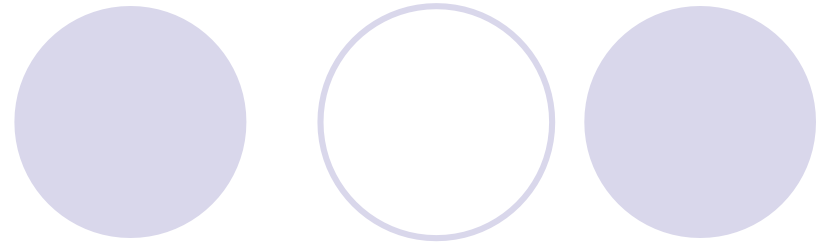
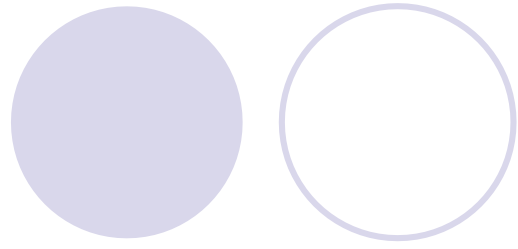


# Lecture # 1

## Introduction to course, & Chapter#1

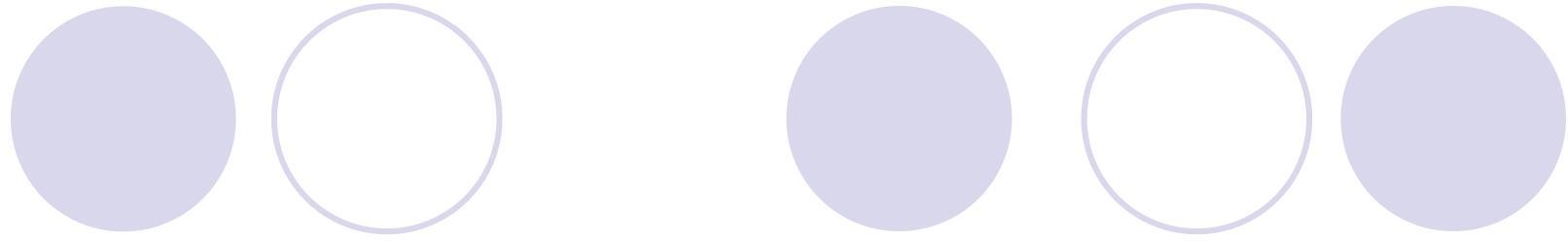
Date: 22/8/2022



HI!!

I am Fizza





# Need some help???

- Email me at [fizza.ageel@nu.edu.pk](mailto:fizza.ageel@nu.edu.pk)
- My Room is in the Basement#1, Room#2
- Ext: 153
- Classroom Code: **bazgqmx**

# Marks Distribution

- **Assignments/quizzes:** 20 marks
- **Mid-I Exam:** 15 marks
- **Mid-II Exam:** 15 marks
- **Final Exam:** 50 marks



# Course Outline

- Logic and Proofs
- Sets and Functions
- Sequences and Series
- Relations
- Number Theory Proof
- techniques Induction
- and Recursion
- Counting and Recurrence Relations
- Graphs
- Trees



## TEXT Book:

- Discrete Mathematics & its Applications, 8<sup>th</sup> edition. By Kenneth H. Rosen.

## References Book:

- Invitation to Discrete Maths, 2nd edition. By Matousek and Nešetřil.
- Discrete Mathematics. By Lovász, Pelikan and Vesztegombi.



# The Foundations: Logic and Proofs

Chapter 1, Part I: Propositional  
Logic

# Discrete Mathematics

- Discrete mathematics is the part of mathematics devoted to the study of discrete objects (Kenneth H. Rosen, 8th edition).
- How to think (and argument) mathematically.
- Learn mathematical facts and their applications.
- Discrete mathematics is the mathematical study of properties, and relationships among discrete objects.
- Discrete mathematics is the study of mathematical structures that are fundamentally discrete rather than continuous.



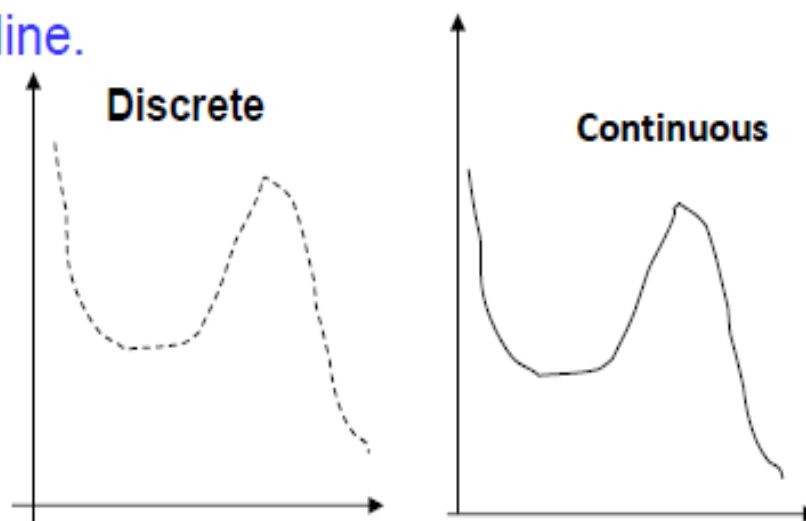
# Discrete Vs Continuous

- **Continuous Data:** A set of data is said to be continuous if the values belonging to the set can take on any value within a finite or infinite interval.
- **Continuous data** is information that can be measured on a continuum or scale. , e.g.,  $[0, 70]$ .
- **Continuous data** can have almost any numeric value and can be meaningfully subdivided into finer and finer increments, depending upon the precision of the measurement system.
- **Discrete Data:** A set of data is said to be discrete if the values belonging to the set are distinct and separate. It is counted e.g.,  $\{1, 2, 3, 4, 5, 6\}$

# Discrete vs Continuous

- Examples of discrete Data
  - Number of boys in the class.
  - Number of candies in a packet.
  - Number of suitcases lost by an airline.

- Examples of continuous Data
  - Height of a person.
  - Time in a race.
  - Distance traveled by a car.





# Why DM?

- Digital computers are based on discrete “atoms” (bits).
- Therefore, both a computer’s
  - structure (circuits) and
  - operations (execution of algorithms)can be described by discrete mathematics.



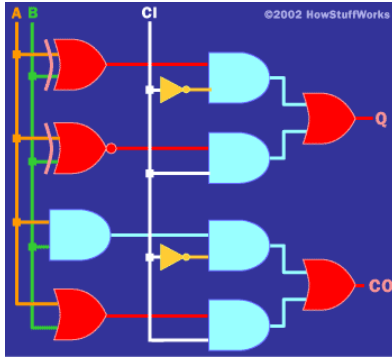
## Course Description:

- This class teaches students
  - how to think logically and mathematically.
  - It stresses mathematical reasoning and different ways to solve problems.

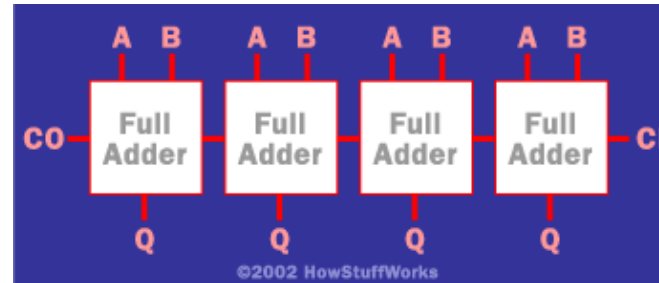
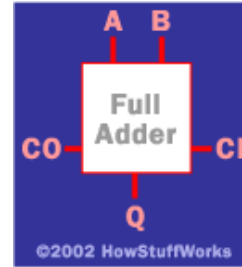
It enhance your ability to formulate and solve applied problems, to analyze and interpret algorithms and functions and to use them effectively.
- Five important themes are interwoven in this class:
  - mathematical reasoning,
  - combinatorial analysis,
  - discrete structures,
  - algorithmic thinking,
  - applications and modeling

# Applications: Logic

## Hardware and software specifications



One-bit Full Adder with  
Carry-In and Carry-Out



4-bit full adder

Formal: `Input_wire_A`  
value in  $\{0, 1\}$

Example 1: Adder

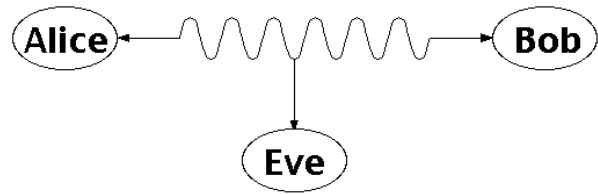
### Example 2: System Specification:

- The router can send packets to the edge system only if it supports the new address space.
- For the router to support the new address space it's necessary that the latest software release be installed.
- The router can send packets to the edge system if the latest software release is installed.
- The router does not support the new address space.

How to write these specifications in a rigorous / formal way? Use Logic

# Applications: Number Theory

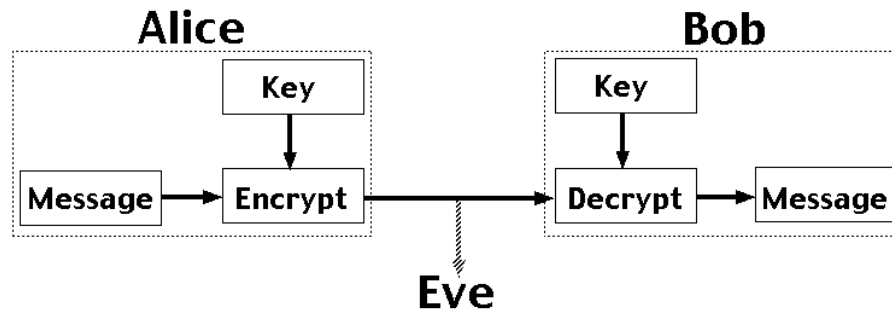
## RSA and Public-key Cryptography



Alice and Bob have never met but they would like to exchange a message. Eve would like to eavesdrop.

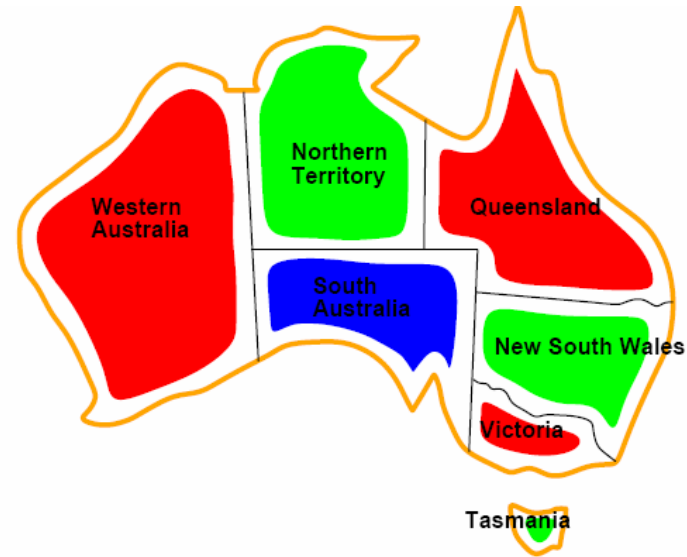
E.g. between you and the Bank of America.

They could come up with a good encryption algorithm and exchange the **encryption key** – but how to do it without Eve getting it? (If Eve gets it, all security is lost.)



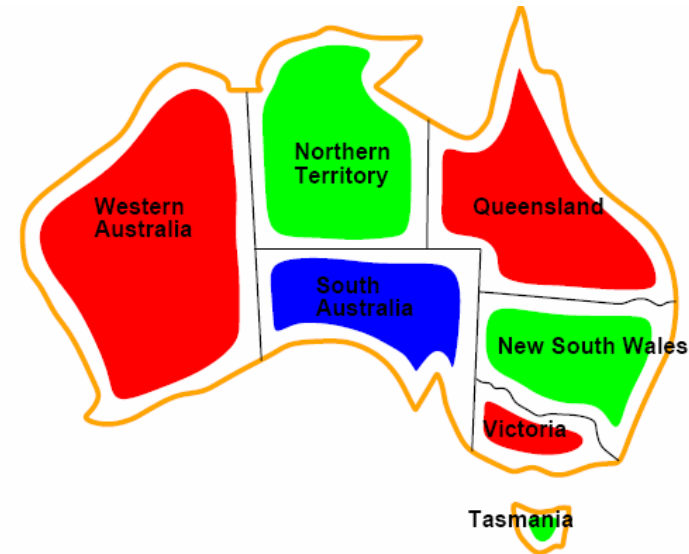
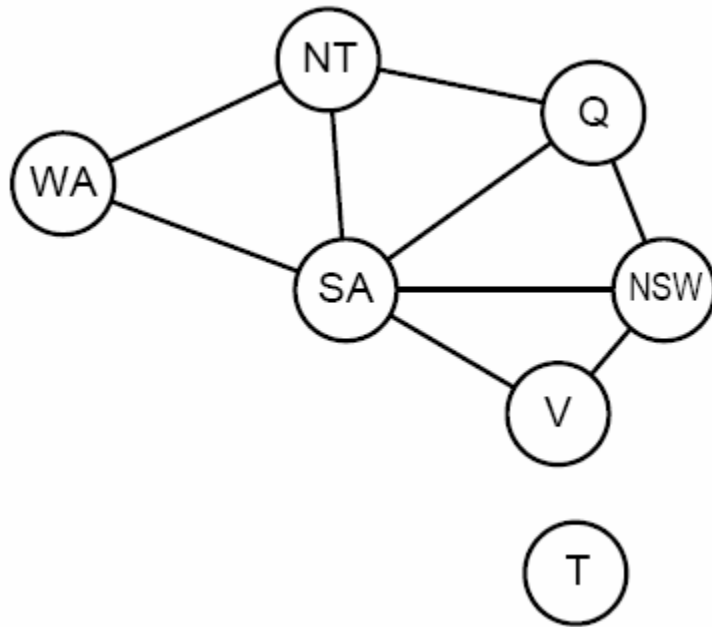
CS folks found the solution: **public key encryption**. Quite remarkable that is feasible.

# Applications: Coloring a Map



How to color this map so that no two adjacent regions have the same color?

# Applications: Graph representation



Coloring the nodes of the graph:

What's the minimum number of colors such that any two nodes connected by an edge have different colors?



# Logic

- Logic is fundamental because it allows us to understand meaning of statements, deduce information about mathematical structures and uncover further structures.
- The rules of logic specify the meaning of mathematical statements.
- These rules are used to distinguish between valid and invalid arguments.

# Propositional Logic

## Introduction

- A **proposition** is a **declarative** sentence (a sentence that declares a fact) that is either **true or false**, but not both.
- Are the following sentences propositions?
  - Islamabad is the capital of Pakistan. (Yes)
  - Read this carefully. (No)
  - $1+2=3$  (Yes)
  - $x+1=2$  (No)
  - What time is it? (No)

# Proposition

## Definition

**proposition** (or **statement**):  
a declarative sentence that is either true or false

- **law of the excluded middle**:  
a proposition cannot be partially true or partially false
- **law of contradiction**:  
a proposition cannot be both true and false

### propositions

- The Moon revolves around the Earth.
- Elephants can fly.
- $3 + 8 = 11$

### not propositions

- What time is it?
- Exterminate!
- $x < 43$



# Examples: Propositions

Is the following sentence a proposition? If it is a proposition, determine whether it is true or false.

Islamabad is the capital of Pakistan.

This makes a declarative statement, and hence is a proposition. The proposition is TRUE (T).

Can Ali come with you?.

This is a question not the declarative sentence and hence not a proposition.



Take two aspirins.

This is an imperative sentence not the declarative sentence and therefore not a proposition.

$x + 4 > 9$ .

Because this is true for certain values of  $x$  (such as  $x = 6$ ) and false for other values of  $x$  (such as  $x = 5$ ), it is not a proposition.

He is a college student.

Because truth or falsity of this proposition depend on the reference for the pronoun *he*, it is not a proposition.

# Activity 1



Write down at least 5 examples of propositions and  
Non-propositions.