



**FC 1110 - Quantitative Reasoning &
Mathematical Thinking**
Monsoon 2024 • Course Overview

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COURSE OVERVIEW

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[**Declaration**] The cover design is due to Processing Foundation (2019 project), [link](#).

1 Overview

Even habitual activities such as driving a car, walking past a busy intersection, managing weekly expenses, or scheduling meetings, need quantitative reasoning intertwined with decision making, often in the presence of incomplete or uncertain data. Viewing through the lens of mathematical formalism, one would learn to appreciate the art of modelling instances, the elegance of logical reasoning, and to gauge the role of randomness and chance in the events occurring around us.

This course will enable students to sharpen their mind with the power of creative thinking and open doors to an enchanting playground where by solving puzzles and quizzes, they would know how to unearth the underlying abstractions and apply them for solving real-world problems, regardless of their prior knowledge of mathematics. The clever tricks of geometry and Boolean algebra, fascinating insights from graph theory, the beauty in algorithms, and the probabilistic approach to foreseeing an event, would boost up their confidence and proficiency.

The vast repertoire of mathematical techniques blended with creativity and rigor will not only change their perspectives towards problem-solving but also provide them boundless opportunities to explore many uncharted territories such as law, finance, healthcare, and social sciences, by reducing challenges therein, to bare essentials. At the end of the course, students are likely to experience the joy of understanding complex problems with precision and clarity while fostering a sense of wonder and discovery. Having laid strong pillars on mathematical fundamentals and empowered with the subtle art of reasoning, they would naturally evolve as leaders in their respective professional frontiers.

2 Objectives / Learning Outcomes

During the course we will walk through a selection from the following topics:

1. Puzzles and paradoxes through patterns and numbers; fallacies in perception; coin-rotation paradox, the mystery of rotating gears; sequences; the art of modelling and judgement;
2. How to count, Hippasus' discovery of irrational numbers; the beauty of primes, the fundamental theorem of arithmetic; power of binary numbers; Magic square in celebration of Ramanujan's birthday;
3. Pigeon-Hole Principle, basic combinatorics, the world of palindromes;
4. Managing finances: The king's chessboard - the magic of geometric progression and compound interest; How many years will I take for my money to double? What is the value of my home loan?
5. Revisiting Euclidean geometry; the marvels of geometry in ancient architectures; the enigma of shortest path; the mystery of solar and lunar eclipses;
6. Arithmetic via geometry: the power of ruler and collapsible compass; computing addition, multiplication, and square root using ruler-and-compass; what ruler-and-compass is unable to do; integer geometry and digital imaging;

7. The beauty of polygons; applications to cognitive assessment; how to guard an art gallery;
8. Sets, relations, and functions, Russell's paradox, equivalence classes and partitions, power set, principle of inclusion and exclusion, counting via sets;
9. How to win in arguments: Proof techniques, inductive and deductive reasoning, disproving by counterexamples;
10. Logical reasoning: Boolean algebra and propositional logic, implications and inferences;
11. Algorithms: Sorting, GCD, exponentiation, Tower-of-Hanoi, recursion, trees and graphs; The Bridges of Königsberg, Traveling Salesperson Problem;
12. Playing dice: Probability and ambiguity, randomness and chance, birthday paradox, mean, median, variance, distributions, expectation; stock-market strategies.