



«УТВЕРЖДАЮ»

Директор передовой инженерной  
аэрокосмической школы

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**ПРОГРАММА  
ВСТУПИТЕЛЬНЫХ ИСПЫТАНИЙ ДЛЯ ПОСТУПАЮЩИХ В  
МАГИСТРАТУРУ ПО НАПРАВЛЕНИЮ ПОДГОТОВКИ  
24.04.01 «РАКЕТНЫЕ КОМПЛЕКСЫ И КОСМОНАВТИКА»  
2025 ГОД**

**Master's program « Aerospace Engineering and Technology »**

**Algebra, Calculus, and Probability**

1. **Algebra basics:** algebraic expressions; linear equations and inequalities; graphing lines and slope; systems of equations; quadratics and polynomials; functions; absolute value & piecewise functions; exponents & radicals; logarithms; transformations of functions; trigonometry
2. **Derivatives:** definition and basic rules: derivative rules (constant, sum, difference, and constant multiple); combining the power rule with other derivative rules; derivatives of  $\cos(x)$ ,  $\sin(x)$ ,  $\tan(x)$ ,  $\cot(x)$ ,  $\sec(x)$ ,  $\csc(x)$ ,  $e^x$ , and  $\ln(x)$ ; product rule; quotient rule
3. **Analyzing functions:** intervals on which a function is increasing or decreasing; relative (local) extrema; absolute (global) extrema; solving optimization problems; analyzing implicit relations
4. **Integrals:** indefinite integrals of common functions; properties of definite integrals; defining integrals with Riemann sums; applications of integrals
5. **Difference Equations:** verifying solutions for differential equations; separation of variables; particular solutions to differential equations;
6. **Linear transformations and matrices:** vectors and spaces; matrices for solving systems by elimination; matrix representation of a linear transformation; eigenvalues and eigenvectors
7. **Statistics and probability:** counting, permutations, and combinations; random variables; sampling distributions; modeling data distributions

**Physics and theoretical mechanics**

1. **Kinematics:** one-dimensional motion (displacement, velocity, and time; acceleration); two-dimensional projectile motion (kinematic formulas and projectile motion; trajectory; velocity and acceleration); circular motion and centripetal acceleration
2. **Forces and Newton's laws:** Newton's laws of motion; normal force and contact force; inclined planes and friction; tension; centripetal force and gravitation; Newton's law of gravitation



3. **Work and mechanical energy:** kinetic energy; gravitational potential energy; work-energy principle; thermal energy from friction; conservative forces; power
4. **Impulse and momentum:** momentum and impulse; impacts and linear momentum; elastic and inelastic collisions; center of mass; rotational kinematics; torque, moments, and angular momentum

### **Principles of Automatic Control**

1. **Fundamental Principle of Automatic Control:** definition of basic principles (signal, system, control, feedback), block scheme of controlled system
2. **Linear Dynamic systems:** solution to differential equations; characteristic equation; Laplace transforms; transfer functions; poles; stability, time constant and oscillation
3. **Control synthesis:** block scheme manipulations; pill-control; design specifications; root locus; frequency response; bode plot; feedforward compensation; connection between the Bode plot of the loop-gain and the stability of the closed-loop system; control synthesis using Bode plot
4. **Compensator design:** phase-lead and phase-lag compensator design; unstable zeros - interpretation in Bode plot
5. **State-space models:** transfer functions vs. state-space models; stability, controllability and observability; nonlinear system in state space form and linearizations; state feedback