Introduction to Math Outline

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Outline for "Introduction to Quantitative Methods for Political Science Graduate Students"

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1. Introduction

- **Purpose of the Document**
  - Overview of the primer's role in preparing students for graduate-level research.
  - Brief explanation of why quantitative methods are essential in political science.
- **What to Expect**
  - Structure of the document: starting with basics and building toward more advanced concepts.

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2. Basic Mathematical Concepts

- **Arithmetic Review**
  - Fractions, decimals, percentages.
  - Order of operations (PEMDAS).
- **Algebra Fundamentals**
  - Variables, constants, expressions, and simple equations.
  - Solving linear equations.
  - Basic functions (e.g., linear, quadratic) and graphing.
- **Intro to Exponents and Logarithms**
  - Definition and use of exponents.
  - Logarithmic functions and their relevance in data analysis (e.g., log scales, growth rates).

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3. Introduction to Common Notation

- **Understanding Symbols**
  - Summation notation (Σ).
  - Product notation (Π).
  - Factorials ($!$).
  - Basic set notation (e.g., ϵ, $\mathbf{X}$, $\subset$).
- **Common Statistical Symbols**
  - Mean (μ), standard deviation (σ), variance (σ^2).
  - Population parameters vs. sample statistics.
  - Correlation (r), regression coefficients (β).
- **Introduction to Probability Notation**
  - Probability of an event (P).
  - Conditional probability ($P(A|B)$).
- **Greek Letters and Common Symbols**
  - Table of Greek letters

  - Table of Common Math Symbols

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4. Descriptive Statistics

- **Measures of Central Tendency**
  - Mean, median, and mode.
- **Measures of Dispersion**
  - Range, variance, and standard deviation.
  - Concept of distributions (normal, skewed).
- **Frequency Distributions**
  - Histograms, bar charts, and frequency tables.
- **Introduction to Probability**
  - Basic probability concepts: events, outcomes, likelihood.
  - Probability distributions (normal, binomial, etc.).

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5. Research Design Concepts

- **What is Quantitative Research?**
  - Differences between qualitative and quantitative research.
  - Importance of data in empirical research.
- **Key Research Design Terms**
  - Population vs. sample.
  - Independent and dependent variables.
  - Causality vs. correlation.
  - Operationalization of concepts.
- **Types of Research Designs**
  - Cross-sectional studies.
  - Longitudinal (panel) studies.
  - Experimental vs. observational research.

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6. Introduction to Data in R

- **What is R?**
  - Brief introduction to R and RStudio.
  - Explanation of its utility for political science research.
- **Basic R Syntax**
  - Data structures (vectors, matrices, data frames).
  - Loading and viewing datasets.
  - Using basic functions in R (e.g., `summary()`, `mean()`, `sd()`).
- **Basic Data Manipulation**
  - Subsetting data.
  - Cleaning data (e.g., dealing with missing values).
- **Basic Visualizations**
  - Plotting data (histograms, bar charts, scatterplots).

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7. Inferential Statistics

- **Basic Concepts in Inference**
  - Sampling distributions and the Central Limit Theorem.

  - Hypothesis testing: null vs. alternative hypotheses.
  - Type I and Type II errors.
  - P-values and significance levels.
- **Common Statistical Tests**
  - T-tests.
  - Chi-square tests.
  - ANOVA (Analysis of Variance).
  - Simple linear regression (basic introduction).

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8. Introduction to Regression Analysis

- **What is Regression?**
  - Understanding the concept of regression.
  - Difference between correlation and causation.
- **Simple Linear Regression**
  - Interpreting the coefficients.
  - Goodness of fit (R-squared).
- **Multiple Regression (Brief Overview)**
  - Introduction to the idea of controlling for multiple variables.

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9. Conclusion and Next Steps

- **Connecting to Graduate Coursework**
  - How these concepts relate to upcoming research methods classes.
- **Recommended Resources**
  - Books, tutorials, and online resources for further learning.
- **Encouragement for Self-Study**
  - Importance of continued practice with R and statistical concepts before and during coursework.

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10. Appendix: Additional Resources

- **Useful Websites**
  - Links to online tutorials, forums, and resources for learning R and statistics.
- **Recommended Books**
  - List of textbooks and reference materials for further study.
- **Sample Datasets**
  - Links to datasets for practice and exploration.