Aerospace Engineering undergraduate studies (course 2006)

The Bachelor of Science degree final exam problems and questions

Specialization administrator: **prof. Cezary Galiński**
Field of Study **Aerospace Engineering**
Field of Specialization **Aerospace Engineering**

A. General and fundamental subjects questions

1. Describe main rules of conservation.
2. Define conditions of balance of an arbitrary system of forces.
3. Formulate laws of variation of: momentum, angular momentum and kinetic energy for various models of a body.
4. Discuss gyroscopic effects.
5. Define static and dynamic balance of rotating machinery parts.
6. Viscosity in the flow around bodies. Boundary layer.
7. Types and properties of steel.
8. What are eutectic, eutectoid and peritectic reactions? Answer the question with the help of the binary diagrams.
9. What is the difference between diffusionless and diffusional reactions?
10. What information on microstructure of carbon steel can be obtained from the TTT diagram?
11. 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.
12. What is the main difference in the structures of thermosetting and thermoplastic polymers?
13. In the case of metals: What is cold work? What is heat treatment applied for?
14. Discuss PID compensator
15. Control systems' quality indicators.
16. Displacements, strain, stress: concepts, units, relations,
17. Equivalent stress hypotheses,
18. Theorem of minimum potential energy in solid mechanics,
19. Basic models of rods: tension, bending, torsion.
20. What is control? Describe differences between control and regulation. Feedback in control and regulation systems.
21. Regulation of dynamic systems. Types of regulators. PID controller. Methods for parameters determination of PID controller.
22. Automation base elements. First and second order dynamic systems.
23. Stability definition and stability determination methods for linear systems. Bandwidth of dynamic system.
24. Stationary linear dynamic systems modeling in the frequency and the time domain.
25. Laplace and Fourier transform. Operator and frequency transfer functions. Determination of dynamical system transfer functions.
26. Numerical methods in engineering calculations. Errors types and their sources in numerical calculations.
27. Basic parameters of deterministic signals, signal decomposition, signals correlation.

B. Aerospace Engineering specjalization subjects questions

1. Basic types of propulsion systems, range of application, characteristics
2. Theoretical and real cycles of piston engines
3. Turbine engines: turbojets and bypass engines, principle of work, design and thermodynamic cycles.
4. Internal efficiency, propulsive efficiency and overall efficiency of aircraft propulsion systems
5. Compressors and turbines of aircraft engines, types, principles of work, efficiency and characteristics.
6. Diffusers (inlets) of aircraft engines, types, ranges of application.
7. Layout of piston engines (in-line, radial, V).
8. Equation of jet engine.
9. Triangles of velocities in single stage of compressor or turbine (draw and describe)
10. What is “degree of reaction” ?
11. Discuss dependence of thermal efficiency of turbojet and its compression ratio for ideal and real cycle.
12. Optimal and economical compression ratio for turbojet engine
13. Justify application of bypass engine in aircraft propulsion.
14. What is surge (stall) of compressor ?
15. Types of rocket engines and their applications.
16. Ciołkowski’s equation. Layouts of space rockets.
17. Definition of specific impulse and its dependencies on other parameters of a rocket engine.
18. Thrust equation for rocket engine.
19. Space velocities: definitions and estimated values for Earth.
20. Kinds of Earth orbits.
21. Discuss the problem of reentry.
22. Propellants used for rocket engines and their applications.
23. Describe basic feeding systems of liquid propellant rocket engines.
24. Discuss criteria of materials selection in aircraft design.
25. Types and properties of aluminum alloys.
26. Why polymeric composites are advantageous in aircraft design.
27. Discuss main geometric properties of the wing, including mean aerodynamic chord and methods to calculate it. What are wing polar and aircraft velocity polar?
28. Properties of an airfoil. Characteristics $C_L(AoA)$,$C_D(C_L)$.
29. High lift devices, properties and reasons of application
30. Define stability and controllability margins
31. Describe method used to create loads envelope
32. Wing and fuselage structures. Typical designs. Loads acting against wing and fuselage.
33. Specify the energy absorption requirements for airplane landing.
34. Discuss methods of joining parts in an aircraf structure.
35. What are master tools used for? What are the principles of optical tooling?
36. Describe legal basis for aircraft operations.
37. Discuss the problem of maintainability and give examples
38. Torsion of thin-walled members (closed and opened),
39. Bending: pure, simple, biaxial: examples,
40. Buckling (frames, thin-walled members), concept of critical load,

41. Review approximate methods in solid mechanics, give consideration to FEM,
42. Extensometry method in solid mechanics,
43. Basic pilot indicators and their location in airplane/helicopter cockpit.
44. Landing augmentation systems: ILS, MLS.
45. Principles of operation of inertial and satellite navigation systems
46. Heading and direction finding instruments on aircraft. Measurement of aircraft angle of attack.
47. Flight data and cockpit voice recorders - purpose of application and operation principles.
48. Propagation of radio waves and its influence on aeronautical systems design.
49. Application of hydraulic system on aircraft. Comparison of hydraulic systems with electrical ones.
50. Electric power supply on aircraft: energy generation, power networks, typical voltages.
51. Fuel systems on aircraft. Fuel level measurement.
52. Aircraft icing prevention. Deicing systems on-board on aircraft.

The Master of Science degree final exam - problems and questions

B. Aerospace Engineering specjalization subjects questions

1. Describe optimization methods, useful in the aircraft design optimization.
2. Describe decision variables used in an aircraft optimization
3. Describe the most frequently used objective functions defined in an aircraft optimization
4. Main assumptions of linearized model applied in dynamic stability analysis – main advantages and constraints.
5. Discuss main modes of motion describing dynamic stability of an aircraft
6. Describe typical methods of stability improvement
7. Describe the atmosphere structure, including variation of main parameters with altitude. What is an international standard atmosphere – its assumptions and meaning.
8. Describe known methods of composites manufacturing in an aircraft industry.
9. How to introduce concentrated loads into an aircraft structure.
10. What is the difference between LPF and FPF criteria? How are they connected to the ultimate loads?
11. What are the principles of reinforcement arrangement in structural composite components of airframes?
12. What is an aircraft loads spectrum?
13. Describe basis of an ultrasound diagnostics
14. Describe main systems of an aircraft operations
15. Complex load in rods, basis cases, examples,
16. Frames (two- and three-dimensional), methods, examples
17. Explain stress and strain states in thin-walled structures,
18. System controllability and observability. Definitions, investigation methods.
19. LQR control. Performance indices of linear control system in time domain.
20. State equations. Nonlinear and linear systems description in state variables.
21. Basic control performance indices and regulators design methods.
22. Stability of linear systems. Methods of stability investigation.
23. Dynamic systems representation in the frequency domain.
24. Signal spectrum. Fourier analysis of deterministic signals.
25. Basic 1^{st} and 2^{nd} order regulation elements: properties and step responses.
26. Sampling, quantization and aliasing. Quantization error in A/C converters.
27. Difference algebra in numerical computation. Discuss discreet representation of continuous variable and discrete derivatives.
28. Linearization. Application, methods and influence on the results of analysis.
29. Actuators of aircraft control systems - types and principle of operation description based on examples.
30. Radiolocation. Principle of radar operation, radar types and their applications.
31. Flight data and cockpit voice recorders - purpose of application and operation principles.
32. Aeronautical warning / awareness systems - types, purpose and operation principles.
33. Inertial navigation systems. Types of sensors used in these systems. Signal processing algorithms.
34. Satellite navigation system. GNSS augmentation systems. The principle of DGPS
35. Aircraft velocity measurement methods and sensors

36. Objectives and methods of aeronautical systems integration.
37. Structure and purpose of wing mechanization.
38. Aircraft stabilization systems – structure, application.
39. Control in dynamic systems. Types of regulators. PID controller. Methods for selecting PID parameters.
40. Analysis of first and second order dynamical systems.
41. Compensators - purpose, types, selection methods.
42. Doppler effect and its application in aeronautical systems.

B. Computer Aided Design specjalization subjects questions

1. Axisymmetric shells, methods, examples,
2. Elastic strain energy,
3. Thermal stress and its meaning in technique,
4. Ritz method and FEM in beam structures computations.
1. Complex load in rods, basis cases, examples,
5. Frames (two- and three-dimensional), methods, examples

B. Robotics specjalization subjects questions

1. What it is robotics?
2. Methods of direct and inverse kinematic problems solution for serial manipulators
3. Jacobians in robotics
4. Methods of description of manipulator dynamics
5. Direct and inverse dynamic problem in robotics
6. Artificial neural networks - fundamentals of the method.
7. The essence and methods of training of artificial neural networks.
8. Applications of artificial neural networks - typical application fields, advantages and constraints