# Lesson Plan

*Cover Page*: Course Overview

*Semester:* **III**  Year: **2017-18**

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| *Course Title*:  **Discrete Mathematical Structures** | *Course Code*: **16CS36** |
| *Total Contact Hours*: 36 hrs | *Duration of SEE*: 3 **hrs** |
| *SEE Marks*: **100 + 50** | *CIE Marks*: **100** |
| *Lesson Plan Author*: Dr.Krishnappa H K, Prof.Poonam Ghuli, Prof.Deepika Dash | *Date*: **Jun 06, 2017** |
| *Checked By:* | *Date*: |

## Course Overview:

## This is a first introductory course in theoretical computer science. This course introduces the learner to the branch of computer science which deals with the theory, basic mathematics and logic. The subject matter considers the basic counting techniques, sets, relations functions and logics.

## Course Learning Objectives-CLO

This course lays down the following objectives -

1. Provide foundational introduction to fundamental discrete mathematics concepts.
2. Cultivate a sense of familiarity and ease in working with mathematical notation and common concepts in discrete mathematics.
3. Teach the basic results in number theory, logic, combinatorics, and graph theory.
4. Cultivate clear thinking and creative problem solving.

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| |  |  | | --- | --- | | **Course Outcomes: After completing the course, the students will be able to** | | | 1 | Understand and explore the fundamental concepts of discrete mathematical structure. | | 2 | Apply the concepts of discrete mathematical structures for effective computation and relating problems in computer science domain. | | 3 | Analyse the concepts of discrete mathematics to various fields of computer science. | | 4 | Design solutions for complex problem using different concepts of discrete mathematical structure as a logical predictable system. | |

**Course Content**

**Course Code: 16CS36**

**Hrs/Week L-T-P-S: 3-1-0-0 CIE: 100 marks**

**Teaching Hours: 36 Hrs SEE: 100 marks**

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|  | **UNIT-I** | **Hours** |
| **1** | **Fundamental Principles of Counting:**  The Rule of Sum and Product, Permutations, Combinations, The Binomial Theorem, Combinations with repetition | **4 Hours** |
| **2.** | **Set Theory**  The principles of inclusion and exclusion: Generalization of the principle. | **3 Hours** |
|  | **UNIT-II** |  |
| **3.** | **Mathematical Induction, Recursive Definitions, Recurrence Relations and Fundamentals of Logic:**  Method of mathematical induction, Recursive definition, First order linear recurrence relation-Formulation problems and examples, Second order linear homogeneous recurrence relations with constant coefficients, The non-Homogeneous recurrence relations. Rules of inference. Open Statement, Quantifiers, Definition and the use of Quantifiers, Definitions and the proofs of theorems. | **8 Hours** |
|  | **UNIT-III** |  |
| **4.** | **Language and Finite State Machine:**  Set Theory of strings,Finite State machine**,** Introduction to Finite Automata, Basic concepts of Automata theory, Deterministic Finite Automata, Non-Deterministic Finite Automata, Finite Automata with epsilon-transitions, Equivalence of NFA & DFA. | **7 Hours** |
|  | **UNIT-IV** |  |
| **5.** | **Relations**  Properties of relations, Composition of Relations, Partial Orders, Hasse Diagrams, Equivalence Relations and Partitions. | **4 Hours** |
| **6.** | **Functions**  Functions-plain, One-to-one, onto functions, Sterling numbers of the second kind, Function composition and Inverse function, Growth of function. | **3 Hours** |
|  | **UNIT-V** |  |
| **7.** | **Groups theory:**  Definition, Examples and Elementary properties, Abelian groups, Homomorphism isomorphism, cyclic groups, cosets and Lagrange’s theorem. | **4 Hrs** |
| **8.** | **Coding Theory:**  Elementary coding theory, the hamming metric, the parity-Check and Generator Matrices | **3 Hrs** |

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| **REFERENCE BOOKS:**   1. Ralph P. Grimaldi and B V Ramana, Discrete and Combinatorial Mathematics- An Applied Introduction, Pearson Education, Asia, 5th Edition – 2007, ISBN 978-81-7758-424-0 2. J.P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Tata – McGraw Hill, 35th reprint 2008, ISBN 13:978-0-07-463113-3 3. Kenneth H. Rosen, Discrete Mathematics and its Applications, Tata – McGraw Hill, 6th Edition, Sixth reprint 2008, ISBN-(13):978-0-07-064824-1 4. C. L. Liu and D P Mohapatra, Elements of Discrete Mathematics, 4th Edition, Tata- McGraw Hill, 2012 , ISBN:9781259006395 . 5. Peter Linz, An Introduction To Formal Languages & Automata, 6th Edition, Narosa Publishing House, 2007,ISBN:978-1-4496-1552-9. 6. Cormen, Leiserson, Rivest, Stein, An Introduction to Algorithms, 3rd Edition, PHI publication,2010.ISBN:978-0-262-03384-8 |

**Unit and Chapter wise Plan**

**Unit 1**

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| *Course Code and Title:* **Discrete Mathematical Structures** (16CS36) | |
| *Chapter Number and Title*:  1. **Fundamental Principles of Counting** | *Planned Hours:* ***4* hrs** |

## Learning Objectives:

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| **Sl. No.** | **Objectives** |
| **1** | Discuss the definition permutation and combinations. |
| **2** | Identify and Apply rule of sum and product. |
| **3** | Apply counting technique like permutation and combination with or without repetition. |
| **4** | Understand the applications of binomial theorem. |

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| ***Lesson Schedule***  *Class No. Portion covered per hour*   1. The Rule of Sum and Product 2. Permutations and Combinations 3. The Binomial Theorem 4. Combinations with repetition |

## Model Questions

1. How many arrangements are there of all the letters in SOCIOLOGICAL?
2. In how many of the arrangements in part (i) are A and G adjacent?
3. In how many of the arrangements in part (i) are all the vowels adjacent?
4. State and prove binomial theorem.
5. Find the co-efficient of w2 x2 y2 z2 in the expansion of

(2w-x+3y+z-2)12.

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| *Course Code and Title:*  **Discrete Mathematical Structures** (16CS36) | |
| *Chapter Number and Title*: *2****.***   **Set Theory** | *Planned Hours:* ***03*  hrs** |

## Learning Objectives

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| **Sl. No.** | **Objectives** |
| **1** | Define sets and subsets. |
| **2** | Perform various set operations. |
| **3** | Understand various laws of set theory and count on sets |

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| ***Lesson Schedule***  *Class No. Portion covered per hour*   1. The principles of inclusion and exclusion: 2. Generalization of the principle. 3. Generalization of the principle. |

**Model Questions**

1. a) State and prove the distributive law of sets over ∩ and U.

b) Simplify the expression (A U B) ∩ C U B.

c) State and prove the extended addition rule.

1. For U={1,2,3,4,…….,8,9,10} let A={1,2,3,4,5}, B={1,2,4,8}, C={1,2,3,5,7}, and D={2,4,6,8}. Determine the following.
2. (A U B)-C
3. B-(C-D)
4. (A U B) – (C ∩ D)
5. (D – A) ∩ (C –B)

**Unit II**

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| *Course Code and Title:*  **Discrete Mathematical Structures** (16CS36) | |
| *Chapter Number and Title*: *3*  **Mathematical Induction, Recursive Definitions, Recurrence Relations and Fundamentals of Logic** | *Planned Hours:* ***08* hrs** |

## Learning Objectives

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| **Sl. No.** | **Objectives** |
| **1** | Apply induction to prove theorems and summations. |
| **2** | Define any sequence by recursion. |
| **3** | To find generic solution to recurrence relations. |
| **4** | Define Declarative statements, propositional logic, Basic connectives |

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| ***Lesson Schedule***  *Class No. Portion covered per hour*   1. Inductive definition, Inductive proofs. 2. Definition of recursion, Recurrence relations. 3. Generic solutions to recurrence relations 4. The non-Homogeneous recurrence relations. 5. Second order linear homogeneous recurrence relations with constant coefficients 6. Logical Implications, Rules of inference. 7. The use of Quantifiers. 8. The proofs of theorems. |

**Model Questions**

1. Prove the following by mathematical induction.

n2 (n+1)2)/4

1. Give the recursive definition to the sequence 0,1,1,2,3,5,………….., along with the boundary conditions. Find the generic solution to this recurrence relation
2. Determine the truth value of q🡪p and ~q🡪~p, if p🡪q is false.
3. Construct the truth table for the following compound proposition.

(p🡪q)🡪(q🡪p).

## UNIT- III

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| *Course Code and Title:*  **Discrete Mathematical Structures** (16CS36) | |
| *Chapter Number and Title*: *4.***Language and Finite State Machine:** | *Planned Hours:* ***07* hrs** |

## Learning Objectives

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| **Sl. No.** | **Objectives** |
| **1** | Discuss Finite State machine |
| **2** | Explain Basic concepts of Automata theory |
| **3** | Discuss key topics like Deterministic Finite Automata, Non-Deterministic Finite Automata |
| **4** | Explain Equivalence of NFA & DFA. |

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| ***Lesson Schedule***  *Class No. Portion covered per hour*   1. Set Theory of strings, 2. Finite State machine**,** 3. Introduction to Finite Automata, 4. Basic concepts of Automata theory, 5. Deterministic Finite Automata, Non-Deterministic Finite Automata, 6. Finite Automata with epsilon-transitions, 7. Equivalence of NFA & DFA. |

**Model Questions**

1. Explain the concept of Finite state machine.
2. Discuss the concept of Automata theory.

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| *Course Code and Title* **Discrete Mathematical Structures** (16CS36) | |
| *Chapter Number and Title*: *5.* **Relations** | *Planned Hours:* ***04*hrs** |

**UNIT- IV**

## Learning Objectives

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| **Sl. No.** | **Objectives** |
| **1** | Explain the Concepts of Hasse Diagrams |
| **2** | Design Equivalence Relations and Partitions. |
| **3** | Discuss the basics of Realtions. |
| **4** | Handling of partial orders |

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| ***Lesson Schedule***  *Class No. Portion covered per hour*   1. Properties of relations, 2. Composition of Relations, Partial Orders, 3. Hasse Diagrams, 4. Equivalence Relations and Partitions. |

**Model Questions**

1. List the ordered pairs in the relation R from A={0,1,2,3,4} to B={0,1,2,3} where (a,b)ε R

iff a=b b) a+b=4 c)a>b d)a|b e)gcd(a,b)=1 f)lcm(a,b)=2.

2. a) List all the ordered pairs in the relation R={(a,b) | a divides b} on the set {1,2,3,4,5,6}.

b) Display this relation graphically.

c) Display this relation in tabular form.

3. For each of these relations on the set {1,2,3,4}, decide whether it is reflexive , symmetric,

antisymmetric and transitive.

1. {(2,2),(2,3),(2,4),(3,2),(3,3),(3,4)}
2. {(1,1),(1,2),(2,1),(2,2),(3,3),(4,4)}
3. {(2,4),(4,2)}
4. {(1,2),(2,3),(3,4)}
5. {(1,1),(2,2),(3,3),(4,4)}
6. {(1,3),(1,4),(2,3),(2,4),(3,1),(3,4)}

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| *Course Code and Title* **Discrete Mathematical Structures** (16CS36) | |
| *Chapter Number and Title*: *6.*  **Functions** | *Planned Hours:* ***03*hrs** |

## Learning Objectives

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| **Sl. No.** | **Objectives** |
| **1** | Discuss the basics of functions |
| **2** | Handling of sterling Numbers |
| **3** | Discuss the inverse function and growth of the function |

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| ***Lesson Schedule***  *Class No. Portion covered per hour*   1. Functions-plain, One-to-one, onto functions, 2. Sterling numbers of the second kind, 3. Function composition and Inverse function, Growth of function. |

**Model Questions**

1. Determine whether or not each of the following relations is a function. If a relation is function, find its range.

a) {(x,y)|x,y ε Z, y=x2+7}, a relation from Z to Z.

b) {(x,y)|x,y ε R, y2=x}, a relation from R to R.

c) {(x,y)|x,y ε R, y=3x+1}, a relation from R to R.

d) {(x,y)|x,y ε Q,x2+ y2=1}, a relation from Q to Q.

2. Does the formula f(x)=1/(x2-2) defines a function f: R🡪R? A function f: Z🡪R?

3. If there are 2187 functions f:A🡪B and |B|=3, what is |A|?

**UNIT- V**

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| *Course Code and Title:*  **Discrete Mathematical Structures** (16CS36) | |
| *Chapter Number and Title*: *7.*   **Groups Theory** | *Planned Hours:* ***04* hrs** |

## Learning Objectives

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| **Sl. No.** | **Objectives** |
| **1** | Understand Elementary Properties |
| **2** | Understand Abelian groups, Homomorphism isomorphism |
| **3** | Explain cyclic groups, cosets |
| **4** | Discuss Lagrange’s theorem. |

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| ***Lesson Schedule***  *Class No. Portion covered per hour*   1. Definition, Examples and Elementary properties, 2. Abelian groups, Homomorphism isomorphism, 3. cyclic groups, cosets and 4. Lagrange’s theorem. |

**Model questions:**

1. Define Isomorphism, homomorphism and cyclic group with respect to group/semi group with an example.

2. Let Z be the set of all integers and T be the set of all e ven integers. Show that the semi groups (Z, +) and (T, +) are isomorphic.

3. Let G be the set of all non-zero real numbers and let a\*b = ab/2. Show that (G, \*) is an abelian group.

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| *Course Code and Title:*  **Discrete Mathematical Structures** (16CS36) | |
| *Chapter Number and Title*: *8. Coding Theory* | *Planned Hours:* ***03* hrs** |

## Learning Objectives

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| **Sl. No.** | **Objectives** |
| **1** | Discuss Elementary coding theory |
| **2** | Solve the hamming metric |
| **3** | Solve for the parity-Check and Generator Matrices |
| **4** | Represent the parity-Check and Generator Matrices |

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| ***Lesson Schedule***  *Class No. Portion covered per hour*   1. Elementary coding theory, 2. the hamming metric, 3. the parity-Check and Generator Matrices |

**Model Questions**

1. Let C be a set of code words, where C C Z27. In each of the following, two of e (error pattern), r (received word) and c (code word) are given, with r=c+e. Determine the third term.
   1. C = 1010110, r = 1011111
   2. e = 0101111, r = 0000111

2. The encoding function E: Z22 → Z25 is given by the generator matrix.

G = 1 0 1 1 0

0 1 0 1 1

Determine all code words. What can we say about the error-detection capability of this code? What about its error-correcting capacity?

**LESSON PLAN /WEEK**

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| **S. No** | **Topic** | **Sub Topic** | **No. of Hrs** | **ICT tools Used** | **Book Referred** |
|  | **Fundamental Principles of Counting and Set Theory** | The Rule of Sum and Product | 01 | Lecture(Black Board) | Ralph P. Grimaldi and B V Ramana, Discrete and Combinatorial Mathematics- An Applied Introduction, |
| Permutations, Combinations, | 01 | Lecture(Black Board |
| The Binomial Theorem, Combinations with repetition | 01 | Flipped Classroom with TPS |
| Sets and Subsets | 01 | Lecture(Black Board) |
| Set operations, Laws of set theory | 01 | Lecture(Black Board) |
| Cartesian products | 01 | Lecture ( Black Board) |
| The principles of inclusion and exclusion: Generalization of the principle | 01 | Lecture ( Black Board) |
| Derangements- Nothing is in its right place, Rook polynomials, and Arrangements with forbidden positions. | 01 | Lecture ( Black Board) |
|  | **Mathematical Induction, Recursive Definitions and Recurrence Relations** | Method of mathematical induction | 01 | Lecture (Black Board) |
| Recursive definition | 01 | Flipped class room |
| First order linear recurrence relation-Formulation problems and examples. | 01 | Lecture (PPT, Black Board) |
| First order linear recurrence relation-Formulation problems and examples. | 01 | Lecture (PPT) |
| Second order linear homogeneous recurrence relations with constant coefficients. | 01 | Lecture (PPT, Black Board) |
| The non-Homogeneous recurrence relations. The method of generating functions. | 01 | Lecture (Black Board) |
| The non-Homogeneous recurrence relations. The method of generating functions. | 01 | Lecture (Black Board) |
|  | **Language and Finite State Machine** | Set Theory of strings, | 01 | Lecture (Black Board) | Ralph P. Grimaldi and B V Ramana, Discrete and Combinatorial Mathematics- An Applied Introduction, |
| Finite State machine**,** | 01 | Lecture (PPT) | Peter Linz, An Introduction To Formal Languages & Automata, 6th Edition, Narosa Publishing House, 2007,ISBN:978-1-4496-1552-9. |
| Introduction to Finite Automata, | 01 | Lecture (PPT, Black Board) |
| Basic concepts of Automata theory, Deterministic | 01 | Lecture (PPT, Black Board) |
| Finite Automata, Non-Deterministic Finite Automata, | 01 | Lecture (Flipped Class room with problem solving) |
| Finite Automata with epsilon-transitions, | 01 | (PPT) |
| Equivalence of NFA & DFA. | 01 | Lecture (PPT) |
|  | **Relations and Functions** | Properties of relations, | 01 | Lecture (PPT, Black Board) | Ralph P. Grimaldi and B V Ramana, Discrete and Combinatorial Mathematics- An Applied Introduction, |
| Composition of Relations, | 01 | Lecture (PPT, Black Board) | Ralph P. Grimaldi and B V Ramana, Discrete and Combinatorial Mathematics- An Applied Introduction, |
| Partial Orders, Hasse Diagrams, Equivalence Relations and Partitions. | 01 | Lecture (Black Board) | Ralph P. Grimaldi and B V Ramana, Discrete and Combinatorial Mathematics- An Applied Introduction, |
| Functions-plain, One-to-one, onto functions, | 01 | Lecture (Black Board) | Ralph P. Grimaldi and B V Ramana, Discrete and Combinatorial Mathematics- An Applied Introduction, |
|  | Group Theory and Coding theory | Sterling numbers of the second kind, | 01 | Lecture (Black Board) | Ralph P. Grimaldi and B V Ramana, Discrete and Combinatorial Mathematics- An Applied Introduction, |
| Function composition and Inverse function. | 02 | Flipped Class Room Lecture with TPS activity | Ralph P. Grimaldi and B V Ramana, Discrete and Combinatorial Mathematics- An Applied Introduction, |
| Definition, Examples and Elementary properties, | 01 | Lecture (PPT) | Ralph P. Grimaldi and B V Ramana, Discrete and Combinatorial Mathematics- An Applied Introduction, |
| Abelian groups, Homomorphism isomorphism, cyclic groups,. | 01 | Lecture (PPT) | Ralph P. Grimaldi and B V Ramana, Discrete and Combinatorial Mathematics- An Applied Introduction, |
| cosets and Lagrange’s theorem | 01 | Lecture (Black Board) | Ralph P. Grimaldi and B V Ramana, Discrete and Combinatorial Mathematics- An Applied Introduction, |
| Elementary coding theory, | 01 | Lecture (Black Board) | Ralph P. Grimaldi and B V Ramana, Discrete and Combinatorial Mathematics- An Applied Introduction, |
| the hamming metric, the parity-Check and Generator  Matrices, Group Codes-decoding with coset Ladders. | 3 | Lecture (PPT) | Ralph P. Grimaldi and B V Ramana, Discrete and Combinatorial Mathematics- An Applied Introduction, |

# Evaluation Scheme

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| **Continuous Internal Evaluation (CIE)**  **( Theory – 100 Marks)** | |
| Evaluation method | Course with Self-study |
| Quiz -1 | 10 |
| Test -1 | 25 |
| Quiz -2 | 10 |
| Quiz -3 | 10 |
| Test -2 | 25 |
| Self-study (EL) | 20 |
| **Total** | **100** |

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| **Semester End Evaluation Theory (100)** | |
| **Part- –A**  **Objective type questions** | **20** |
| **Part –B**  There should be five questions from five units. Each question should be for maximum of 16 Marks.  The **UNIT-1**, **UNIT-4** and **UNIT-5** should not have any choice.  The **UNIT-2 and UNIT-3** should have an internal choice.  Both the questions should be of the same complexity in terms of COs and Bloom’s taxonomy level. | **80** |
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| **Total** | **100** |

## Course Unitization for Internals and Semester End Examination

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| **UNITS** | Teaching Hours | No. of Questions in | | | No. of Questions in SEE |
| Internals I | Internals II | Internals III |
| **UNIT – I** | 8 | 3 | - | - | 1 |
| **UNIT – II** | 7 | 2 | - | - | 1 |
| **UNIT – III** | 7 | - | 3 | - | 1 |
| **UNIT – IV** | 7 | - | 2 | - | 1 |
| **UNIT – V** | 7 | - | - | 5 | 1 |

**Faculties In-charge Head of Department**

**Course Articulation Matrix (16CS35)**

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| |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **CO-PO Mapping** | | | | | | | | | | | | | | | **CO/PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | | **CO1** | **M** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **M** | **-** | **-** | | **CO2** | **H** | **H** | **M** | **-** | **-** | **L** | **L** | **M** | **M** | **M** | **-** | **M** | | **CO3** | **M** | **H** | **L** | **L** | **-** | **-** | **-** | **-** | **L** | **H** | **-** | **M** | | **CO4** | **M** | **M** | **-** | **L** | **-** | **-** | **-** | **M** | **M** | **M** | **-** | **L** | |
| **Program Articulation Matrix**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Course - PO Mapping** | | | | | | | | | | | | | | |  | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | | **Course** | **M** | **M** | **L** | **L** | **-** | **L** | **L** | **L** | **L** | **M** | **-** | **L** | |
| |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | **CO –PSO Mapping** | | |  | **Course – PSO Mapping** | | | | **CO/PSO** | **PSO1** | **PSO2** |  | **Course** | **PSO1** | **PSO2** | | **CO1** | **-** | **-** |  | **L** | **-** | | **CO2** | **-** | **-** |  |  |  |  | | **CO3** | **L** | **-** |  |  |  |  | | **CO4** | **L** | **-** |  |  |  |  |   **CO-PSO Mapping COURSE-PSO Mapping** |

**Flipped Class Room Activity**

**Out\_of\_class Activity Design-1:**

**After watching the video student should be able to know**

* **The Binomial Theorem**
* **Combinations with repetition**
* **Functions and Inverse of a function**

**Out-of-class Activity Design – 2**

Uploaded Video URL: <https://www.youtube.com/watch?v=L9i_rVVC-4U>

License of Video: Creative common attribution License

Duration of video: V1-10.13 MIN

**In\_Class Activity: (Active Learning Strategy)**

**Think-Pair-Share (TPS) Activity:**

Domain: Discrete Mathematical Structures

Topic: Functions, Binomial Theorem, Recurssions

Target Students: BE (CSE) 3rd Sem

Think Phase -              [3 minutes]

Question: Give real time application for onto and One to One functions

What Teacher does - Poses the question, asks students to think individually and write the answer

What students do - **Thinks individually and Write down the application**

Pair Phase -                [7 minutes]

Question: Discuss your answer with your neighbor

What Teacher does - Poses the question, asks students to pair up and discuss, goes around the class to check whether students are discussing, and provides clues to pairs who are in doubt.

What students does - Pairs up with neighbor, Checks each other’s result by verifying that the application has both the function or not

Share Phase -              [5 minutes]

What Student Does – Shares the result with whole class.

What Teacher Does - **Notes down the correct answer in the board, summarizes the key concepts involved in this problem.**

**Flipped Class Room Activity Incharges:**

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| **Sl No** | **Topic** | **Faculty** |
| 1 | Relations, Composition of relations | HAS |
| 2 | Functions, Composition of Functions | PB |