Syllabus
Course Program

CAD of hydroturbines, reversible hydraulic machines, small, mini and micro hydropower plants

Specialty
133 – Industry Engineering

Institute
Educational-scientific Institute of Mechanical Engineering and Transport

Educational program
Industry Engineering

Department
Hydraulic machines named after G.F. Proskura (150)

Level of education
Bachelor

Course type
Optional

Semester
5

Language of instruction
English

Lecturers and course developers

Yevhenii Krupa

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Candidate of Technical Sciences, Associate Professor of the Department of Hydraulic Machines named after G.F. Proskura of NTU "KhPI"

The author of more than 80 scientific and educational works. Courses: "Fundamentals of bladed hydraulic machines theory", "Hydraulic turbines and reversible hydraulic machines", "Fundamentals of CAD for bladed hydraulic machines", "Design of bladed hydraulic machines", "Machines and Equipment for Oil and other Hydrocarbons Mining".

Kseniia Riezva

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Candidate of Technical Sciences, Associate Professor of the Department of Hydraulic Machines named after G.F. Proskura of NTU "KhPI"

Work experience is 10 years.
Author and co-author of more than 60 scientific and educational works.
Courses: "Technical equipment and technology of well repair", "Introduction to the specialty. Introductory practice", "Hydrogasdynamics", "Hydraulics", "Basics of scientific research", "Fountain and gas safety in the oil and gas industry", "Machines and equipment for wells drilling, equipment for oil and gas production".

General information

Summary

The course " CAD of hydroturbines, reversible hydraulic machines, small, mini and micro hydropower plants " studies modern CAD technologies in hydropower design. Students master the skills of working with CAD programs, learn the techniques of building three-dimensional models and conducting CAE analysis. The course is aimed at understanding and applying CAD in the creation of hydroturbines, reversible hydraulic machines and hydroelectric power plant systems of various sizes.

Course objectives and goals

The goal of the course is to systematically study and master modern CAD technologies for the effective design and analysis of hydroturbines, reciprocating hydraulic machines and power plants. Students will gain deep skills in working with specialized software, learn to model and analyze complex engineering systems to improve the efficiency of hydropower projects on a scale from large to micro hydroelectric power plants.

Format of classes

Lectures, laboratory work, independent study, consultations. Final assessment – exam.

Competencies

ZK1. Knowledge and understanding of the subject area and understanding of professional activity.
ZK2. Ability for abstract thinking, analysis and synthesis.
ZK5. Ability to develop and manage projects.
SK2. Ability to apply knowledge and understanding of physical, mathematical and engineering sciences to solve professional problems.
SK3. Ability to apply a systems approach, multidimensional optimization and decision-making methods, modern technologies and engineering methods in the design of hydropower facilities and equipment.
SC4. Ability to ensure the efficiency of hydropower facilities and systems, taking into account constraints, including those related to issues of nature protection, sustainable development, human health and safety, and risk assessments.

Learning outcomes

RN3. Apply specialized conceptual knowledge of hydropower in professional activities, including knowledge and understanding of the latest achievements that provide the ability to innovate and research.
RN5. Clearly and unambiguously communicate one's own conclusions on hydropower problems, as well as the knowledge and explanations that substantiate them, to specialists and non-specialists, in particular to students.
RN7. Make informed decisions on engineering issues of hydropower in complex and unpredictable conditions, including using modern methods and tools for optimization, forecasting, and decision-making.
RN8. Analyze, evaluate, and have decision-making skills on issues related to the development of the team's professional knowledge and practices in the field of hydropower.
RN10. Analyze, apply, and create complex engineering technologies, processes, systems, and equipment for hydropower.

Student workload

The total workload of the course is 120 hours (4 ECTS credits): lectures – 32 hours, laboratory classes – 16 hours, self-study – 72 hours.

Course prerequisites

Fundamentals of hydraulic machinery working process. Hydraulic machine design.

Features of the course, teaching and learning methods, and technologies

The specifics of the course include the use of modern technologies and software for hydraulic machine modeling. The course is practice-oriented, enabling students to acquire skills in working with specialized CAD programs. Interactive practical sessions, project work, and close interaction with the instructor contribute to the development of students' creative thinking and prepare them to solve real-world problems in the field of hydrotechnics and energy.

Program of the course

Topics of the lectures

Topic 1. Introduction to CAD and its application in hydropower design.
Overview of the main CAD programs (SolidWorks, Autodesk Inventor, etc.). The role of CAD in the creation of hydroturbines and reciprocating hydraulic machines.
Topic 2. Fundamentals of modeling and design in CAD.
Creation of three-dimensional models of hydroturbines and their elements.
Topic 3. Mathematical models in CAD.
Mathematical models in hydraulic machines. Use of mathematical models in the design of the flow part.
Topic 4. Graphical capabilities of CAD.
General information and capabilities of Autodesk Inventor, SolidWorks programs. User interface, settings of Autodesk Inventor, SolidWorks working environments. Coordinate systems. Geometric operations with the simplest geometric elements. Screen management. Construction of objects. Using scripts. Construction of curvilinear objects. Construction of complex objects. Linear transformations of drawings. Drawing design commands. Construction of a spiral chamber of a hydroturbine. Construction of the profile of the final thickness of an impeller blade.
Topic 5. Conducting a numerical experiment in Inventor and SolidWorks.
Strength calculations. Numerical study of spatial flow in hydraulic machines.
Topic 6. Presentation of research results.
Designing text documents. Creating drawings in Autodesk Inventor, SolidWorks. Creating photorealistic images using built-in routines. Using Surfer, Grapher programs for graphical processing of research results.

Topics of the workshops

Practical work within the discipline is not provided.

Topics of the laboratory classes

Topic 1. Basics of CAD modeling.
Exercises on creating simple geometric objects. Working with basic tools.
Topic 2. Principles of creating three-dimensional models in CAD programs.
Arrays in Solidworks. Modeling simple parts by extruding sketches. Creating parts by extruding and rotating sketches. Creating parts of complex configuration using extrusion along sections and along a trajectory.
Topic 3. Design of elements of the flow part of a hydroturbine in three-dimensional form.
Construction of a shaft, spiral case, runner, and draft tube in SolidWorks.
Topic 4. CAE stress analysis in hydroturbine structures and spatial flow analysis in flow parts.
Using SolidWorks Flow Simulation to calculate spatial flow in the flow-through elements of a hydroturbine. Calculation of the strength of a hydroturbine shaft using SolidWorks Simulation.

Self-study

Studying lecture material. Preparing for practical classes. Independent study
topics and issues that are not covered in lectures. Students are also recommended additional materials (videos, articles) for independent study and analysis.

Course materials and recommended reading

Basic literature

1 Yeshchenko O.A. Fundamentals of CAD [Electronic resource]: lecture notes for students of the direction 6.050503 “Mechanical Engineering” full-time and part-time forms of study. / Yeshchenko O.A., R.L. Yakobchuk, Zmievsky Y.G. – Kyiv: NUKHT, 2014. – 205 p.
2 Information technologies in high-tech engineering: Computer support of industrial business / Edited by A. M. Bratukhin. – Kyiv: Tekhnika, 2001, – 728 p.: ill.
3 Mykhailenko V. E. Engineering and computer graphics: textbook [Text] / V. E. Mykhailenko, V. M. Naydysh, I. M. Pidkorytov, I. A. Skydan; Ed. V. E. Mykhailenko.– 3rd ed., revised and supplemented. – K.: Publishing House “Slovo”, 2011. – 352 p.
4 Donchenko M. V. Computer design technologies: a textbook / M. V. Donchenko - Mykolaiv: Petro Mohyla Chernihiv National University Publishing House, 2021. - 364 p.
5 Golovchuk A.F. Engineering and computer graphics: a textbook. / A.F. Golovchuk, O.I. Kepko, N.M. Chumak. – Kyiv: Center for Educational Literature, 2010. – 160 p.
6 Kozyar M.M., Feshchuk Y.V., Parfenyuk O.V. Computer graphics: SolidWorks. Kyiv: Publishing House "Oldi-Plus", 2018. – 252 p. ISBN 978-966-289-191-1.

Additional literature

1 1 Sham Tickoo. SOLIDWORKS 2021 for Designers, 19th Edition Paperback. - CADCIM Technologies, 2021. - 1040. ISBN-10: 1640571035.
2. http://library.kpi.kharkov.ua/uk.
3. https://library.sumdu.edu.ua/uk.

Assessment and grading

Criteria for assessment of student performance, and the final score structure

100% of the final grade is made up of the results of the exam (40%) and the ongoing assessment (60%).

Exam: written assignment (2 theory questions + problem solving) and oral report.
Current assessment: online test (20%) and laboratory work tasks (40% : 10% for each laboratory assignment)

Grading scale

Total points	National	ECTS
90–100	Excellent	A
82–89	Good	B
75–81	Good	C
64–74	Satisfactory	D
60–63	Satisfactory	E
35–59	Unsatisfactory (requires additional learning)	FX
1–34	Unsatisfactory (requires repetition of the course)	F

Norms of academic integrity and course policy

The student must adhere to the Code of Ethics of Academic Relations and Integrity of NTU "KhPI": to demonstrate discipline, good manners, kindness, honesty, and responsibility. Conflict situations should be openly discussed in academic groups with a lecturer, and if it is impossible to resolve the conflict, they should be brought to the attention of the Institute's management.
Regulatory and legal documents related to the implementation of the principles of academic integrity at NTU "KhPI" are available on the website: http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/

Approval

Approved by	Date of approval, signature	Head of the department Andrii ROGOVYI
	Date of approval, signature	Guarantor of the educational program Irina TYNIANOVA