Master's degree program "Navigation and Control Systems"

The list of entrance examination questions:

1. The shape and size of the Earth. Geoid, ellipsoids of rotation. The main directions on the Earth's surface. Track lines (loxodrome, orthodrome). Basic coordinate systems used in the navigation of objects moving near the Earth's surface.

2. Kinematic parameters of objects moving near the Earth's surface. Orientation parameters: Euler-Krylov angles, direction cosines, quaternions, it's relationship.

3. Maps: map classification, map projections.

4. The gravitational field of the Earth. Basic concepts and definitions. Normal gravity on the surface of the Earth.

5. Definition of matrix and vector. Matrix operations. Inverse matrix. Solution of a system of linear equations in matrix form.

6. Ordinary differential equations. The concept of a dynamic model in state space. Classification of dynamical systems.

7. The main functions used in the description of linear systems: transfer and weighting function, frequency response. The relationship between these functions.

8. Stability of control systems. Stability criteria.

9. Quality indicators of control systems. Regulation error. Regulation time. Overshoot. Amplitude and phase stability margins. Oscillation's indicator.

10. Determination of a random vector and the corresponding concepts of the probability density function, mathematical expectation, covariance matrix and root-mean-square error ellipse.

11. General formulation of the estimating a constant vector problem using the least squares method. Solving the problem of estimating a constant value and amplitude of a harmonic signal using the least squares method.

12. General statement of the discrete linear filtering problem. Algorithm for solving it using the Kalman filter.

13. Three-degree (positional) gyroscope in gimbals. Precessional and nutational motions.

14. Schematic diagram of a fiber optic gyroscope (FOG). Current state, application and typical accuracy characteristics of FOG.

15. Basic design schemes and operation principles of micromechanical gyroscopes (MMG). Current state, application and typical accuracy characteristics of MMG.

16. The operation principle of the optical ring resonator and the structural diagram of the laser gyroscope (LG). Current state, application and typical accuracy characteristics of LG.

17. Scheme and operation principle of a gyroscope with an electrostatic rotor suspension (ESRG). Current state, application and typical accuracy characteristics of ESRG.

18. Algorithm for solving the navigation problem in modern satellite navigation systems (SNS). The current state of the SNS.

19. Gyrocompasses. Operating principle. State of the art.

20. Schematic diagram of a vertical gyro designing with integral correction. Shuler period.

21. Inertial navigation method. Primary navigation measurements. Algorithms for solving orientation and navigation problems in a strapdown inertial navigation system (SINS).

22. Integrated inertial-satellite orientation and navigation systems. The designing and main advantages of integrated systems over autonomous SINS and SNS.

23. Calculation of the strength, rigidity and stability of the structure. Hooke's Law. The main types of loads: calculation of compression, torsion and bending.

24. Calculation of the force (torque) moment. Equilibrium conditions for a body, a theorem on three non-parallel forces. The mechanism freedom degree number calculation.