

Aerospace Engineering Graduate Studies

The Master of Science degree final exam problems and questions

Specialization administrator: prof. Cezary Galiński

Group A: General questions

1. Finite-difference approximation in numerical computation: discrete representation of continuous variables and discrete derivatives.
2. Linearization of the aircraft equations of motion: methods, main assumptions of the linearized model used in dynamic stability analysis, advantages and limitations.
3. Discuss the main modes of motion describing the dynamic stability of an aircraft.
4. Methods of aircraft stability improvement: design measures and stability augmentation systems (structure and application).
5. State-space description of nonlinear and linear systems. Controllability and observability.
6. Stability of linear systems. Methods of stability analysis.
7. Dynamic systems representation in the frequency domain.
8. Analysis of first- and second-order dynamic systems: properties and step responses of basic regulation elements.
9. Controller design: time-domain performance indices, methods of PID parameter selection, and compensators (purpose, types, selection).
10. Signal spectrum. Fourier analysis of deterministic signals.
11. Sampling, quantization, and aliasing. Quantization error in A/D converters.
12. Describe optimization methods useful in aircraft design.
13. Formulation of an aircraft design optimization problem: decision variables, constraints, and typical objective functions.
14. Describe the structure of the atmosphere and how its main parameters vary with altitude. What is the International Standard Atmosphere, and what are its assumptions and significance?
15. What is an aircraft load spectrum?
16. Describe the basis of ultrasonic diagnostics.
17. Describe the main systems of aircraft operation.

Group B: Specialization questions

Subgroup B1: Aerospace Propulsion Systems

1. Diffusive and kinetic combustion: discuss both and give their areas of application.
2. What is the role of the diffuser in a combustion chamber?
3. Types of combustion chambers in turbine engines: requirements, advantages, and disadvantages.
4. Discuss the methods of flame stabilization in jet engine combustion chambers.
5. Harmful emissions from aero engines: the problem and methods of reducing pollutants in combustion chambers.
6. Draw a general diagram of the control system and discuss the most important tasks of the control system for a selected type of aero engine.

7. Discuss steady-state operating conditions and the limit lines that define stable operation of a turbine engine.
8. Discuss the methodology for selecting a propulsion system for an aircraft.
9. Draw and discuss the velocity triangle for a selected stage of a compressor or turbine.
10. Define the degree of reaction of a turbine or compressor stage in a turbine engine.
11. Discuss how the thermal efficiency of a jet engine depends on the compression ratio for both the ideal and the real cycle.
12. What is surge in a jet engine compressor?

Subgroup B2: Aerospace Structures and Systems

1. Describe known methods of composite manufacturing in the aircraft industry.
2. Principles of reinforcement arrangement in structural composite components of airframes.
3. What is the difference between the LPF and FPF criteria? How are they related to ultimate loads?
4. Explain stress and strain states in thin-walled structures.
5. How are concentrated loads introduced into an aircraft structure?
6. Combined loading of rods: basic cases, examples.
7. Frames (two- and three-dimensional): methods, examples.
8. Aircraft velocity measurement methods and sensors.
9. Inertial navigation systems: types of sensors used and signal-processing algorithms.
10. Satellite navigation systems (GPS, Galileo, etc.). GNSS augmentation systems. The principle of DGPS.
11. Radiolocation: radar operating principle, radar types, and applications. The Doppler effect and its use in aeronautical systems.
12. Actuators of aircraft control systems: types and operating principles, with examples.
13. Wing high-lift devices (wing mechanization): structure and purpose.
14. Flight data and cockpit voice recorders: purpose and operating principles.
15. Aeronautical warning/awareness systems: types, purpose, and operating principles.
16. Objectives and methods of aeronautical systems integration.