

# Mathematics Foundations (CBCA104)

Lecture-1  
27/09/2022

## Course Details

Course Code: CBCA104

Course Name: Mathematics Foundations

Credits: 3-1-0 (4)

# Course Details

## **Module 1 (14 hours)**

Sets, Relations, and Functions: Sets and their representations, Empty set, Finite & Infinite sets, Equal sets, Subsets, Power set, Universal set, Venn diagrams, Union and Intersection of sets, Difference of sets, Complement of a set, Types of functions – Definitions, Inverse functions, Fundamental Principle of counting, Sum and Product rule. The principle of inclusion-exclusion, Permutation definition, Linear and circular permutations, Permutations of 'n' dissimilar things taken 'r' at a time, Permutations when repetitions allowed, Circular permutations, Permutations with constraint repetitions, Combinations, Combination with repetition, Combination without repetition, Ordered and Unordered partitions, Binomial coefficients and properties, The binomial and Multinomial theorem and Applications.

# Course Details

## **Module 2 (14 hours)**

Concept of matrix: Notation, Order and Equality, Types of matrices, Transpose of a matrix, Symmetric and Skew symmetric matrices, Addition, Multiplication and Scalar multiplication of matrices, Properties of matrix addition and multiplications, Determinant of a square matrix, Properties of determinants, Adjoint and Inverse of a square matrix, Concept of elementary row and column operations, Invertible matrices, Cramer's rule, Consistency, Inconsistency, and Number of solutions of system of linear equations by examples, Solving system of linear equations in two or three variables using inverse of a matrix, Characteristic equation, Eigen value and eigen vectors, Singular value decomposition, Mathematical Induction, Principle of Mathematical Induction & Theorems, Applications of Mathematical Induction.

# Course Details

## **Module 3 (14 hours)**

Probability and Statistics: Measure of dispersion, Mean, Median, Mode, Range, Mean deviation variance of ungrouped/grouped data, Standard deviation of ungrouped/grouped data, Coefficient of variation, Analysis of frequency distribution with equal means but different variances, Random experiments: Outcomes, Sample spaces, Events, Mutually exclusive events, Multiplication theorem on probability, Conditional probability, Independent events, Total probability, Baye's theorem and examples, Random variables, Independent random variables, Discrete and continuous probability distributions, Distribution functions, Mathematical expectation, Variance, Standard deviation, Special probability distributions: Binomial distribution, Normal distribution, Relation between the Binomial, and Normal distributions, Central limit theorem.

# Course Details

## **Suggested Textbooks:**

- a) Stephen H. Friedberg Lawrence E Spence and Arnold J Insel, Elementary Linear Algebra: A Matrix Approach (2 ed.), Pearson India, 2019. ISBN 978-0128119051.
- b) Sheldon M. Ross, Introduction to probability and statistics for engineers and scientists (6 ed.), Elsevier, 2021. ISBN 978-9351073987.
- c) E. Mendelson, Schaum's Outline of Beginning Calculus (2nd ed.), Mc-Graw Hill, 1997. ISBN978-0071635356, ISBN0071635351.

# Evaluation Policy

EVALUATION COMPONENTS:	
Components of Course Evaluation	Percentage Distribution
Mid Term	15
End Term	35
Continuous Evaluation (Tutorial)	30
Continuous Evaluation (Lecture)	10+10
Total	100

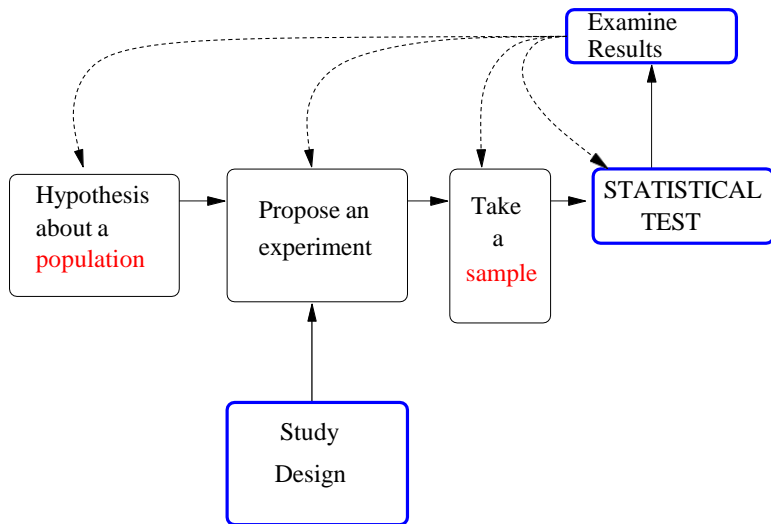
Why to study Mathematics Foundations?



# Outline

Why do we need Set Theory?

## The general focus of the Experiment



## What is Statistics?

Statistics is a branch of applied mathematics which deals with the collection, classification and interpretation of data.

- ❖ Data exploration and analysis
- ❖ Inductive inference with probability
- ❖ Quantification of uncertainty

## An Example

Psychologists have long been interested in the relationship between stress and health.

A focused question might involve the study of a specific psychological symptom and its impact on the health of a population.

To assess whether the symptom is a good indicator of stress we need to measure the symptom and stress level in a sample of individuals from the population.

It is not immediately clear how we should go about collecting this sample, i.e. how we should design the study.

## Dataset consists of measured variables

The datasets that Psychologists, Human Scientists and Medical Scientists collect will usually consist of one or more observations on one or more variables.

A **variable** is a property of an object or event that can take on different values.

**Example:** we collect a dataset by measuring, for every student in a class, the

- hair colour
- resting heart rate
- and score on an IQ test.

The variables in this dataset are therefore

- the hair colour
- resting heart rate
- and score on an IQ test.

# Types of variables

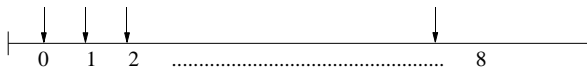
There are 2 main types of data/variable:

- **Measurement / Quantitative Data** occur when we measure objects/events,  
*e.g. when we measure someone's height or weight.*
- **Categorical / Qualitative Data** occur when we assign objects into labelled groups or categories,  
*e.g. when we group people according to hair colour or race.*

# Types of variables

## Discrete Data

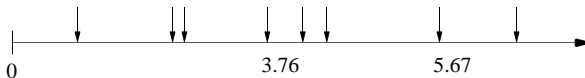
No. of students late for a lecture



There are only a limited set of distinct values/categories  
i.e. we can't have exactly 2.23 students late, only integer values  
are allowed.

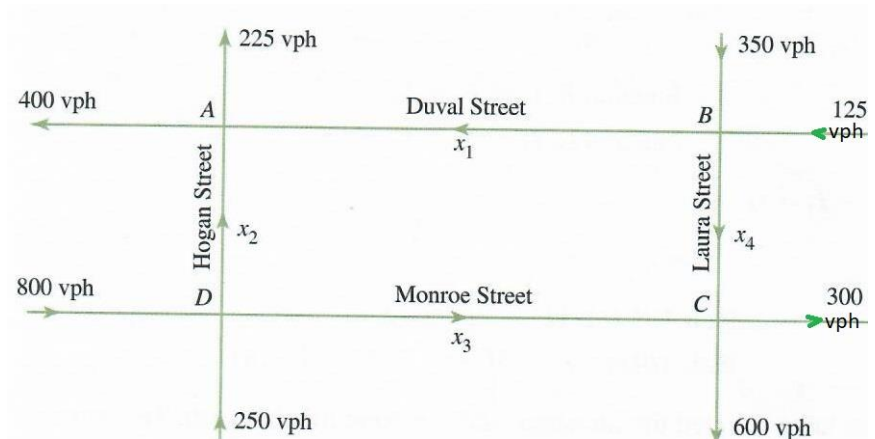
## Continuous Data

Time spent studying statistics (hrs)



In theory there are an unlimited values!

# Traffic Flow





# Traffic Flow

- The streets are all one way with the arrows indicating the direction of the traffic flow.
- The traffic is measured in vehicles per hour(vph).

Construct the mathematical model that can be used to analyze the flow  $x_1, \dots, x_4$  within the network.

# Traffic Flow

## Traffic law

All traffic entering an intersection must leave that intersection.