# MATH 545
# STATISTICAL INFERENCE AND SAMPLING THEORY
# COURSE OBJECTIVES
# 2010 - 2011
# DR. PADRAIG MCLOUGHLIN

**Length of Course:**
One semester

**Use of Course:**
M.A. and M.Ed. degree programs in Mathematics Education.
M. S. in Nursing. MBA in Business. BS in Mathematics.

**Prerequisites:**
Math 540 or the equivalent with a grade of **"C"** or better or consent of instructor.

**Text (required):**
*Statistics (11th edition),* McClave, Sincich and Mendenhall (ISBN: 0132069512)

**Texts (supplemental):**
The instructor may suggest supplemental reading from a number of sources; including, but not limited to:
*Statistics,* Agresti & Franklin, (1st Edition). Prentice-Hall.
*Fundamentals Statistical Concepts,* Fisher, Canfield Press.
*Probability with Statistical Applications,* Mosteller, Addison-Wesley.
*Probability and Statistical Inferences,* Hogg & Tanis, Prentice Hall.
*Probability and Statistics,* Walpole, Prentice Hall.
*Mathematical Statistics*, Rice (any edition). Wadsworth & Brooks - Cole.
*Mathematical Statistics*, Freund (any edition). Prentice - Hall.
*Schaum Outline Series: Probability and Statistics*, Hsu (any edition). McGraw - Hill.
*Introduction to the Practice of Statistics,* Moore & McCabe, Freeman.
*Elementary Statistics,* Pelosi, Wiley.
*Elementary Statistics for ther Behavioural Science,* Games, McGraw - Hill.

**Course Objective:**

This course is designed to provide the student with an intense foundation in fundamental concepts of stochastic mathematics used in advanced statistics and sampling theory. This course focuses on the theory of applied mathematics in the form of mathematical statistics. As such, we consider the form and way that the theory creates the applications. So, there we shall be discussing and proving certain results and then we shall consider how they are applied to biometrics, econometrics, edumetrics, technometrics, decision science, etc. After completing the course the student should be able to work basic problems mathematical statistics with special attention to properties of expectation, estimation (point and interval), hypothesis testing, correlation, and simple linear regression. Furthermore we will concentrate on the Weak and Strong Law of Large Numbers; Central Limit Theorem; estimation of parameters; confidence intervals; multiple regression analysis; sampling from a normal population; and, testing hypotheses.
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A student should have mastered and demonstrated the following skills after completing Math 545:

- the student is able to think logically
- the student is able to reason and recognise patterns and be able to make conjectures
- the student is able to use mathematical symbols
- the student is able to compute point estimates, confidence intervals, and make inferences based on said.
- the student is able to compute covariance, correlation, and work basic problems in linear regression.
- the student will learn basic statistical concepts and methods

- the student will study and implement applications of statistical procedures.
- the course will prepare the student for further study of statistical concepts and methods
- the student will study a body of knowledge which contains a proper balance of mathematical rigor and applicational procedures.
- the student will understand graphical methods of describing data sets and be able to calculate and interpret numerical descriptive statistical measures.
- the student will understand basic probability theory, including rules for finding probabilities of complex events, conditional probability, and probabilities for repeated independent and dependent trials.
- the student will understand the concepts of sampling, including the use of random number tables to select samples.
- the student will understand the probability distributions of discrete random variables, including calculation of means and variances of such distributions.
- the student will understand the binomial probability distribution, including calculation of probabilities, means, and variances.
- the student will understand the use of density functions to describe distributions of continuous random variables.
- the student will be able to calculate probabilities and percentiles for random variables with uniform and normal probability distributions.
- the student will be able to use the normal distribution to approximate binomial probabilities.
- the student will understand the concept of sampling distribution of a statistic and be able to calculate the sampling distribution for simple sampling situations.
- the student will understand the Central Limit Theorem and be able to use it to find probabilities for sample statistics.
- the student will be able to use confidence intervals to estimate unknown population means using large or small samples (with z- or t-distributions) for numerical variables and to estimate unknown proportions in populations for categorical variables.
- the student will understand the concept tests of hypotheses and be able to perform hypothesis tests for means and proportions for one-sample data.
- the student will be able to extend confidence intervals and tests of hypotheses to two-sample situations, including differences in means and proportions for independent samples and differences in means for paired data.
- the student will understand the multinominal probability model and will be able test hypotheses for categorical data in one-way and two-way tables using chi-squared methods.
- the student will be able use the SPSS computer software system for basic statistical calculations and basic inferential procedures.
- the student will understand how to conduct inferences and interpret tests for the slope, intercept, and the regression line in straight-line linear regression analysis.
- the student will understand the relationship between the correlation coefficient and straight-line regression analysis.
- the student will be able to conduct tests of hypothesis and construct confidence intervals for the correlation coefficient of one population and the difference between the correlation coefficients of two populations.
- the student will understand and apply the assumptions concerning multiple regression analysis and the analysis of variance table for a multiple regression.
- the student will be able to conduct test of hypothesis in a multiple regression such as the test for significant overall regression, partial and multiple partial F-tests.
- the student will be able to compute multiple, partial and multiple partial correlation coefficient coefficients and conduct the corresponding F-tests.
- the student will be able to determine interaction and confounding in regression.
- the student will be able to apply regression diagnostics that include residual analysis to treat outliers and collinearity and scaling problems.
- the student will be able to use dummy variables in the comparison two straight lines and in the comparison of four regression equations.
- the student will be able to select the best regression equation using procedures such as the step-wise, forward elimination, the backward elimination and the all-possible regression procedures.
- the student will be able to conduct one-way and two-way analysis of variance with multiple comparisons.

**Assessment of Learning Outcomes**

Problems based on the learning outcome objectives will be assigned on a regular basis and may appear in a variety of contexts

- Homework problems serve as both learning and assessment tools for both familiarization with and understanding of the topics covered. Evaluation of homework never includes grading of assignments.
- Classroom discussion of homework problems and other topics provides additional assessment of students' understanding of the topics covered.
- Questions in class are used to assess the students' understanding of concepts covered.
- Computer assignments will be used to evaluate the students' ability to use the SPSS computer software system and assess the students' ability to analyze the various data output and to draw inferences from the outputs.
- Midterm and final examinations will be used to evaluate the students' mastery of the topics covered.
- *Quizzes* are used to assess students' understanding of newly presented topics and previously covered material.
- *Take-home assignments* are course projects. They provide an opportunity for students to work on more complicated problems that involve large data sets and to effectively apply various methods learned in class to solve these problems. The take-home exams are also used to determine whether the students learned the statistical methods.
- *Presentations* are designed to assess the students' ability to express their thought clearly and to demonstrate their understanding of the ideas covered.

**Outline of the Course: Suggested Pace:**

The course will run such that we will spend a about week on each chapter.

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| Chapter 1, 2 | the week of August 30th |
| Chapter3 | Tuesday class, the week of Sept. 7th |
| Chapter 4 & 5 | the week of Sept. 13th |
| Chapter 6 | the week of Sept. 20th |
| Chapter 7, 8 | the week of Sept. 27th |
| Chapter 7, 8 | the week of October 4st |
| No Class | the week of October 11th |
| Mid-term Exam | the week of October 18th |
| Chapter 9 | the week of October 25th |
| Chapter 10 | the week of November 1st |
| Chapter 11 | the week of November 8th |
| Chapter 11 | the week of November 15th |
| Chapter 12 | the week of November 22nd |
| Chapter 12 | the week of November 29th |
| Chapter 13 | the week of December 6th |
| Final | the week of December 13th |