Elective Course (Thesis-Related)

Additive Technologies in Aircraft Manufacturing

Programme Subject Area: *G12 Aerospace Engineering*

Level of Higher Education	*Third (PhD)*
Course Status	*Elective course, Semester 3*
Scope of discipline	150 hours / 5 ECTS credits: lectures (32 hours), practical classes (32 hours), self-study (86 hours)
Language	*Ukrainian / English*
What will be studied (subject of study)	The course is aimed at developing systematic knowledge among third-level higher education students on modern additive manufacturing methods and the specific features of their application in the aerospace and rocket-space industries. The course covers the following topics: - Basic concepts and definitions of additive technologies (AT). Structure of the additive manufacturing market. Types of additive technologies. Advantages and disadvantages of AT. Prospects for the development of AT. - 3D CAD modeling and creation of a digital layer-by-layer representation (model) of a product. Concepts of product and part manufacturability. - FDM (Fused Deposition Modeling). - CJP (ColorJet Printing) – full-color printing based on bonding powder or photopolymer materials. - SLS (Selective Laser Sintering). - 3DW (Three-Dimensional Welding) – three-dimensional deposition (welding), and DMD (Direct Metal Deposition) – direct metal deposition technology. - LLM (Layer Laminate Manufacturing) – a layer-by-layer lamination process. - SLA (Stereolithography Apparatus) – laser stereolithography. - Materials used in additive manufacturing. - Positioning features and selection of product orientation during the layer-by-layer fabrication process. - Tooling and manufacturing of tools and products using Rapid Tooling and Rapid Manufacturing technologies. - Direct manufacturing methods. - Indirect manufacturing methods. - Economic efficiency of integrated generative technologies. - Potential and prospects for the development of additive technologies. - Major examples of additive manufacturing applications in the aerospace and space industries. The course is delivered by professor holding Doctor of Technical Sciences degrees, whose activities encompass the following functions: 1. generation of scientific knowledge; 2. dissemination of knowledge; 3. training of highly qualified specialists.
Why is it interesting/should be studied (goal)	Goal: to provide knowledge on the fundamentals of additive manufacturing (AM) processes for producing aircraft and helicopter components; on systematic approaches to integrated additive technologies for aircraft and helicopter assembly; to develop skills in calculating the key parameters of component manufacturing and assembly processes for typical structures using additive manufacturing technologies; to train students in methods for the rational design of additive manufacturing processes and related tooling; and to master research methods for typical operations employing additive manufacturing technologies.

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<tr><td>Why is it interesting/should be studied (goal)</td><td>Objectives (tasks): To develop knowledge and research skills in the application of additive manufacturing (AM) technologies and computer-aided analysis of manufacturing processes for components produced from sheet materials, profiles, and tubes by cutting and forming operations, including advanced part-forming techniques and methods for improving existing manufacturing processes. Particular attention is paid to modern tooling solutions for additive manufacturing and to the design and production of tooling for manufacturing monolithic aircraft and helicopter components using AM technologies.</td></tr>
<tr><td>How can you use the acquired knowledge and skills (competencies)</td><td>Upon successful completion of the course, PhD students will acquire the following general and professional competencies and achieve the corresponding learning outcomes.
General Competencies
Ability to identify, formulate, and solve problems.
Ability to search, process, and analyze information from various sources.
Ability to solve complex problems in the field of aerospace engineering based on a systematic scientific worldview and broad cultural awareness, while adhering to the principles of professional ethics and academic integrity.
Professional Competencies
Ability to conduct original research and obtain scientific results that generate new knowledge in aerospace engineering and related interdisciplinary fields.
Ability to initiate, develop, and implement complex innovative projects in aerospace engineering and related interdisciplinary areas.
Ability to apply modern information technologies, specialized software, and advanced automated equipment in planning, conducting, and processing experimental investigations.
Learning Outcomes
Formulate and test hypotheses, and use appropriate evidence to substantiate conclusions, including the results of theoretical analyses, experimental investigations, mathematical and/or computer modeling, and available literature data.
Develop and investigate conceptual, mathematical, and computer models of processes and systems, and effectively use them to generate new knowledge and/or create innovative products in aerospace engineering and related interdisciplinary fields.
Plan and conduct experimental and/or theoretical studies on the development of advanced aerospace products and related interdisciplinary areas using modern tools; critically analyze the results of their own research and those of other researchers in the context of current knowledge related to the investigated problem.
Apply modern tools and technologies for information retrieval, processing, and analysis, including statistical methods for analyzing large and/or complex datasets, specialized databases, and information systems.
Understand the general principles and methods of engineering and natural sciences, as well as research methodology, and apply them in their own studies in aerospace engineering, related interdisciplinary fields, and teaching practice.</td></tr>
<tr><td>Prerequisites</td><td>Materials Science for Aerospace Engineering and Advanced Welding Technologies; Mechanical and Physico-Technical Processing Methods, Equipment and Tooling; Foreign Language; Processing and Analysis of Research Results Using Information Technologies</td></tr>
<tr><td>Organization of training</td><td>Types of classes: lectures, practical, self-study.
Forms of education: full-time / part-time.
Forms of control: exam.</td></tr>
<tr><td>Department</td><td>Aircraft Manufacturing Engineering (#104)</td></tr>
<tr><td>Faculty</td><td>Aircraft Engineering</td></tr>
<tr><td>Teachers</td><td>  </td><td><table><tr><td>Name</td><td>Olga Shypul</td></tr><tr><td>Position</td><td>Professor</td></tr><tr><td>Academic title</td><td>Professor</td></tr><tr><td>Scientific degree</td><td>Dr.Tech.Sc.</td></tr><tr><td>e-mail</td><td>o.shipul@khai.edu</td></tr></table></td></tr>
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Links to course materials	Shypul Olga: https://www.scopus.com/authid/detail.uri?authorId=57192959380 1. Kalpakjian S. Manufacturing Engineering and Technology. Addison-Wesley Publishing Company. USA. – 1199 p. 2. Ian Gibson, David Rosen, Brent Stucker. Additive Manufacturing Technologies. 3D Printing, Rapid Prototyping and Direct Digital Manufacturing. Second Edition. New York, 2015. – 498 p. 3. On productivity of laser additive manufacturing (англ.) // Journal of Materials Processing Technology. — 2018-11-01. — Vol. 261. — P. 213–232. 4. "Mentor" Distance Learning System: 5. https://mentor.khai.edu/course/view.php?id=9825