Ministry of Education and Science of Ukraine
Sumy National Agrarian University
Faculty of Engineering and Technology
Department of Technical Service

Work program (syllabus) of the educational component

CC 14 – Innovative technological solutions in industrial machinery engineering
(mandatory)

Implemented within the educational program
"Industrial machinery engineering"
(name)
in specialty 133 "Industrial machinery engineering"
(code, name)

third (educational and scientific level) level of higher education

Sumy – 2023

Developers: _____, Tarelnyk V.B., Doctor of Technical Sciences, Professor, Head of the Department of Technical Sciences

(signature) (surname, initials) (academic degree and title, position)

Reviewed, approved and ratified at a meeting of the Technical Service Department (name of the department)	protocol of June 05, 2023 No. 17
	Head departments _____ (signature) Tarelnyk V.B. (last name, initials)

Agreed:

Guarantor of the educational program _____ (signature) V.B. Tarelnyk (full name)

Dean of the Faculty _____ (signature) V.M. Zubko (full name)

Review of the work program (attached) provided by: _____ V.M. Zubko (Full name)

_____ M.Yu.Dumanchuk (Full name)

Methodologist of the Education Quality Department, licensing and accreditation _____ (signature) N.M. Baranik

Registered in the electronic database: date: 06.07. 2023.

Information on reviewing the work program (syllabus):

Academic year in which changes are made	Number of the appendix to the work program with a description of the changes	Changes reviewed and approved		
		Date and number of the minutes of the department meeting	Head of the Department	Educational program guarantor

1. GENERAL INFORMATION ABOUT THE EDUCATIONAL COMPONENT

1	Name CC	Innovative technological solutions in industrial mechanical engineering			
2	Faculty/department	Faculty of Engineering and Technology / Department of Technical Service			
3	Status CC	Mandatory			
4	Program/Specialty (programs) of which the CC for (to be filled in for mandatory CCs) is a component	Educational and scientific program "Industrial Mechanical Engineering" in specialty 133 "Industrial Mechanical Engineering"			
5	NRC level	Level 8			
6	Semester and duration of study	Daily 2semester, 9 weeks			
7	Number of ECTS credits	3			
8	Total hours and their distribution 2nd semester – 90 hours.	Contact work (classes)			Independent work
		Lectures	Practical / seminar	Laboratory	
		6	6	-	78
9	Language of instruction	Ukrainian, English			
10	Teacher/Educational Component Coordinator	Tarelnyk V.B., Doctor of Technical Sciences, Professor, Head of the Department of Technical Service. Consultation hours – every Monday from 9:00 to 11:00, room 302m			
10.1	Contact information	tarelnyk@ukr.net			
11.	General description of the educational component	The main focus of the educational component is on methodologiesachieving operational properties of friction surfaces, assemblies and parts bydue to strengthening effects of various physical nature and application of functional coatings.			
12.	Purpose of the educational component	Acquisition by applicants of the necessary amount of knowledge for studying tribotechnical laws that operate during the life cycle of machines. Mastering design and technological methods for increasing the wear resistance of working surfaces of machine parts, in order to ensure the operability of machines at optimal cost of work.			
13.	Prerequisites for studying CC, connection with other educational components of ESP	The educational component is based on knowledge and skills in solving applied scientific problems in the field of mechanical engineering using methods of modern science based on a systems approach, taking into account the complexity and uncertainty of the operating conditions of technological systems.			
14.	Academic Integrity Policy	If a candidate submits another candidate's work as their own, such work is canceled and retaken. In case of cheating, retake the corresponding assignment. In case of using text borrowings without proper citation (academic plagiarism), the work will be canceled.			
15	Link to the course in Moodle	https://cdn.snau.edu.ua/moodle/course/view.php?id=1183			

1. LEARNING OUTCOMES BY EDUCATIONAL COMPONENT AND THEIR RELATIONSHIP WITH PROGRAM LEARNING OUTCOMES

Learning outcomes for CC: After studying the educational component, the applicant is expected to be able to...	Program learning outcomes that the CC aims to achieve (indicate the number according to the numbering given in the ESP)						How is the LOA assessed?
	PLO1	PLO3	PLO4	PLO9	PLO11	PLO12	
LOA1. Conduct systemic, structural and functional analysis of technical systems and promising areas of development of technical and technological systems.	X			X			Research work with presentation, peer evaluation
LOA2. Formulate justified technical and economic requirements for the machines being created, technological processes for their manufacture, repair and reengineering.			X		X	X	Preparation of theses with justification of rational research methods in accordance with the selected object and task, mutual evaluation
LOA 3. Conduct research on the influence of technological process parameters on quantitative and qualitative characteristics.		X		X			Conducting experimental research, presenting results
LOA 4. Know and be able to apply progressive methods of forming specified characteristics of machine parts.	X				X	X	Research paper with presentation
LOA 5. Make a scientifically based choice of constructive and technological methods to achieve the specified characteristics of technical and technological systems.	X				X	X	Research paper with presentation,written exam (solving a complex problem and short theoretical answers)

PLO 1. Have conceptual and methodological knowledge in mechanical engineering and at the border of subject areas, as well as research skills sufficient to conduct scientific and applied research at the level of the latest world achievements in the relevant field, obtain new knowledge and/or implement innovations.
PLO 3. Formulate and test hypotheses; use appropriate evidence to substantiate conclusions, in particular, the results of theoretical analysis, experimental studies and mathematical and/or computer modeling, and available literature data.
PLO 4. Develop and research conceptual, mathematical and computer models of processes and systems, effectively use them to obtain new knowledge and/or create innovative products in mechanical engineering and related interdisciplinary areas.
PLO 9. Deeply understand the general principles and methods of mechanical engineering, as well as the methodology of scientific research, apply them in their own research in the field of industrial mechanical engineering and in teaching practice.
PLO 11. Carry out reengineering to improve the operational characteristics of machines, equipment, complexes, and production lines using safe technological and energy-efficient methods.

PLO 12. Increase the efficiency of systems engineering aimed at the creation, operation and utilization of industrial mechanical engineering products.

3. CONTENT OF THE EDUCATIONAL COMPONENT (COURSE PROGRAM)

Topic. List of issues to be addressed within the topic	Distribution within the overall time budget				Recommended reading
	Classroom work			Independent work	
	Lec	PC	Lab		
Topic 1. Purpose, objectives and place of the discipline. General information. Basic terms and concepts. Purpose and objectives of the discipline	1	-		10	[1-6]
Topic 2. Purpose and methods of analysis of technical systems. Analysis tasks. Formalization and formulation of the task of analyzing technical systems. Technology of analyzing technical systems. Structure of the process of analyzing technical systems. Formation of a description of a technical system A priori information. Example of machine analysis of a technical system	1	-		10	[1-10], [12], [18], [21]
Topic 3. Synthesis of technical systems. The essence of the problem of synthesis of a technical system. On changing the formulation of the problem of synthesis. Methods of evaluating technical systems. Suboptimal and optimal synthesis of technical systems. Algorithm of suboptimal synthesis of technical systems. Rules for changing the structure and parameters of technical systems. Morphological analysis and synthesis of technical systems.	1	2		12	[1-5], [9-12], [14], [15], [17]
Topic 4. Methods of finding new technical solutions. Classification of methods for searching for new technical solutions. Trial and error method. Heuristic methods for activating the search for new technical solutions. Brainstorming method. Method of control questions. Method of morphological analysis. Synectics. Rules for formulating the problem.	1	2		14	[1-11], [14], [21]
Topic 5.Principles of resolving technical contradictions. Material-field analysis. Typical principles of resolving technical contradictions and examples of their use. Physical effects and their application. Application of chemical effects. Geometric effects and their application	1	-		14	[1], [2], [6-8], [14], [21]
Topic 6. Technology for forming protective surface layers of parts	6	2		18	[1-5], [9-14],

Surface quality of machine parts. Technology of parts restoration. Quality management of surface layers. Methods of increasing the wear resistance of metals: surfacing with hard and wear-resistant materials; plasma spraying; heat treatment; chemical-thermal treatment; spraying; condensed ion bombardment; laser processing; electro-spark alloying, surface-plastic deformation and others. Innovative technological solutions for improving the quality of surfaces of typical parts.					[16-21]
Total	6	6		78	

4. TEACHING AND LEARNING METHODS

LOA	**Teaching methods** (work that will be carried out by the teacher during classroom lessons, consultations)	**Number of hours**	**Teaching methods** (what types of educational activities should a postgraduate student perform independently)	**Number of hours**
LOA 1	Problem lecture, thematic discussion, discussion of current issues	6	Independent work with the textbook, study of theoretical material.	8
LOA 2	Showing examples of solving production problems using an interactive method during lectures and practical classes	8	Independent work with the textbook, study of theoretical material.	12
LOA 3	Multimedia lecture, brainstorming, discussion of current issues.	6	Independent work with the textbook, completion of individual tasks.	10
LOA 4	Showing examples of solving production problems using an interactive method during lectures and practical classes	8	Personalized learning, independent work with the textbook, completion of individual tasks.	12
LOA 5	Problem lecture, thematic discussion, round table, discussion of current issues.	8	Independent work with the textbook, learning through research.	12

5. EVALUATION BY EDUCATIONAL COMPONENT

5.1. Diagnostic assessment (indicated as needed)

5.2. Summative assessment

5.2.1. To assess the expected learning outcomes, there are

No.	Summative assessment methods	Points / Weight in the overall score	Date of compilation
1.	Completing an individual task	*25 points / 25%*	*For 3 weeks*
2.	Completing an individual task	*25 points / 25%*	*At 6 weeks*
3.	Analytical review with presentation	*20 points / 20%*	*At 8 weeks*
4.	Written exam (solving a complex problem and short theoretical answers)	30 points /30%	Week 9 (as scheduled)

5.2.2. Evaluation criteria

Component	Unsatisfactorily	Satisfactorily	Good	Perfectly
Performing individual tasks	*<30 points*	*15-37 points*	*38-44 points*	*45-50 points*
	Little awareness of the problem, a brief description is provided. Does not demonstrate independent thinking on the chosen topic.	The problem is mostly described (without analysis), the main points are not sufficiently substantiated, the argumentation is not sufficiently consistent, the presentation is absent or superficial. Only literature recommended by the teacher is reviewed.	Demonstrated understanding, depth and/or detail of the problem; main problem aspects are substantiated, arguments are consistent; different points of view are explored, presentation is meaningful, consistent. Literature reviewed is only recommended by the teacher.	The problem is sufficiently deeply and/or in detail disclosed, different views on the problem are analyzed; all main points are stated, the arguments are consistent and weighty; different points of view are analyzed, and one's own suggestions are given.
Analytical review with presentation	*<12 points*	*12-14 points*	*15-17 points*	*18-20 points*
	Task requirements not met	Most requirements are met, but individual components are missing or insufficiently disclosed, there is no analysis of other approaches to the issue	All task requirements met	All task requirements have been met, creativity and thoughtfulness have been demonstrated, and an original solution to the problem has been proposed.
Written exam	*<18 points*	*18-22 points*	*23-26 points*	*27-30 points*
	<60% correct answers, problem tasks not completed	60-74% correct answers, problem tasks partially completed	75-89% correct answers, problem tasks completed with minor inaccuracies.	90-100% correct answers, problem tasks completed with full, reasoned answers.

5.3. Formative assessment:

To assess current progress in learning and understand areas for further improvement,

No.	Elements of formative assessment	Date
1	Verbal feedback from the teacher and students regarding individual task iconography	Within 3 weeks
2	Verbal feedback from the teacher and students regarding individual task iconography	Within 6 weeks
3	Verbal feedback from the teacher and students regarding analytical review with presentation	During the 8th week
4	Written test with elements of problem tasks	During the 9th week

6. LEARNING RESOURCES (LITERATURE)

6.1. Main sources:

1. Problems of safe operation of compressor and pumping equipment in modern industry: monograph / V.S. Martsynkovsky, V. B. Tarelnyk, et al.; ed. V. B. Tarelnyk, E.V. Konoplyanchenko. - Sumy: FOP Lytovchenko E.B., 2020.- 410p
2. Kravets S.V., Luk'yanchuk O.P., Tymeichuk O.Yu. Research of machine working processes and optimization methods: a textbook. Rivne: NUVGP, 2011. 239.
3. Loveikin V.S. Theory of technical systems / V.S. Loveikin, Yu.O. Romasevich. – K.: CP “KOMPRINT”, 2017. – 291 p.
4. Innovative development of the enterprise. Textbook / edited by P.P. Mykytyuk. Ternopil: PP "Printer Inform", 2015. 224 p.
5. Ilyashenko CM Management of innovative development: problems of the concept, methods: textbook / Ilyashenko S. M. - Sumy: University Book, 2010.- 129 p.
6. Tarelnyk V.B. Tribotechnology of machine parts: a textbook / [Tarelnyk V.B., Konoplyanchenko E.V., Martsynkovsky V.S., Antoshevsky Bohdan]; edited by Prof. V.B. Tarelnyk.- Sumy: Publishing house "MakDen", 2010.- 264 p.
7. Increasing the stability of cutting tools by technological methods: a textbook / [Tarelnyk V.B., Konoplyanchenko E.V., Martsynkovsky V.S. and others]; edited by Prof. V.B. Tarelnyk.- Sumy: University Book, 2011.- 189 p.
8. Tarelnyk V.B. Modern methods of shaping friction surfaces of machine parts: Monograph / Tarelnyk V.B., Martsynkovsky V.S., Antoshevsky B..- Sumy: Publishing house "MakDen", 2012.-280 p.
9. Antoszewski B., Tarelnik W., Konopliaczenko J.Improvement of resistance to fretting wear in sprzęgłach with elastic metal elements. W: Wybrana Problematyka w Technologiach Inżynierii Mechanicznej: Monografie, Studia, Rozprawy, M 135. redakcija Radek N., Sęk P. Kielce, Wydawnictwo Politechniki Świętokrzyskiej, 2020, pp. 67-76.
10. Makarysheva T.S., Eremkin E.A. Real innovations in the machine-building industry // Science and Innovations. 2010. Vol. 6. No. 4. P. 55–66/
11. Selected problems of surface engineering and tribology: Monografie, Studia, Rozprawy, M 85/ V. Martsynkovskyy, V. Tarelnyk, B. Antoszewski, Ie.

Konoplianchenko, A. Zhukov and etc.; edited by B. Antoszewski, V. Tarelnyk - Kielce: Wydawnictwo Politechniki Świętokrzyskiej, 2016. – 111p.

Additional sources:

12. Tarelnyk V.B. Control of the quality of the surface layers of parts by combined electroerosion alloying. - Sumy.: MakDen, 2002.-323p.
13. V.B. Tarelnyk, V.S. Marcinkovsky, B. Antoshevsky Improving the quality of sliding bearings: Monograph. - Sumy: "MakDen" Publishing House, 2006.-160 p.
14. V.B. Tarelnyk, O.P. Gaponova, V.B. Loboda, E.V. Konoplyanchenko, V.S. Martsynkovsky, Yu.Y. Semirnenko, N.V. Tarelnyk, M.A. Mykulina, B. Sarzhanov .AND. Increasing the environmental safety of the formation of wear-resistant coatings on the surfaces of parts such as rotating bodies made of 12X18N10T steel using a combined technology based on electrospark alloying. Electronic materials processing, 2020. Volume 56 (5). WITH. 115-127.
15. Novakovsky S. Yu. Electrospark treatment of friction surfaces as a means of increasing the service life of machine parts / S. Yu. Novakovsky, E. V. Kalgankov // Integration of world scientific processes as the basis of social progress: Mater. II int. scient.-practical conf. (Kyiv, November 23–24, 2018) / NGO “Institute of Innovative Education”; Scientific and Educational Center of Applied Informatics of the NAS of Ukraine. – Kyiv: NGO “Institute of Innovative Education”, 2019. – P. 204-208.
16. Ishchenko A.A. Technological foundations of restoration of industrial equipment with modern polymer materials - Mariupol: PGTU, 2007. - 250 p.
17. V. Tarelnyk, D. Hlushkova, V. Martsynkovskyy, M. Dumanchuk, B. Antoszewski, Cz. Kundera, Ie. Konoplianchenko, N. Tarelnyk, S. Hudkov, A. Zahorulko. Increasing fretting resistance of flexible element pack for rotary machine flexible coupling Part 1. Analysis of the reasons affecting fretting resistance of flexible elements for expansion couplings. Journal of Physics: Conference Series. 1741 (2021) pp. 012048-1 - 012048-11.https://doi.org/10.1088/1742-6596/1741/1/012048
18. Antoszewski B, Gaponova OP, Tarelnyk VB, Myslyvchenko OM, Kurp P, Zhylenko TI, Konoplianchenko I. Assessment of Technological Capabilities for Forming Al-CB System Coatings on Steel Surfaces by Electrospark Alloying Method. Materials. 2021; 14(4):739. https://doi.org/10.3390/ma14040739
19. Tarelnyk V., Konoplianchenko Ie, Gaponova O., Antoszewski B., Kundera Cz., Martsynkovskyy V., Dovzhyk M., Dumanchuk M., Vasilenko O. (2020) Application of multicomponent wear-resistant nanostructures formed by electrospark allowing for protecting surfaces of compression joint parts. In: Pogrebnjak A., Bondar O. (eds) Microstructure and Properties of Micro- and Nanoscale Materials, Films, and Coatings (NAP 2019). Springer Proceedings in Physics, Chapter 18, vol 240. Springer, Singapore, pp 195-209.https://doi.org/10.1007/978-981-15-1742-6_18
20. Xiang Hong, Ke Feng, Ye-fa Tan, Xiao-long Wang, Hua Tan, Effects of process parameters on microstructure and wear resistance of TiN coatings deposited on TC11 titanium alloy by electrospark deposition, Transactions of Nonferrous

Metals Society of China, Vol. 27, Issue 8, (2017), pp. 1767-1776.https://doi.org/10.1016/S1003-6326(17)60199-7

21. T. Penyashki, G. Kostadinov, I. Mortev, E. Dimitrova, Investigation of properties and wear of WC, TiC and TiN based multilayer coatings applied onto steels C45, 210CR12 AND HS6-5-2 deposited by non-contact electrospark process, Journal of the Balkan Tribological Association, Vol. 23, No. 2, 325–342 (2017).https://www.researchgate.net/publication/322199533

22. Ph.V. Kiryukhantsev-Korneev, AN Sheveyko, NV Shvindina, EA Levashov, DV Shtansky, Comparative study of Ti-C-Ni-Al, Ti-C-Ni-Fe, and Ti-C-Ni-Al/Ti-C-Ni- Fe coatings produced by magnetron sputtering, electro-spark deposition, and a combined two-step process, Ceramics International, Vol. 44, Issue 7, (2018), pp. 7637-7646.https://doi.org/10.1016/j.ceramint.2018.01.187