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Boosting the role of HEIs in the industrial transformation towards the Industry 4.0 paradigm in Georgia and Ukraine / HEIn4

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Produced under Activity 2.2.1

HEI: ***Ukrainian state university of science and technologies (National Metallurgical Academy of Ukraine until 01.11.2021)***

SYLLABUS

"Integration of Industry 4.0 to Manufacturing Operations"

Name of discipline	Integration of Industry 4.0 to Manufacturing Operations
Code and specialty name	131 - Applied Mechanics
Name of educational program	Manufacturing Technology
Higher education level	Second (master's)
Status of discipline	Selective discipline of the training cycle (professional) training
Scope of the discipline in ECTS	4 ECTS (120 academic hours)
Term of the discipline	2nd semester (III quarter)
Name of the department teaching the discipline	Manufacturing Technology Department
Leading teacher (lecturer)	Associate Professor, Ph.D. Abramov Serhii
Language of instruction	Ukrainian
Prerequisites for study	The study should be preceded by the learning of disciplines: - Theory of automated control; - Special and electrophysical methods of surface treatment; - Special machines and mechatronic systems in mechanical engineering; - Information-measuring and control systems in mechanical engineering
Purpose	Acquisition of knowledge and skills required for: - experimental research; - technology design integrated with modern methods and equipment, robot hardware and systems; - process design for engineering industries; - the ability to formulate and solve of practical problems in the field of development of integrated technologies through engineering research, design and implementation in production.

Competences provided	Students shall be able to: - Identify and solve complex problems in mechanical engineering technology, which involves the use of acquired professional knowledge, skills and abilities; - introduce innovative forms of work and research in the field of mechanical engineering technology; - make informed decisions; - apply information & communication technologies; - develop and manage manufacturing projects; - apply appropriate mathematical, scientific and technical methods, information technology and applied computer software to solve engineering and scientific problems in applied mechanics; - describe, classify and model a wide range of technical objects and processes, based on deep knowledge and understanding of mechanical theories and practices, as well as basic knowledge of related sciences; - work independently and function effectively as a group leader or structural unit in the performance of production tasks, complex projects, research; - take responsibility for the development of professional knowledge and practices in a team; - use the features and benefits of special, electrophysical and mechanochemical methods of processing in professional activities.

Learning outcomes	As a result of study the students must **know:** ✓ basic terms and concepts of integrated technologies; ✓ materials used in additive technologies; ✓ physical bases of layer-by-layer production of materials by additive technologies; ✓ the process of forming the surface layer in 3D printing; **be able to**: ✓ apply modern experimental methods to assess quality of materials in lab and in industrial conditions; use knowledge and skills for operating, maintenance and production control; ✓ argue the choice of methods for solving specific problems, critically evaluate the results obtained and defend the decisions made; ✓ apply professional knowledge and skills to solve typical industrial problems in practical situations; ✓ analyze and compare the parameters of different measuring instruments and according to the requirements of the technological process **The discipline ensures the achievement of the following learning outcomes:** ✓ Knowledge of the principles of design and operation of automation systems; ✓ Ability to use the means of methodology, methods and techniques for developing new type of product, in particular through R&D; ✓ Ability to perform computer based static and dynamic analysis of structures, mechanisms, materials and processes; ✓ Knowledge of the structure, operation, hardware and software of computerized measurement systems in manufacturing, in particular during the finishing operations
Course content	*Module 1* Design of technological processes of integrated technologies in the conditions of sustainable production and Industry 4.0 *Module 2* Functional organization of equipment of the "Manufacturing Factory Learning Lab“ *Module 3* Practical aspects of creating schemes of experimental robotic technological complexes within the framework of Industry 4.0, based on the "Manufacturing Factory Learning Lab" for the specific machine parts *Module 4* Technological and dimensional aspects in machinery manufacturing related to the process of creating integrated technology in the context of Industry 4.0
Measurement	Assessment of the Modules 1-4 is based on the results of test which includes questionnaire and assignments. Each module is graded on a 12-point scale. The final grade of the discipline is defined as the arithmetic mean of 4 modular grades on a 12-point scale

Workload

	Total
Total hours according to the curriculum	120

including: **Classroom**	32
of which: - lectures	16
- laboratory work	4
- practical classes	12
- seminars	0
Independent work	88
including: - preparation for classroom classes	64
- preparation for modular control activities	0
- implementation of course projects (works)	0
- implementation of individual tasks	12
- elaboration of sections of the program that are not taught in lectures	12
Semester control	Exam

Specific learning tools/equipment	process involves the use of a multimedia system, application software: Power INSPECT. Modern computer-aided design packages: AutoCAD, CAD / CAM systems: T-FLEX, Compass, SolidWorks, Siemens NX, Delcam, Mastercam and modern programming languages. Laboratory equipment: 3D printers, 3D scanner, CNC machine, laser engraver.

Recommended literature	Ukrainian 1. Integrated processes of material processing by cutting: a textbook for higher education/ A.I Grabchenko, V.A Zaloga, Yu.N. Vnukov; ed. A.I. Grabchenko and V.A Zaloga. Sumy: University Book, 2017. 451 p. 2. Workflows of high technologies in mechanical engineering: Textbook / A.I Grabchenko, M.V Verezub, Y.M. Vnukov, P.P. Melnichuk, G.M. Vygovsky/ ed. A.I. Grabchenko. Zhytomyr: ZhSTU, 2018. 507 p. 3. Integrated generative technologies: textbook. / A.I. Grabchenko, Y.N. Vnukov, V.L. Dobroskok, L.I. Pupan, V.A. Fadeev; ed. A.I. Grabchenko. - Kharkiv: NTU "KhPI", 2019. - 416 p. 4. Working processes of high technologies in mechanical engineering: Textbook / Grabchenko A.I, Verezub M.V, Vnukov Y.M, Melnichuk P.P, Vygovsky GM / Ed. A.I. Grabchenko. - Zhytomyr: ZhDTU, 2013. - 451 p. 5. Integrated technologies of accelerated prototyping and manufacturing/ Tovazhnyansky L.L, Grabchenko A.I, Chernyshov S.I, Verezub N.V, Vityazev Y.B, Dobroskok V.L, Knut H., Lierat F. / Ed. Tovazhnyansky L.L, Grabchenko A.I - Kharkiv: OAO Model Universe, 2015. - 224 p. 6. Introduction to nanotechnology: the lectures for engineering students / A.I Grabchenko, L.I Pupan, L.L. Tovazhnyansky. Kharkiv: NTU "KhPI", 2012. 272 p. 7. Grabchenko A.I, Dobroskok V.L, Fedorovich V.A 3D modeling of diamond-abrasive tools and grinding processes: Textbook. - Kharkiv: NTU "KhPI", 2006. - 364 p. English 8. H. Abdel-Aal, Additive Manufacturing of Metals: Fundamentals and Testing of 3D and 4D Printing, McGraw Hill, 2021, 496 p. 9. New Industry 4.0 Advances in Industrial IoT and Visual Computing for Manufacturing Processes, L. N. L. de Lacalle, J. Posada, MDPI, 2020, 428 p. 10. D. Galar, P. Daponte, U.Kumar, Handbook of Industry 4.0 and SMART Systems, CRC Press, 2019, 386 p.

Approved at the meeting of the quality assurance group of the educational program " Manufacturing Technology " (Protocol № 1of 15.09.2021).

Revised at the meeting of the quality assurance group of the educational program "Manufacturing Technology " (Protocol № 1 of 13.09.2023).

Guarantor of the educational program, PhD Serhii Bondarenko