Course Title: **Discrete Mathematics**

Course No.: Math. Ed. 456 Nature of course: Theoretical

Level: BICTE Credit Hour: 3

Semester: Fifth Teaching Hour: 48 hours

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1. Course Description:

This course is designed for the students of BICTE under Faculty of Education, Tribhuvan University. The course, Discrete Mathematics, is a 3- credit unit course for students studying towards acquiring the Bachelor of Information and communication technology in Education. In this course we will study about discrete objects and the relationship between them and introduce the applications of discrete mathematics in the field of Computer Science. This course provides an introduction to foundational topics in discrete mathematics and the theory of computation. It covers essential concepts such as combinatory, induction and recurrence relations, Boolean algebra, cryptography, functions and sorting algorithms, and finite state automata. Students will develop problem-solving skills and gain a solid understanding of the theoretical foundations of computer science.

2. General Objectives

The general objectives of this course are as follows:

1. To understand the fundamental principles and techniques of combinatory and their applications.
2. To analyze mathematical statement and proofs using induction and recurrence relations.
3. To apply Boolean algebra to analyze and design digital circuits and logical expressions.
4. To explore the principles of cryptography and understand various cryptographic algorithms and protocols.
5. To study the concepts of functions and sorting algorithms and analyze their efficiency and performance.
6. To understand finite state automata and their applications in formal languages and computational models.

3. Specific Objectives and Contents

Unit 1	I: Combinatory (6 hr)
• to apply counting principles to solve problems. • to solve problems by using the pigeonhole principle • To apply Ramsey's theorem to solve problems. • to calculate and use of the binomial coefficients to solve problems. • to apply the principle of inclusion and exclusion to solve problems.	1.1 Counting principles 1.2 The Pigeonhole Principle and uses 1.3 Ramsey's Theorem 1.4 Outing Strategies 1.5 The binomial coefficients 1.6 principle of inclusion and exclusion
Unit 2	**II: Induction and Recurrence Relations (10 hr)**
• To apply inductive and deductive reasoning to prove mathematical statements. • To use mathematical induction and strong induction to prove mathematical statements. • To solve linear recurrence relations with constant coefficients. • To describe Predicates and Quantification. • To find a particular solution to a linear recurrence relation with constant coefficients. • To apply particular solutions to solve problems. • To apply total solutions to solve problems. • To use generating functions to solve problems involving recurrence relations.	2.1 Inductive and deductive reasoning Mathematical induction 2.2 Applications of mathematical induction 2.3 Strong induction 2.4 Predicates and Quantification 2.5 Recurrence Relations 2.6 Linear recurrence Relations with constant Coefficients 2.7 Particular solution 2.8 Total solution 2.9 Generating function
Unit 3	**III: Boolean Algebra (6 hr)**
• To understand the basic concepts of Boolean algebra, with operators. • To construct and simplify Boolean expressions. • To describe and use of Boolean fuctions. • To use Karnaugh maps to simplify Boolean expressions.	3.1 Boolean Algebra 3.2 Boolean Expression POS and SOP expressions 3.3 Boolean functions Representation, minimization, duality, and complement 3.5 Karnaugh Maps
Unit 4	**IV: Cryptography (10 hr)**
• To review modular arithmetic, such as the modulus, the Euclidean algorithm, and Fermat's little theorem.	4.1. Modular arithmetic and properties 4.2. Classical cryptography 4.3. Modern cryptography

• To describe classical cryptography, such as substitution ciphers, transposition ciphers, and the one-time pad. • To apply the basic principles of modern cryptography, public-key cryptography, symmetric cryptography, and hash functions. • To use the basic principles of private-key cryptography, RSA algorithm, modulus,	4.4. Private- key cryptography 4.5. Public- key cryptography 4.6. The RSA system
Unit 5	**V: Functions and Sorting Algorithm (6 hr)**
• To define relations and functions using graphs and tables. • To find the composite of two functions and inverse of a function. • To understand the special properties of some common functions, such as hashing, greatest integer function, celling function, and floor function. • To use different notations to represent algorithms, such as pseudo code and flowcharts. • To understand and use of the different sorting algorithms.	5.1 Relations (equivalence relation and ordering (partial and linear) relation) and functions 5.2 Composite and inverse function 5.3 Special types of functions(Hashing, Greatest integer function, celling function, floor function) **5.4** Sorting algorithm(Quick, insertion, Radix, Heap, Bubble, Merge, counting)
Unit 6	**VI: Finite State Automata. (10hr)**
• Review the basic concepts of graphs, such as vertices, edges, and paths, adjacency matrix, etc. • To understand the basic concepts of alphabets, languages, and grammars. • To construct and classify different types of grammars. • To construct derivation trees for different types of grammars. • To construct and analyze finite-state machines with output. • To construct and analyze finite-state machines with no output. • To design and implement language recognizers.	6.1. Review of graphs (concept only) 6.2. Alphabet, Languages and Grammars 6.2.1 Introduction 6.2.2 Phrase- structure grammar and types 6.2.3 Deviation tree 6.3. Finite-State Machines with Output 6.4. Finite-State Machines with No Output 6.5. Sequence Recognizer Machine 6.6. Language Recognition 6.7. Turing Machines

• To prove that Turing machines are computationally universal.	

4. **Instructional Techniques**

Units	Activity and Instructional Techniques
Unit I	• Individual and group discussion on calculating errors • Individual and group discussion on bisection and iteration methods
Unit II	• Group and individual discussion on different methods of solving linear simultaneous equations
Unit III	• Group and individual discussion on Differences of polynomials and operators
Unit IV	• Individual and group assignments on Interpolations
Unit V	• Presentation and discussion with problem solving method on interpolations with unequal intervals.
Unit VI	• Individual and group presentation on Numerical Differentiation and integration
Unit I - V	• *The classroom instructions may include the numerical calculation and computation by using programming language C++ or JAVA or different computer applications like: Matlab, Geogebra and MS Excel.*

5. Evaluation

A. Internal evaluation

Internal evaluation will be conducted by course teacher based on following activities:

a. Attendance 5 points
b. Participation in learning activity 5 points
c. First assignment / test 10 points
d. Second assignment / test 10 points
e. Third assignment / test 10 points

Total 40 points

NOTE: Internal evaluation and assignments may include the numerical calculation and computation by using different computer application like as Matlab, Geobebra and MS Excel also.

B. External Evaluation:

Faculty of Education, Examination division will conduct final examination of weight 60 points at the end of semester. This 60 points is divided in final examination paper as

Objective questions (10 x 1) 10 points
Short answer questions (6 x 5) 30 points

Long answer questions	(2x 10)	20 points
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Total		60 points

6. Recommended books

Kenneth, H. Rosen (2012). *Discrete mathematics and its applications*, Seventh Edition McGraw Hill Publication.

B. Kolman, R. Busby, Sharon C. Ross (2015). *Discrete Mathematical Structures*, Sixth Edition Pearson Publications,

Joe L Mott, Abraham Kandel, Theodore P Baker (2008), *Discrete Mathematics for Computer Scientists and Mathematicians*, Printice Hall of India, Second Edition,