Syllabus template

Semester: 2	
Programme: Mathematics	
Course: Multi-disciplinary (Symmetries and Patterns)	
Paper code: M1MT230211T	**Credits: 3**
Hours/week: 3 hours	
Category: MDS	
Theory / Practical / Composite : Theory	
No of Modules : Nil	

Course Overview: This course explores the intersection of mathematics, logic, and puzzles through games, graphs, and patterns. Students study topics like Nim games, magic squares, graph colouring, Eulerian and Hamiltonian paths, the pigeonhole principle, and combinatorial reasoning. It also introduces mathematical vectors, shuffling algorithms, De Bruijn sequences, and the Gilbreath principle, connecting them to probability, fractals (Mandelbrot set), and the philosophy of chance in the I Ching. The focus is on developing creative, logical, and analytical thinking through engaging mathematical problems.

Course Outcome:

1. Explain and apply logical reasoning to solve Nim games, Magic squares, and logic-based puzzles.
2. Analyze and model problems using Handshake problem, Pigeonhole principle, and graph theory concepts (coloring, Hamiltonian, Eulerian paths).
3. Use movement control and mathematical vectors to formulate and simulate path-based puzzle problems like Kongsa Bridge and Royal Hammer.
4. Construct and explore Brujin sequences, universal cycles, and understand Gilbreath principles and Mandelbrot sets for pattern and sequence generation.
5. Evaluate and perform perfect, Monge, inside–down–under, and miracle shuffles to study combinatorial structures and probabilistic outcomes.
6. Interpret and relate the Book of Changes (I Ching) to concepts of probability and randomness, reflecting on mathematical and philosophical perspectives.

Prerequisites: ***Basic knowledge about any prior course****: Permutation Combinaion in plus-2 level*

SYLLABUS

UNIT/Module	CONTENT	HOURS or NUMBER OF CLASSES	CO Mapping	COGNITIVE LEVEL
I.	Nim Games (2), Magic square (2) Logic through puzzles (4) Kongsa Bridge Problem (2) Handshake problem (1) Graphs colouring problems, Hamiltonian, Eulerian through	20 hours	CO1, CO2, CO3	K3, K4

	examples (5) Pigeon Hole principle(2)			
II.	Movement control and mathematical vectors	2 hours	CO3	K3, K4,
III.	Royal Hammer (2) Brujin Sequences, Universal Cycles (4) Gilbreath Principle (2)Mandelbrot Set(2) Perfect shuffles, Monge Milk shuffles, Inside down under shuffles, Miracle Divination (5)	15 hours	CO3, CO4, CO5	K3, K4, K5, K6
IV.	Books of changes, Probability in book of changes, I ching and probability(4) .	4 hours	CO6,	K2, K4, K5,

Text Books

1. Jason Davison and Peter McQwan: Maths Made Magic.
2. Diaconis and Graham: Magical Mathematics

Suggested readings

1. "The I Ching or Book of Changes" – Translated by Richard Wilhelm
2. Mathematics, Magic and Mystery" – Martin Gardner
3. "The Fractal Geometry of Nature" – Benoît B. Mandelbrot

Web Resources

1. https://www.youtube.com/watch?v=UV9OXm2OeLQ
2. https://www.youtube.com/watch?v=RSSfO0lnEp8
3. https://www.youtube.com/watch?v=zhvjSAtxEhc
4. https://www.youtube.com/watch?v=FN3ELX2swJ

Evaluation: Theory CIA: 10+3+2=15 Semester Exam: 35

Paper Structure for Theory Semester Exam: 7 questions each carrying 5 marks out of 11 questions.

Course outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive levels
CO1	Explain and apply logical reasoning to solve Nim games, Magic squares, and logic-based puzzles.	K3
CO2	Analyze combinatorial and graph-theoretical problems such as Handshake problem, Pigeonhole principle, coloring, Hamiltonian, and Eulerian paths.	K4
CO3	Use movement control and mathematical vectors to formulate and simulate path-based puzzle problems	K3,K4

	like Kongsa Bridge and Royal Hammer.	
CO4	Construct and explore Brujin sequences, universal cycles, and understand Gilbreath principles and Mandelbrot sets for pattern and sequence generation.	K6
CO5	Evaluate and perform perfect, Monge, inside–down–under, and miracle shuffles to study combinatorial structures and probabilistic outcomes.	K5
CO6	Interpret and relate the Book of Changes (I Ching) to probability and randomness, demonstrating conceptual understanding.	K2, K5