Syllabus of the educational component
Program of educational discipline

WORKING PROCESSES IN MODERN PRODUCTIONS

Specialty
131 – Applied mechanics

Institute
NNI of Mechanical Engineering and Transport

Educational program
Applied mechanics

Department Foundry production (142)

Level of education
Master's degree

Course type
Special (professional). Mandatory

Semester
1

Language of instruction
Ukrainian, English

Lecturers and course developers

Olga Ivanivna Ponomarenko,

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doctor of technical sciences, professor of the department of foundry production of NTU "KhPI"

Work experience - 35 years. the author of more than 380 scientific and educational and methodological works, of which 20 are of an educational and methodological nature, 8 methodological manuals with the stamp of the Ministry of Education of Ukraine, 1 textbook, 3 monographs and 17 author's certificates and patents.

Courses:"Theory of the formation of castings", "Forming materials and mixtures", "Physico-chemical foundations of foundry production", "Resource-saving technologies and melting of alloys with special properties", "Design of cast products and equipment"., "Additive technologies in foundry production"

Learn more about the teacher on the department's website

General information

Summary

The course of lectures presents information about modern working processes of obtaining castings; about methodsdesign and analysis ofside processes;the methodology of system analysis and synthesis of complex technical systems and the methodology of the system approach for solving scientific and practical problems of foundry production are presented; apparatus of systems theory, applied mathematical methods for increasing the efficiency of solving problems in the design, reconstruction and operation of foundry technological systems based on knowledge of work processes; the theory of structural and parametric reliability of systems for the creation of new technological solutions based on them in the field

of technology and equipment of foundry production, which ensure the production of a given number of quality castings.

Course objectives and goals

The purpose of the course- to give future specialists knowledge onmodern trends and prospects for the development of machine-building industries and generative (additive) technologies, about the physical and technological features of the working processes of modern industries,basics of system analysis of complex technical systems.

As a result of studying the course, the student should know:

- modern working processes of obtaining castings;
- be abledesign and analyze rside processes;
- to know the methodology of system analysis and synthesis of complex technical systems and the methodology of the system approach for solving scientific and practical problems of foundry production;
- use the system theory apparatus, knowledge of applied mathematical methods and computer technology to increase the efficiency of solving problems in the design, reconstruction and operation of foundry technological systems based on knowledge of working processes;
- the theory of structural and parametric reliability of systems for the creation of new technological solutions based on them in the field of technology and equipment of foundry production, which ensure the production of a given number of quality castings.

Format of classes

Lectures, laboratory, calculation tasks, independent work, consultations.
Final control -exam

Competencies

GC1. Ability to identify, pose and solve engineering and technical and scientific and applied problems.
GC2. Ability to make informed decisions.
GC5. Ability to develop and manage projects.
GC8. Ability to learn and master modern knowledge
FC1. The ability to apply specialized conceptual knowledge of the latest methods and techniques of designing and researching structures, machines and/or processes in the field of mechanical engineering.
FC2. The ability to critically analyze and forecast performance parameters of new and existing mechanical structures, machines, materials and engineering production processes based on knowledge and use of modern analytical and/or computerized methods and techniques.
FC9. The ability to work independently and effectively function as a group or structural unit leader when performing production tasks, complex projects, and scientific research. Responsibility for the development of professional knowledge and practices, assessment of the team's strategic development.
FC10. The ability to clearly and unambiguously convey one's own conclusions, knowledge and explanations to specialists and non-specialists, in particular, in the process of teaching. Ability to understand the work of others, give and receive clear instructions

Learning outcomes

LR2. Develop and put into production new types of products, in particular, perform research and design work and/or develop technological support for the process of their production.
LR 3. Apply automation systems for research, design and construction work, technological preparation and engineering analysis in mechanical engineering.
LR 7. It is clear and unambiguous to present the results of research and projects, to convey one's own conclusions, arguments and explanations in national and foreign languages orally and in writing to colleagues, students and representatives of other professional groups of various levels.
LR 9. Organize the work of the group when completing tasks, complex projects, scientific research, understand the work of others, give clear instructions.
LR 10. Search for necessary information in scientific and technical literature, electronic databases and other sources, assimilate, evaluate and analyze this information.

LR 13. Demonstrate the ability to justify and evaluate projects, knowledge of methods of promoting them on the market, ability to perform econometric and scientific evaluations.
LR 14. Demonstrate knowledge of the basics of organization and personnel management.

Student workload

The total volume of the discipline is 120 hours. (4 ECTS credits): lectures – 32 hours, laboratory work – 16 hours, independent work – 72 hours.

Course prerequisites

To successfully complete the course, you must have knowledge and practical skills in the following disciplines: "Drawing geometry, engineering and computer graphics", "Fundamentals of informatics", "Modern foundry equipment", "Modern methods of molding in foundry production","Fundamentals of CAD", "Systems and means of automated design in foundry production».

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

Lectures are conducted interactively using multimedia technologies. Practical classes use a project approach to learning, game methods, and focus on the application of information technologies in the industrymodern work processes to obtain new technological solutions in the field of foundry technology and equipment, which ensure the production of a given number of high-quality castings.Study materials are available to students through OneNote Class Notebook.

Program of the course

Topics of lectures

Introduction. Emergence and development of systemic concepts. Sciences dealing with the study and research of complex systems. The main features that distinguish complex systems. Peculiarities of the system approach to solving problems of complex technical systems. Basic concepts of the system.

The emergence of automated and robotic complexes and systems of foundry equipment as the beginning of a new stage in the development of technological casting systems. Main stages. Definition and principles of system analysis and its use for solving problems related to the management of technological systems at the stages of their creation and operation.

Topic 1. Fundamentals of system analysis and synthesis.

General attitude and modern methods of solving problems of analysis and synthesis of technical systems. Systems, structure, elements, subsystem, meta system, system effects, functional and structural connection'connection, criteria for optimal synthesis of the system. Composition and decomposition of complex technical systems. Hierarchical systems and their description.

Development of efficiency criteria and target functions based on a system approach in solving optimization problems of foundry production. Levels of system analysis in foundry production, casting, technology, manufacturing method, technological complex, foundry shop as the main technical systems of foundry production.

Topic 2.The system-structural method of systems research.

Choosing the optimal variant of the structure of a complex system. Search for the optimal variant of the design scheme of the press forming machine. Analysis of the state of the production system.

The use of the system-structural method for the design of automatic foundry lines (ALL) based on unified aggregates. The method of forecasting new solutions in the design of foundry equipment.

Topic 3. Structural models.

Graph theory. Using graph theory to analyze the structure and layouts of automatic foundry lines.

The use of elements of graph theory in the study of the technological process of production of cast iron castings from spherical graphite.

Topic 4. Models of foundry systems.

Two-sided nature of the foundry system. Operational-technological and aggregate-technological graphs. Analysis of graphs using necessity and responsibility matrices.

Conditions of expedient construction and operation of the foundry system. Foundry system as a transport network. Definition and properties of the transport system.

Conditions of a rational structure, expedient functioning, expedient technological process, need for raw materials, expedient power of aggregates, system interaction, responsibility, smallest intersection, continuity of system functioning, expedient regulation.

Modeling of melting systems and conditions for their appropriate structure. Production of steel and cast iron. Modeling of mixing systems.

Fresh molding materials and semi-finished products. Processing systems of fresh molding materials. Modeling of the system of preparation of fresh molding materials. Principles of regulation and control of systems during their design and manufacture. Mixture preparation systems.

Production preparation systems. Modeling of the production system of model kits. Modeling of rod systems and conditions for their appropriate construction.

Production of castings in conditions of mass and large-scale production. Mechanization of the mold making process. Modeling the process of making molds and the conditions for their appropriate construction.

Modeling of finishing operations.

Modern foundries. Models of foundries. Appropriate arrangement of foundry systems. Foundry systems and automated control systems.

Topic 5. Optimization of the foundry shop.

Analysis of the foundry shop as a complex dynamic technical system. Subsystems of the foundry shop and their interactions'connection System-wide effects and changes during foundry operation. Methodology of development of dynamic models of functioning of foundry subsystems based on a probabilistic statistical approach.

Methods of solving the problem of calendar and operational planning of a foundry based on mathematical programming methods. Attitude and problem solving based on linear programming. Reduction of the problem to the canonical form, formation of the simplex matrix of the problem, the technology of using standard mathematical support for the solution of the problem.

The problem of calendar and operational planning of a foundry shop as an optimization problem of the combinatorial type. Mathematical formulation and methods of solving problems of discrete mathematical programming. Algorithmic solutions of the problem based on the discrete programming method and its implementation on a computer.

Comp'computer systems for managing production and the technological process of manufacturing castings. Basic concepts, content of tasks and methods of solving them within the framework of automated production management systems of a foundry.

Automated control system of technological processes of foundry production. Preparation of molding mixture, production of molds and rods, liquid metal, molding, finishing operations. Composition of system structure tasks, mathematical and software support of ACS TP of foundry production.

The process of hardening and cooling of metal in a casting mold. Methods of determining the speed and time of hardening of castings.

Topic 6. Mathematical description of elements of complex systems.

Selection of a mathematical scheme for describing the elements of complex systems. Differential and difference equations. General dynamical systems: finite automata, probabilistic automata, mass service systems. Markov processes, regenerating processes, piecewise linear processes. Selection of a unified abstract scheme. Formation of a general mathematical model of a complex system.

The use of mathematical schemes to describe the operation of foundry equipment.

Mathematical apparatus for the analysis and synthesis of foundry systems. Basic concepts of set and graph theories. Relationships, their types, matrix and graphic methods of their representation. Elements and their formal description. Abstract probabilistic automaton as a universal mathematical scheme of technical subsystems of dynamic type in foundry production. Methods of constructing the main characteristics of probabilistic automata.

Modern methods of analysis of complex stochastic dynamic systems. Analytical and quantitative methods, their possibility and field of use.

Topic 7. Simulation modeling of complex technical systems.

Simulation modeling methodology. Advantages. Comparison with physical and mathematical modeling. Areas of use of simulation modeling. Stages of the process of simulation research of complex systems.

Monte Carlo method and features of its implementation on computers. Determination of the required accuracy of numerical modeling of complex systems. Methodology for implementing numerical experiments on OEMs with models of complex systems.

Topic 8. Analysis and synthesis of foundry technology.

The basic concepts of the system morphological and functional-value approaches for the analysis of the functional and combinatorial-structural side of the means of manufacturing castings. Casting production tool as a technically developing system.

Structural and functional model of the means of making molds and models. The main parameters of the method: 1) materials or a set of materials for making forms and models; 2) provision of form configuration; 3) stabilization of the form: 4) destruction of the form after hardening of the casting: 5) disposal of waste.

The method of systematization of the availability of technical informatics for various methods of manufacturing castings. Matrices of technological possibilities, advantages and disadvantages of existing methods of manufacturing castings. Frame models of knowledge presentation and casting manufacturing technology.

Setting the problems of choosing the optimal means of manufacturing castings. Existing methods of determining the rational means of manufacturing castings depending on the type of production, grade of alloy, axial and dimensional characteristics, as well as technical requirements for the casting and the cast part. Graphical and analytical methods of determining the rational means of casting production.

A systematic approach to choosing the optimal method. Formation of criteria for choosing the optimal method of manufacturing castings within the framework of the system: "manufacturing tooling - manufacturing casting - mechanical processing - operation of the cast part". Existing methods of manufacturing equipment for various methods of manufacturing a casting.

Comp'computer systems for managing the quality of castings. Basic concepts of expert systems. Knowledge and their machine representation. Production and frame approaches to the formalization of technical knowledge.

The concept of active knowledge and industrial experiments in technological systems. A frame model of knowledge about the properties of molding mixtures for automatic production lines of foundry systems.

Topic 9. Foundry technological systems.

Definition of the technological system of foundry production, which consists of subsystems: "casting - equipment - subsystems for managing the quality of castings and reliability of equipment". System-wide parameters and variable effects of interaction of subsystems.

Analysis of elements of foundry technology. Current, conveyor and automatic lines, transport systems, robotic equipment complexes as complex nonlinear stochastic systems. Analytical, numerical and software methods of studying the dynamics of complex nonlinear stochastic dynamic systems.

Methods of functional, structural and parametric analysis and synthesis of assembly systems of foundry equipment. Development of hierarchical and topological models of a complex foundry system.

Synthesis of the mathematical model of the operation of an arbitrary element based on the mathematical apparatus of probabilistic automata. Identification of input and output alphabets, modeling of the dynamics of internal stage changes, development of probable models of transition and output functions of the studied system.

The concept of normative mathematical modeling of complex technical systems. Development of normative mathematical models of foundry systems based on the apparatus of probabilistic modeling methods. Solutions of practical problems on simulation models.

Study of the dynamics of the molding and mixing preparation systems of the foundry shop. Methods of collecting and processing statistical information about system operation parameters. Determination of empirical conditions of the system failure distribution function.

Analysis of recovery processes in the training system. The system of mathematical models of the dynamics of deterioration of system reliability, as a normative basis for the synthesis of the system of restoration of molding and mixing preparation equipment.

The formation and methods of solving the problems of optimizing the operational reliability of foundry equipment systems based on the search for the extremum of the general criterion of the efficiency of the system.

Topics of practical classes and laboratory works

Topic 1.Modeling of foundry systems based on the apparatus of graph theory.

Topic 2.Calculation on a PC of the optimal amount of melting equipment for mass and large-scale production shops.

Topic 3.Development of a mathematical model of foundry technological systems.
Topic 4.Study of the operation of automatic lines on simulation models.
Topic 5.Structural optimization of the process of electromagnetic separation of used molding mixtures and its calculation on a PC.

Self-study

The course provides ppreparation of a calculation task on an individual topic.
On the basis of the given subsystem of the foundry shop, develop its technological model (orientational and technological graph of the subsystem of the foundry shop).
Students are also recommended additional materials for independent study and analysis.

Course materials and recommended reading

Basic literature

1. Ponomarenko O.I. Management of foundry systems and processes Monograph / O.I. Ponomarenko, T.V. Lysenko, A.L. Stanovskyi, O.I. Shinsky - Kharkiv: Textbook of NTU "KhPI". - 2012. - 368 p.
2. Pelikh S.G., Lytvynenko M.M. Analysis and synthesis of foundry systems. - H.: KhSU. - 1994. - 172 p.
3. Ponomarenko O.I. Optimization of technological solutions for foundry workshops. - Kharkiv: NTU "KhPI". - 2007. -320 p.
4. Ponomarenko O.I. Automated design of forming and rod machines [text]: training. manual / O.I. Ponomarenko, I.I. Gunko, S.V. Porohnia, N.S. Yevtushenko. - Kharkiv: NTU "KhPI", 2014. - 256 p.
5. Pelikh S.G. Optimization of foundry processes. - Kyiv: Higher School. - 1979.

Additional literature

1. Holofaev A.M. Design of foundry technology./ A.M. Holofaev, Yu.V. Kryvolapchuk. – Luhansk: Department of SNU named after Dalya, 2004. – 296 p.

Assessment and grading

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

100% of the final grade consists of evaluation results in the form ofexams (40%) , and assessmentcalculation task(20%), current assessment (40%).

Exam:written assignment (3 questions from theories) and an oral report.
Current assessment: 2 modular control and calculation task (20% each).

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": show discipline, education, benevolence, honesty, responsibility. Conflict situations should be openly discussed in study groups with the teacher, and if it is impossible to resolve the conflict, it should be brought to the attention of the employees of the institute's directorate.
Regulatory and legal support for the implementation of the principles of academic integrity of NTU "KhPI" is posted on the website:http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/

Approval

Approved by

22.08.2023

Date, signature

Head of the department
Oleg AKIMOV

22.08.2023

Date, signature

Guarantor of the educational program
Oleksandr SHELKOVY