YSU Department of Mathematics and Mechanics

YSU - ISTC Joint Master Program

Applied Statistics and Data Science

Entrance Exam Material Coverage

1 Calculus

1. Continuous functions and their properties: Intermediate Value Theorem (Cauchy intermediate value theorem), Extreme Value Theorem (Weierstrass theorem)
2. Differentiation of a univariate function: differentiation rules, the derivative of elementary functions, the derivative of a composite function (the chain rule); Mean Value Theorem (Lagrange Mean Value Theorem); Monotonicity; Extrema of functions, necessary and sufficient conditions; Tangent lines
3. Indefinite Integrals: List of Elementary Integrals; Integration by Parts and Substitution
4. Definite Integrals: Fundamental Theorem of Calculus (Newton-Leibnitz Formula), Calculation of areas and volumes by integrals;
5. Multivariate Calculus: Partial Derivatives, the chain rule; Tangent planes; Unconstrained Optimization

Bibliography You can use any of your favorite Calculus (Mathematical Analysis) books or online materials. Say, some suggestions are:

- Stewart J., Calculus, 8th edition, 2016
- Fikhtengolts G., Differential and Integral Calculus Course, in 3 parts, 10th edition, 2016 (in Russian)

2 Linear Algebra

1. Systems of Linear Equations, Gaussian elimination;
2. Vectors in $\mathbb{R}^n$, Linear combinations, Linear Dependence and Independence;
3. Matrices, the sum and product of two matrices, transpose of a matrix, the determinant of a square Matrix, Inverse of a square Matrix;
4. Lines and Planes in $\mathbb{R}^2$ and $\mathbb{R}^3$ spaces

Bibliography Here again, you can use any of your favorite Linear Algebra books or online materials. Say, some suggestions are:

- Strang G., Introduction to Linear Algebra, 5th edition, 2016
- Strang G., Linear Algebra, MIT Course, MIT OpenCourseWare
- Poole D., Linear Algebra: A Modern Introduction, 4th edition, 2014

3 Probability Theory

1. Discrete Probability Spaces: Experiments with Equally Likely Outcomes, Combinatorial Probability Problems, Geometric Probabilities;
2. The Total Probability Formula and the Bayes Formula;
3. Random Variables: The Cumulative Distribution Function (CDF) and the Probability Density (Mass) Function (PD(M)F); Calculation of probabilities using the CDF or the PD(M)F;
4. Some Well-Known Distributions: Bernoulli and Binomial Distributions; Poisson Distribution; Uniform Distribution; Exponential Distribution and the Normal (Gaussian) Distribution
5. Expectation and Variance of a random variable: Calculation of the Expected value and the Variance through PD(M)F

Bibliography Here again, you can use any of your favorite Probability books or online materials. Some suggestions are:

- Ross Sh., A First Course in Probability, 9th edition, 2014
- Shiryaev A., Probability, 5th edition, 2011 (in Russian)

4 Algorithmic Thinking

Here we are not going to check some specific knowledge and topics, rather we want to assess the ability of basic algorithmic thinking via solving some logical problems without prior knowledge of standard algorithms.