

Aerospace Engineering Undergraduate Studies

The Bachelor of Science degree final exam problems and questions

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Group A: General Engineering and Faculty-wide questions

1. Describe the main rules of conservation.
2. Define the conditions of balance for an arbitrary system of forces.
3. Formulate the laws of variation of momentum, angular momentum, and kinetic energy for various models of a body.
4. Discuss gyroscopic effects.
5. Define the static and dynamic balance of rotating machinery parts.
6. Viscosity in the flow around bodies. The boundary layer.
7. Types and properties of steel.
8. What are eutectic, eutectoid, and peritectic reactions? Answer the question with the help of binary diagrams.
9. What information on the microstructure of carbon steel can be obtained from the TTT diagram?
10. What is the precipitation hardening process? For which binary systems can it be applied? Answer the question with the help of the relevant equilibrium diagram.
11. What is the main difference in the structures of thermosetting and thermoplastic polymers?
12. In the case of metals: what is cold work? What is heat treatment applied for?
13. Quality indicators of control systems.
14. Displacements, strain, stress: concepts, units, and relations.
15. Equivalent stress hypotheses.
16. The theorem of minimum potential energy in solid mechanics.
17. Basic models of rods: tension, bending, torsion.
18. What is control? Describe the differences between control and regulation. Feedback in control and regulating systems.
19. Regulation of dynamic systems. Types of controllers. The PID controller. Methods for determining the parameters of a PID controller.
20. Basic elements of automation. First- and second-order dynamic systems.
21. Definition of stability and stability determination methods for linear systems. Bandwidth of a dynamic system.
22. Modeling of stationary linear dynamic systems in the frequency and time domains.
23. Laplace and Fourier transforms. Operator and frequency transfer functions. Determination of dynamic system transfer functions.
24. Numerical methods in engineering calculations. Error types and their sources in numerical calculations.
25. Basic parameters of deterministic signals, signal decomposition, and signal correlation.

Group B: Aerospace Engineering Major questions

1. Basic types of propulsion systems, their ranges of application, and characteristics.
2. Diffusers (inlets) of aircraft engines: types and ranges of application.
3. Velocity triangles in a single stage of a compressor or turbine (draw and describe).
4. Theoretical and real cycles of piston engines.
5. Turbine engines: turbojets and turbofan engines, principles of operation, design, and thermodynamic cycles.
6. Internal efficiency, propulsive efficiency, and overall efficiency of aircraft propulsion systems.
7. Compressors and turbines of aircraft engines: types, principles of operation, efficiency, and characteristics.
8. Thrust equation of a jet engine.
9. Define the first, second, and third space velocities; state these values for the Earth.
10. Types of Earth orbits: define and briefly describe them.
11. Discuss the problem of reentry.
12. Discuss the criteria for material selection in aircraft design.
13. Types and properties of aluminum alloys.
14. Why are polymeric composites advantageous in aircraft design?
15. Discuss the main geometric properties of a wing, including the mean aerodynamic chord and methods for calculating it. What are the wing polar and aircraft velocity polar?
16. Properties of an airfoil. Characteristics $CL(AoA)$ and $CD(CL)$.
17. High-lift devices: properties and reasons for application.
18. Define stability and controllability margins.
19. Describe the method used to create a loads envelope.
20. Wing and fuselage structures. Typical designs. Loads acting on the wing and fuselage.
21. Specify the energy absorption requirements for airplane landing.
22. Describe the legal basis for aircraft operations.
23. Discuss the problem of maintainability and give examples.
24. Torsion of thin-walled members (closed and open).
25. Bending: pure, simple, and biaxial, with examples.
26. Buckling (frames, thin-walled members) and the concept of critical load.
27. Review approximate methods in solid mechanics, with consideration of FEM.

Group C: Specialization questions

Subgroup C1: Aerospace Propulsion Systems

1. Design and layouts of piston engines (in-line, radial, V).
2. What is the "degree of reaction"?
3. Discuss the dependence of the thermal efficiency of a turbojet on its compression ratio for ideal and real cycles.
4. Optimal and economical compression ratios for a turbojet engine.
5. Explain the use of turbofan engines.
6. What is a surge (stall) in a jet engine compressor?
7. Types of rocket engines and their applications.
8. Tsiolkovsky's equation. Design and layouts of space rockets.
9. Define specific impulse and its dependence on other parameters of a rocket engine.
10. Describe rocket propellants and their typical applications.
11. Describe the basic feeding systems of liquid-propellant rocket engines.

Subgroup C2: Aerospace Structures and Systems

1. Discuss methods of joining parts in an aircraft structure.
2. What are master tools used for? What are the principles of optical tooling?
3. Extensometry methods in solid mechanics.
4. Basic pilot indicators and their locations in an airplane/helicopter cockpit.
5. Radionavigation systems: VOR, DME, ILS.
6. Principles of operation of inertial and satellite navigation systems.
7. Heading and direction-finding instruments on aircraft. Measurement of aircraft angle of attack.
8. Application of hydraulic systems on aircraft. Comparison of hydraulic systems with electrical ones.
9. Electric power supply on aircraft: energy generation, power networks.
10. Aircraft icing prevention. On-board deicing systems.