

# Course Outline

## Introduction to Probability and Statistics Stat 3205

CSEDU



# About the Instructor

# Mahbub Latif

- Professor of Applied Statistics and Data Science
- Institute of Statistical Research and Training (ISRT) at the University of Dhaka [1996 - ]

## Educational Qualifications

- PhD in Applied Statistics (University of Goettingen, Germany) [2005]
- MSc in Statistics (University of British Columbia, Canada) [2001]
- BSc and MSc in Statistics (University of Dhaka, Bangladesh) [1993, 1995]

# Employments

- Professor, Institute of Statistical Research and Training [2012 -]
- Professor, St. Luke's International University, Tokyo, Japan [2016 - 2019]
- Postdoctoral Research Assistant, Queen Mary University of London, UK [2008 - 2010]
- P. K. Sen Visiting Professor, University of North Carolina at Chapel Hill, USA [2013]

## Homepage @ ISRT

- <https://www.isrt.ac.bd/people/mlatif/>

# Contact details

## Office

- Room 104, ISRT Building

## Email

- mlatif@isrt.ac.bd

## Meetings

- Tuesdays and Wednesdays, 2:00 pm - 3:30 pm

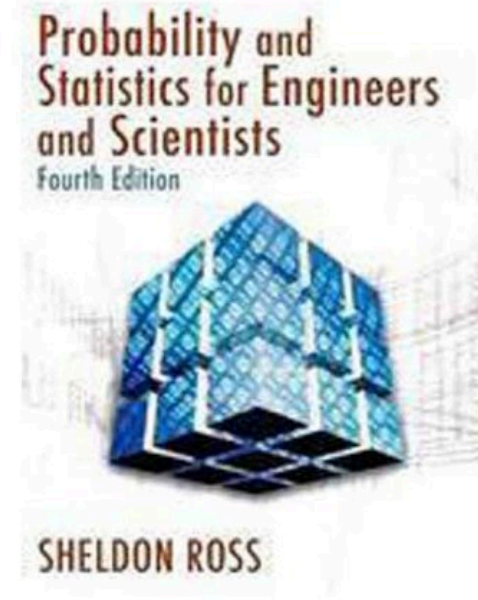
## Office hours

- TBA

# About the Course

# Textbook

- **Sheldon M. Ross** (2009). *Introduction to Probability and Statistics for Engineers and Scientists*, fourth edition. Elsevier.



## Reference Book

- **Anthony Hayter** (2012). *Probability and Statistics for Engineers and Scientists*, fourth edition. Cengage Learning.



# Chapter 1: Introduction to Statistics

- Types and Sources of Data, Descriptive and Inferential Statistics, Uses and Abuses of Statistics,

# Chapter 2: Describing Statistics

- Presentation of Data and Exploratory Data Analysis Tools
  - Stem and Leaf plots, Frequency Tables, Histograms, Skewness and Modes, Percentiles and Quartiles, Estimating Percentiles from Histograms, Extremes and Median, Hinges, Outliers, and five Number Summaries, Box-and-Whisker plots, Use of R or MATLAB for exploratory data analysis.
- Characteristics of Data
  - Measures of location: Mean, Median, Mode;
  - Measures of Spread/Scale: Spread and Variability, Range, Standard Deviation; Measures of Location and Spread under Affine Transformations;
  - Robust Measures of Location and Spread: Trimmed Mean, Winsorized Mean; Interquartile Range, Median Absolute Deviation; Markov's inequality and Chebyshev's inequality for list data

# Chapter 2: Describing Statistics

- Multivariate Data
  - Scatterplots and Scatterplot Matrices
  - Linearity and Non-linearity, Homoscedasticity and Heteroscedasticity, Outliers
- Correlation and Association
  - Correlation and Causality
  - Correlation Coefficient, the Effect of Nonlinear Association, Homoscedasticity and Heteroscedasticity, and Outliers on the Correlation Coefficient;
  - Rank Correlation

## Chapter 3: Elements of Probability

- Experiments, Events, Set Theory
- Interpretations of Probability, Axioms of Probability and Counting Methods for Computing Probability
- Conditional Probability, Independence, Conditional Independence, and Bayes' Theorem,

## Chapter 4: Random Variables and Expectation

- Random variables, types of random variables, jointly distributed random variables
- Expectation, Variance, Moments and Moment Generating Functions, Transformation of Variable

# Chapter 5: Special random variables

- Special Discrete Distributions
  - Bernoulli, Binomial, Geometric, Multinomial, Hypergeometric, and Poisson
- Special Continuous Distributions
  - Uniform, Gamma, Exponential, and Beta.
  - Normal Distribution and its properties Q-Q plots and the Normal Probability Plot,
- Limit Theorems: Markov's and Chebyshev's Inequality, Central Limit Theorem, Laws of Large Numbers.

# Grading distribution

Grading tool	% points
Midterm	15
Quiz	5
Attendance + Participation	5
Assignments	5
Final Exam	70
Total	100

**Some useful stuff for the course!**

# A Scientific Calculator

- You should bring a scientific calculator to all the classes and exams.
- Mobile phone cannot be used as a calculator!





# Differentiation

- Derivative of a function  $y = f(x)$  is defined as

$$\frac{dy}{dx} = \frac{d}{dx} f(x)$$

- *E.g.*  $y = 2x^2 + 5x + 10$

$$\frac{dy}{dx} = \frac{d}{dx}(2x^2 + 5x + 10) = 4x + 5$$

# Differentiation

- $y = [g(x)]^n \Rightarrow \frac{dy}{dx} = n[g(x)]^{n-1} \left[ \frac{dg(x)}{dx} \right]$

*E. g.*  $y = (2x + 3)^4$

$$\frac{dy}{dx} = 8(2x + 3)^3$$

- $y = g(x)f(x) \Rightarrow \frac{dy}{dx} = \frac{dg(x)}{dx}f(x) + g(x)\frac{df(x)}{dx}$

*E. g.*  $y = (2x + 3)(x^2 + 5)$

$$\frac{dy}{dx} = 2x(2x + 3) + 2(x^2 + 5)$$

# Differentiation

- $y = \frac{g(x)}{f(x)} \Rightarrow \frac{dy}{dx} = \frac{f(x)\frac{dg(x)}{dx} - g(x)\frac{df(x)}{dx}}{f(x)^2}$
- $y = \ln x \Rightarrow \frac{dy}{dx} = \frac{1}{x}$
- $y = e^x \Rightarrow \frac{dy}{dx} = e^x$
- $y = e^{g(x)} \Rightarrow \frac{dy}{dx} = e^{g(x)} \left[ \frac{dg(x)}{dx} \right]$

# Integration

- For  $n \neq -1$ ,

$$y = x^n \Rightarrow \int_a^b x^n dx = \frac{x^{n+1}}{n+1} \Big|_a^b = \frac{b^{n+1} - a^{n+1}}{n+1}$$

- It can be shown

$$\frac{d}{dx} \frac{x^{n+1}}{n+1} = (n+1) \frac{x^n}{(n+1)} = x^n$$

# Integration

- $\int_a^b e^x dx = e^x \Big|_a^b = e^b - e^a$

*E. g.*  $\int_1^2 e^x dx = e^2 - e^1$

- $\int_a^b e^{kx} dx = \frac{e^{kx}}{k} \Big|_a^b = \frac{e^{kb} - e^{ka}}{k}$

*E. g.*  $\int_1^2 e^{5x} dx = \frac{e^{10} - e^5}{5}$