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MODELING OF SYSTEMS

UNIVERSITY COURSE PROGRAMME

For Learning Control and Informatics at Technical Systems

Prerequisites:
The student must know the material of Differential Equations, Stochastic Differential Equations, Numerical Analysis, Probability theory.

Aims:
To disclose the concept of «Modeling», to define a technical system, to teach students to replace the original object with its model and to apply appropriate techniques for its study.

Synopsis:
classification of models and types of modeling, examples of models of systems, the main provisions of the theory of similarity, the stages of mathematical modeling, principles of construction and the basic requirements for mathematical models of systems, goals and objectives of the study of mathematical models of systems, general scheme for the development of mathematical models, the mathematical modeling methods for the study of mathematical models of systems and processes, methods of simplifying the mathematical models, hardware and software of modeling.

Aim description:
After the course the student should be able to:

- make statement of the physical problem;
- transfer from the physical problem to its mathematical model;
- make statement of the mathematical problem;
- find the method for solving a mathematical problem;
- solve a mathematical problem;
- make the transition from the solution of a mathematical model to the solution of the original physical problem;
- draw conclusions on the initial physical problem.

Evaluation:
Required assignments, pass or fail, internal evaluation by teacher.

MODELING

1. Definitions of model.
2. Classification of models.
3. Mathematical model.
4. Modeling. The general data.
5. Bases of introduction of models.
6. Physical and analog modeling.
7. Imitating modeling.
8. Probabilistic modeling.
9. Computer modeling.
10. Conceptual modeling.
11. Structurally functional modeling.
12. Mathematical modeling.

13. Stages of mathematical modeling.
14. A full error of an investigated problem.
15. Aprioristic and after effect estimations.
16. Concepts homomorphism and isomorphism in the theory of modeling.
17. Model verification.
18. Model validation.
19. A method of the similarity and the dimensions.

TECHNICAL SYSTEMS

20. Definition and fundamental attributes of technical systems.
21. Functions of technical systems.
22. The basic parts of technical systems.
23. Stages of becoming of technical systems.
24. The law of completeness of technical systems.
25. The law of power conductivity of technical systems.
26. The law of the coordination of rhythmic of parts of technical systems.
27. The law of non-uniformity of development of parts of technical systems.
28. The law of the transition of a technical system to a up-system.
29. The law of the transition of a technical system from a macro level to a micro level.
30. The law of the increase vepol technical systems in a degree.
31. The law of the S-shaped development of technical systems.

THE THEORY OF STOCHASTIC PROCESSES

32. The theory of stochastic processes. The general data and examples.
33. Stochastic processes. The basic definitions.
34. Classification of stochastic processes.
35. A flow of events. Definitions and examples.
36. An ordinary flow of events.
37. Intensity (density) of an ordinary flow of events.
38. A flow of events without after-effect.
39. Poisson flow of events.
40. A stationary flow of events.
41. The elementary flow of events.
42. A Palm input.
43. Concept of aggregate model.
44. The theory of regeneration. Initial data.

MISCELLANEOUS

45. Monte Carlo method. The general data.
46. Modeling of information resources. The general data.
47. Mathematical modeling of processes of the financial market.
48. Mathematical modeling of problems of mechanics on an example harmonic oscillator.
49. Application of methods of mathematical modeling to a political life on an example of model of race of arms.
50. Modeling of problems mathematical history and mathematical linguistics.

51. The decision of problems of mathematical ecology on an example of model of the community of type a predator-victim.
52. Mathematical modeling of problems of astrophysics on an example of one model of the theory of flashes of new and supernew stars.
53. Interaction of analog and mathematical modeling on an example of electromechanical analogies.