Southern Connecticut State University

Mathematics 321 – Mathematical Statistics

I. Catalog Description.

Mathematical development of sampling distributions, estimation of parameters, confidence intervals, hypothesis testing, introduction to nonparametric methods.

II. Credit.

MAT 321 carries three (3) semester-hours of University credit.
MAT 321 is an elective any mathematics major.

III Prerequisite

The student must have passed MAT 320.

IV. Format

MAT 321 is primarily a lecture-based course.

V. Outline

- Sampling Distributions: distribution of the sample mean, T, χ^2 ,F
- Estimation Theory: Unbiased estimators, consistency, sufficiency, Robustness, method of moments, maximum likelihood, Bayesian methods
- Estimation Applications: means, difference of means, proportions, variances
- Hypothesis Testing Theory: statistical hypotheses, Neyman-Pearson Lemma, statistical power functions, Likelihood ratio tests
- Hypothesis Testing Applications: means, difference of means, proportions, variances, r x c tables, goodness of fit
- Regression: method of least squares, correlation
- ANOVA: experimental design, One-way, multiple comparisons, randomized block, two-way tables
- Non-parametric tests: sign tests, rank tests, permutation tests

VI. Proposed Text

Irwin Miller and Maryless Miller, John E. Freund's Mathematical Statistics with Applications, Eighth Edition, Prentice Hall, 2013

VII. Other Recommended Text

Richard J. Larsen and Morris L. Marx, An Introduction to Mathematical Statistics and Its Applications, Sixth Edition, Pearson, 2012

VIII. Outcomes

Upon completion of MAT 321 students should be able to demonstrate satisfactory knowledge of the major concepts of statistical inference, they should be able to

construct correct proofs of basic statistical concepts and solve problems using concepts of statistics. In particular students should:

1. To use the axioms of probability and the rules of algebra to formally prove mathematical statements about statistics.
2. To understand, apply and interpret estimation techniques.
3. To understand, apply and interpret hypothesis testing techniques.
4. To understand, apply and interpret linear regression techniques.
5. To understand, apply and interpret categorical data analysis techniques.
6. To understand, apply and interpret analysis of variance techniques.
7. To understand, apply and interpret basic non-parametric statistics techniques.

IX. Course Outline

Weeks 1-3: Estimation (Confidence Intervals for a population mean, proportion, and variance)
Weeks 4-6: Statistical Inference (Hypothesis Testing for a population mean, proportion, and variance, two-sample inference)
Weeks 7-8: Categorical Data Analysis (Goodness of Fit Tests, Tests of Independence)
Weeks 9-11: Linear Regression (Intro, Estimating Parameters, Inferences, Evaluating the Models)
Weeks 12-13: Analysis of Variance (Single Factor, Multiple comparisons, modeling, Two-Factor experiments)
Weeks 14-15: Non-parametric Statistics (Rank tests, permutation tests)

Estimation (3 weeks 20%)

1. Introduction: sampling distributions
2. Method of Moments
3. Maximum likelihood estimation
4. Minimum-Variance Estimators
5. Sufficient estimators
6. Consistency
7. Bayesian Estimation

Hypothesis Testing (3 weeks 20%)

1. Introduction: sampling distributions
2. Decision Rules
3. Type I and II Errors
4. Testing Binomial Data
5. Inferences about μ
6. Two Sample Inference: $\mu_1 = \mu_2$
7. Two Sample Inference: $p_1 = p_2$
8. Two Sample Inference: $\sigma_1 = \sigma_2$

Categorical Data (2 weeks 14%)

1. Multinomial Distribution

2. Goodness of Fit Tests
3. Contingency Tables
4. Tests of Independence

Regression (3 weeks 20%)

1. The Method of Least Squares
2. The Linear Model
3. Covariance and Correlation
4. Multiple Linear Regression
5. Evaluating the Model

Analysis of Variance (2 weeks 14%)

1. Designed Experiments
2. The F-Test
3. Multiple Comparisons
4. Data Transformations

Non-Parametric Statistics (2 weeks 14%)

1. Rank Tests
2. Permutation Tests

X. Assessment

Individual instructors may vary assessment modes, but typically grades will be based on a combination of homework assignments, quizzes, and exams.

XI. Waiver Policy

MAT 321 may not be waived.

XI. Preparer

Raymond Mugno

XII. Prepared and Approved

Prepared October 2017
Approved by the Mathematics DCC on
Approved by the Mathematic Department on

XIII. Bibliography.

D. Bertsekas, J. Tsitsiklis, Introduction to Probability, Second Edition, Athena Scientific, 2006.
G. Casella, R. Berger, Statistical Inference, Duxbury Press, 1999.
J. Devore, Probability and Statistics for Engineers, Thompson, Toronto 2004.
Richard J. Larsen and Morris L. Marx, An Introduction to Mathematical Statistics and Its Applications, Sixth Edition, Pearson, 2012
J. McClave, T. Sincich, Statistics, Prentice Hall, New Jersey, 2012.

S. Ross, A First Course in Probability, Seventh Edition, Pearson, 2006.