6/2 | 2 | 6/2 | /8 | Basic: 2 Methodical: 1 Others: 2, 5, 7 |
| Topic 6. <i>Transportation problem.</i> Formulation of a transportation problem. Solving a transportation problem in Ms Excel. Solving an open transportation problem in Ms Excel. | 4 | | 4/2 | /6 | Basic: 2 Methodical: 1 Others: 3, 5, 7 |
| Topic 7. <i>Assignment problem.</i> Setting the assignment problem. Solving the assignment | 2 | | 2/2 | /4 | Basic: 2 Methodical: 1 Others: 1-5, 7 |

| | | | | | |
|---|-------|--|-------|--------|---|
| problem in Ms Excel. | | | | | |
| Topic 8. <i>Dynamic programming.</i> General formulation of the dynamic programming problem. Optimality principle and Bellman's equation. Solving the dynamic programming problem. Solving the dynamic programming problem in Ms Excel | 4/2 | | 4/2 | /6 | Basic: 2 Methodical: 1 Others: 4, 5,7 |
| Topic 9. <i>Integer linear programming problems.</i> Formulation of an integer linear programming problem. Examples of integer optimization models in agricultural economics. Algorithm for solving an integer linear programming problem | | | | 45/45 | Basic: 2 Methodical: 1 Others: 7 |
| Topic 9. <i>Game theory.</i> Elements of game theory. Payoff matrix. Lower and upper price of the game. Solving games in mixed strategies. Solving the problem of planning the optimal placement of agricultural land taking into account the uncertainty of weather conditions | 4 | | 6 | /6 | Basic: 2 Methodical: 1 Others: 6, 7 |
| Topic 10. <i>Nonlinear, stochastic and multi-criteria optimization problems in agricultural economics.</i> Nonlinear optimization models in agricultural economics. Stochastic optimization models in agricultural economics. Multi-criteria optimization models in agricultural economics | | | | 45/41 | Basic: 1, 2 Methodical: 1 Others: 7 |
| Total | 30/12 | | 30/10 | 90/128 | |

4 TEACHING AND LEARNING METHODS

| ALO | Teaching methods (work that will be carried out by the teacher during classroom lessons, consultations) | Number of hours | Learning methods (what types of learning activities should the student perform independently) | Number of hours |
|--|---|-----------------|--|-----------------|
| ALO 1. Formulate optimization problems, build optimization economic and mathematical models | Lectures, laboratory and practical classes, providing applicants with the necessary assistance in mastering theoretical knowledge and developing practical skills by answering specific questions or explaining individual theoretical provisions or aspects of their practical application using active learning methods (technical teaching aids, educational and control tests, lecture notes), interactive, multimedia learning technologies. | 10/5 | Studying theoretical material using traditional methods (compiling lecture notes, independent work with textbooks and manuals), performing calculation tasks according to methodological instructions. | 15/10 |
| ALO 2. Solve economic optimization problems using mathematical tools and software | Lectures, laboratory and practical classes, providing applicants with the necessary assistance in mastering theoretical knowledge and developing practical skills by answering specific questions or explaining individual theoretical provisions or aspects of their practical application using active learning methods (technical teaching aids, educational and control tests, lecture notes), interactive, multimedia learning technologies. | 40/5 | Studying theoretical material using traditional methods (compiling lecture notes, independent work with textbooks and manuals), performing calculation tasks according to methodological instructions. | 25/60 |
| ALO 3. Analyze the results of | Lectures, laboratory and practical classes, providing applicants with the necessary assistance in mastering theoretical | 5/5 | Studying theoretical material using traditional methods (compiling | 25/30 |

| | | | | |
|--|---|-------|--|--------|
| solving optimization problems | knowledge and developing practical skills by answering specific questions or explaining individual theoretical provisions or aspects of their practical application using active learning methods (technical teaching aids, educational and control tests, lecture notes), interactive, multimedia learning technologies. | | lecture notes, independent work with textbooks and manuals), performing calculation tasks according to methodological instructions. | |
| ALO 4. Provide practical recommendations for making management decisions | Lectures, laboratory and practical classes, providing applicants with the necessary assistance in mastering theoretical knowledge and developing practical skills by answering specific questions or explaining individual theoretical provisions or aspects of their practical application using active learning methods (technical teaching aids, educational and control tests, lecture notes), interactive, multimedia learning technologies. | 5/5 | Studying theoretical material using traditional methods (compiling lecture notes, independent work with textbooks and manuals), performing calculation tasks according to methodological instructions. | 25/30 |
| Total | | 60/20 | | 90/130 |

5 EVALUATION BY EDUCATIONAL COMPONENT

5.1. Summative assessment

5.1.1 For the assessment of expected learning outcomes, there are

| № | Summative assessment methods | Points / Weight in the overall score | Date of compilation |
|----|------------------------------|--------------------------------------|---------------------|
| 1. | Laboratory work №1-№4 | 25 points / 25 % | 7 week |
| 2. | Testing 1 | 5 points / 5% | 7 week |
| 3. | Laboratory work №5-№8 | 30 points / 30 % | 14 week |
| 4. | Testing 2 | 5 points / 5 % | 14 week |
| 5. | Self-study testing | 5 points / 5% | 14 week |
| 6. | Exam | 30 points / 30 % | 15 week |

5.1.2 Evaluation criteria

| Component | Unsatisfactorily | Satisfactorily | Good | Perfectly |
|---------------------------|--|--|---|--|
| Laboratory work №1 | 0-2 points | 3 points | 4 points | 5 points |
| | <i>The tasks are not completed (methodology and answers are incorrect). The answers to the control questions are incorrect</i> | <i>The task was completed with significant errors (the execution method is correct, but there are significant errors, the answers are mostly incorrect). The answers to the control questions are mostly incorrect</i> | <i>The task is completed, but there are minor errors. The answers to the control questions are mostly correct</i> | <i>The task is completely completed. There are no errors. The answers to the control questions are correct</i> |
| Laboratory work №2 | 0-2 points | 3 points | 4 points | 5 points |
| | <i>The tasks are not completed (methodology and answers are incorrect). The answers to the control questions are incorrect</i> | <i>The task was completed with significant errors (the execution method is correct, but there are significant errors, the answers are mostly incorrect). The answers to the control questions are mostly incorrect</i> | <i>The task is completed, but there are minor errors. The answers to the control questions are mostly correct</i> | <i>The task is completely completed. There are no errors. The answers to the control questions are correct</i> |

| | | | | |
|---|--|--|---|--|
| Laboratory work №3 | 0-4 points | 5-6 points | 7-9 points | 10 points |
| | <i>The tasks are not completed (methodology and answers are incorrect). The answers to the control questions are incorrect</i> | <i>The task was completed with significant errors (the execution method is correct, but there are significant errors, the answers are mostly incorrect). The answers to the control questions are mostly incorrect</i> | <i>The task is completed, but there are minor errors. The answers to the control questions are mostly correct</i> | <i>The task is completely completed. There are no errors. The answers to the control questions are correct</i> |
| Laboratory work №4 | 0-2 points | 3 points | 4 points | 5 points |
| | <i>The tasks are not completed (methodology and answers are incorrect). The answers to the control questions are incorrect</i> | <i>The task was completed with significant errors (the execution method is correct, but there are significant errors, the answers are mostly incorrect). The answers to the control questions are mostly incorrect</i> | <i>The task is completed, but there are minor errors. The answers to the control questions are mostly correct</i> | <i>The task is completely completed. There are no errors. The answers to the control questions are correct</i> |
| Testing 1 (multiple choice test) | 0-2 points | 3 points | 4 points | 5 points |
| | <i>Depends on the number of correct answers on the test</i> | <i>Depends on the number of correct answers on the test</i> | <i>Depends on the number of correct answers on the test</i> | <i>Depends on the number of correct answers on the test</i> |
| Laboratory work №5 | 0-2 points | 3 points | 4 points | 5 points |
| | <i>The tasks are not completed (methodology and answers are incorrect). The answers to the control questions are incorrect</i> | <i>The task was completed with significant errors (the execution method is correct, but there are significant errors, the answers are mostly incorrect). The answers to the control questions are mostly incorrect</i> | <i>The task is completed, but there are minor errors. The answers to the control questions are mostly correct</i> | <i>The task is completely completed. There are no errors. The answers to the control questions are correct</i> |
| Laboratory work №6 | 0-2 points | 3 points | 4 points | 5 points |
| | <i>The tasks are not completed (methodology and answers are incorrect). The answers to the control questions are incorrect</i> | <i>The task was completed with significant errors (the execution method is correct, but there are significant errors, the answers are mostly incorrect). The answers to the control questions are mostly incorrect</i> | <i>The task is completed, but there are minor errors. The answers to the control questions are mostly correct</i> | <i>The task is completely completed. There are no errors. The answers to the control questions are correct</i> |
| Laboratory work №7 | 0-4 points | 5-6 points | 7-9 points | 10 points |
| | <i>The tasks are not completed (methodology and answers are incorrect). The answers to the control questions are incorrect</i> | <i>The task was completed with significant errors (the execution method is correct, but there are significant errors, the answers are mostly incorrect). The answers to the control questions are mostly incorrect</i> | <i>The task is completed, but there are minor errors. The answers to the control questions are mostly correct</i> | <i>The task is completely completed. There are no errors. The answers to the control questions are correct</i> |
| Laboratory work №8 | 0-4 points | 5-6 points | 7-9 points | 10 points |
| | <i>The tasks are not completed (methodology and answers are incorrect). The answers to the control questions are incorrect</i> | <i>The task was completed with significant errors (the execution method is correct, but there are significant errors, the answers are mostly incorrect). The answers to the control questions are mostly incorrect</i> | <i>The task is completed, but there are minor errors. The answers to the control questions are mostly correct</i> | <i>The task is completely completed. There are no errors. The answers to the control questions are correct</i> |
| Testing 2 (multiple choice test) | 0-2 points | 3 points | 4 points | 5 points |
| | <i>Depends on the number of correct</i> | <i>Depends on the number of correct answers on the test</i> | <i>Depends on the number of correct</i> | <i>Depends on the number of</i> |

| | | | | |
|---------------------------|---|---|---|---|
| | <i>answers on the test</i> | | <i>answers on the test</i> | <i>correct answers on the test</i> |
| Self-study testing | 0-2 points | 3 points | 4 points | 5 points |
| | <i>Depends on the number of correct answers on the test</i> | <i>Depends on the number of correct answers on the test</i> | <i>Depends on the number of correct answers on the test</i> | <i>Depends on the number of correct answers on the test</i> |
| Exam | 0-9 points | 10-16 points | 17-24 points | 25-30 points |
| | <i>Depends on the number of correct answers to the exam questions</i> | <i>Depends on the number of correct answers to the exam questions</i> | <i>Depends on the number of correct answers to the exam questions</i> | <i>Depends on the number of correct answers to the exam questions</i> |

5.2 Formative assessment:

| No | Elements of formative assessment | Date |
|----|--|---|
| 1 | Oral survey after studying each topic | After completing the topic study |
| 2 | Passing a test with feedback from the teacher | According to the educational process schedule |
| 3 | Taking a test to self-check your knowledge after completing each topic | Regulated by the student independently |
| 4 | Oral feedback from the teacher during laboratory work, independent work during classes | Throughout the semester |

5.3 Grading scale – generally accepted for the University

Grading scale: national and ECTS

| Total points for all types of learning activities | Rating ECTS | Total points for all types of learning activities | |
|---|-------------|--|--|
| | | for exam, course project (work), practice | for credit |
| 90 – 100 | A | perfectly | enrolled |
| 82-89 | B | good | |
| 75-81 | C | | |
| 69-74 | D | satisfactorily | |
| 60-68 | E | | |
| 35-59 | FX | unsatisfactory with the possibility of reassembly | unsatisfactory with the possibility of reassembly |
| 0-34 | F | unsatisfactory with mandatory re-study of the discipline | unsatisfactory with mandatory re-study of the discipline |

6 LEARNING RESOURCES (LITERATURE)

6.1 Basic sources

1. Ng X. W. Concise Guide to Optimization Models and Methods. Cham : Springer International Publishing, 2022. URL: <https://doi.org/10.1007/978-3-030-84417-2> (date of access: 15.08.2025).
2. Taha H. Operations Research: An Introduction. Pearson, 2016.

6.2 Methodological support

1. Економіко-математичні методи і моделі: навч. посіб. / Я.В. Долгіх Суми : ФОП Цьома С.П., 2024. 125 с.

6.3 Additional sources

1. Dolgikh, Ya.V. (2024). Evaluation of the efficiency of agricultural higher education institutions of Ukraine and the dynamics of its change by data envelopment analysis. *Ekonomika APK*, 31(1), 29-40. <https://doi.org/10.32317/2221-1055.202401029>
2. Dolgikh, Ya.V. (2023). Evaluation of the efficiency of agrarian institutions of higher education of Ukraine using the DEA method. *Ekonomika APK*, 30(1), 30-39. <https://doi.org/10.32317/2221-1055.202301030>
3. Dolgikh, Ya.V. (2022). Improvement of crop production planning in Ukraine using the Cobb-Douglas production function. *Ekonomika APK*, 29(1), 10-17. <https://doi.org/10.32317/2221-1055.202201010>

6.4 Other sources

1. iLearn.iShare. MS: Linear Programming Excel Solutions Part 4: Modeling and Graphical Solutions (Minimization LP), 2021. *YouTube*.
URL: <https://www.youtube.com/watch?v=zK99zV3-XqM> (date of access: 15.08.2025).
2. Within minutes. Simplex method in Excel/Simplex linear programming in Excel/Use of Solver/Simplex Method, 2021. *YouTube*.

URL: <https://www.youtube.com/watch?v=QMWUfsvxkdE> (date of access: 15.08.2025).

3. Joshua Emmanuel. Solving LP Transportation Problem | Excel Solver, 2022. *YouTube*. URL: <https://www.youtube.com/watch?v=k9iFrgWD-WY> (date of access: 15.08.2025).

4. Tech With Tim. Dynamic Programming Explained (Practical Examples), 2022. *YouTube*. URL: <https://www.youtube.com/watch?v=Sz9yH-RDAgo> (date of access: 15.08.2025).

5. Leila Gharani. Excel Solver - Example and Step-By-Step Explanation, 2017. *YouTube*. URL: <https://www.youtube.com/watch?v=dRm5MEoA3OI> (date of access: 15.08.2025).

6. Game Theory 101 – Game Theory 101: Game Theory Made Easy. Game Theory 101 – Game Theory 101: Game Theory Made Easy. URL: <https://gametheory101.com/> (date of access: 15.08.2025).

7. Долгіх Я.В. Оптимізаційні методи та моделі (в Moodle). URL: <https://cdn.snau.edu.ua/moodle/course/view.php?id=1734>

6.5 Software

1. Ms Excel. URL: <https://www.microsoft.com/uk-ua/microsoft-365/excel> (date of access: 16.06.2024).