INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

COMPUTER SCIENCE AND ENGINEERING

COURSE DESCRIPTOR

Course Title	**DISCRETE MATHEMATICAL STRUCTURES**				
Course Code	ACSB04				
Programme	B.Tech				
Semester	III	CSE | IT			
Course Type	Core				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Ms. K Mayuri, Assistant Professor				
Course Faculty	Mr. N V Krishna Rao, Assistant Professor Ms. N M Deepika, Assistant Professor Ms. G Nishwitha, Assistant Professor Ms. B Dhanalaxmi, Assistant Professor Ms. B Pravallika, Assistant Professor				

I. COURSEOVERVIEW:

The purpose of this course is to provide a clear understanding of the concepts that underlying fundamental concepts and tools in discrete mathematics with emphasis on their applications to computer science. It emphasizes mathematical definitions and proofs as well as applicable methods. The course contents include formal logic notation, proof methods; induction, well-ordering; sets, relations; growth of functions; permutations and combinations, counting principles, recurrence equations, trees and more general graphs.

II. COURSEPRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
-	-	-	Basic Principles of Mathematics	---

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Discrete Mathematical Structures	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONALMETHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	χ	MOOCs
✔	LCD / PPT	✔	Seminars	χ	Mini Project	✔	Videos
χ	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weight age in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	**Theory**			**Total Marks**
Type of Assessment	CIE Exam	Quiz	AAT	
CIA Marks	20	05	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz - Online Examination

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

Alternative Assessment Tool (AAT)

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning centre. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc.

VI. HOW PROGRAM OUTCOMES AREASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Assignments
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	3	Assignments
PO 3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Seminars
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	5 minutes video

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES AREASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** The ability to understand, analyze and develop computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient design of computer-based systems of varying complexity.	2	Projects
PSO 2	**Problem-Solving Skills:** The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.	3	Lectures, Assignments
PSO 3	**Successful Career and Entrepreneurship:** The ability to employ modern computer languages, environments, and platforms in creating innovative career paths to be an entrepreneur, and a zest for higher studies.	1	5 minutes video

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES:

The course should enable the students to:	
I	Describe the logical and mathematical foundations, and study abstract models of computation.
II	Illustrate the limitations of predicate logic.
III	Define modern algebra for constructing and writing mathematical proofs.
IV	Solve the practical examples of sets, functions, relations and recurrence relations.
V	Recognize the patterns that arise in graph problems and use this knowledge for constructing the trees and spanning trees.

IX. COURSE OUTCOMES(COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	To understand the concepts associated with Mathematical Logic and Predicate calculus	CLO 1	Understand logical connectives and compound prepositions for building compound statements.
		CLO 2	Learn the formal symbols and use the preposition logic and predicate logic to solve problems on logical equivalences and implications.
		CLO 3	Memorize different scientific notations to simplify the logical statements.
		CLO 4	Prepare valid arguments from the given propositional statements by using rules of inference.
CO 2	Ability to learn the basic concepts about relations, functions and to draw different diagrams like Lattice, Hasse diagrams.	CLO 5	Identify ordered pairs to form a binary relation from the given sets.
		CLO 6	Construct directed graph and a matrix representation using a binary relation on finite order pairs.
		CLO 7	Identify the properties of relations to check for equivalence relation and partial order relation and compute relations using operations on relations.
		CLO 8	Construct a hasse diagram to recognize the relevant partial ordered sets from the given binary relation.
		CLO 9	Describe the types of functions (one to one, on-to, bijective, Identity and constant function).
		CLO 10	Implement the concept of the inverse and recursive functions to get an optimized solution for an appropriate problem.
		CLO 11	Use the concept of lattices (Greatest Lower Bound (GLB) and Least Upper Bound (LUB) to represent a defined finite set in multi- dimension applications.
		CLO 12	Explain about the properties and types of lattices (bounded and distributive lattice).
CO 3	To understand the concepts of Algebraic Structures And Combinatorics .	CLO 13	Construct different algebraic structures by using concepts of groups, sub groups, monoids and rings.
		CLO 14	Understand binomial and multinomial theorems to compute the coefficients for the given expansions.
		CLO 15	Understand the concept of homomorphism and isomorphism of semi-groups.
		CLO 16	Analyze the given sets by using inclusion and exclusion principle.
		CLO 17	Identify the different counting techniques (permutations) related to mathematics and computer science.
		CLO 18	Solve discrete probability and set problems by using permutations and combinatorics.
CO 4	To describe various types of recurrence relations and the methods to find out their solutions .	CLO 19	Identify the series of expansion to represent the sequence by using generating functions.
		CLO 20	Identify the general solution for first-order and second-order linear homogeneous recurrence relations.
		CLO 21	Identify the roots of second and higher order linear non-homogeneous recurrence relations.
CO 5	To understand the basic concepts associated with Graphs and Trees.	CLO 22	Understand the use of graphs and trees as representation tools in a variety of context.
		CLO 23	Identify Euler's and Hamilton rule for a simple connected graph in NP-complete problems.
		CLO 24	Construct a spanning tree by using search techniques (Depth First Search and Breadth First Search).

		CLO 25	Construct a minimal spanning tree by using Kruskal's and Prim's algorithm in order to obtain a solution for a real time problem.
		CLO 26	Possess the knowledge and skills for employability and to succeed in national and international level competitive exams.

X. COURSE LEARNING OUTCOMES(CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
ACSB04.01	CLO 1	Understand logical connectives and compound prepositions for building compound statements.	PO 2	3
ACSB04.02	CLO 2	Learn the formal symbols and use the preposition logic and predicate logic to solve problems on logical equivalences and implications.	PO 1, PO 2	3
ACSB04.03	CLO 3	Memorize different scientific notations to simplify the logical statements.	PO 1	3
ACSB04.04	CLO 4	Prepare valid arguments from the given propositional statements by using rules of inference.	PO 2, PO 4	2
ACSB04.05	CLO 5	Identify ordered pairs to form a binary relation from the given sets.	PO 1,PO 2	3
ACSB04.06	CLO 6	Construct directed graph and a matrix representation using a binary relation on finite order pairs.	PO 2, PO 3	3
ACSB04.07	CLO 7	Identify the properties of relations to check for equivalence relation and partial order relation and compute relations using operations on relations.	PO 1,PO 2	3
ACSB04.08	CLO 8	Construct a hasse diagram to recognize the relevant partial ordered sets from the given binary relation.	PO 3	2
ACSB04.09	CLO 9	Describe the types of functions (one to one,on-to, bijective, Identity and constant function).	PO 2	3
ACSB04.10	CLO 10	Implement the concept of the inverse and recursive functions to get an optimized solution for an appropriate problem.	PO 2, PO 4	2
ACSB04.11	CLO 11	Use the concept of lattices (Greatest Lower Bound (GLB) and Least Upper Bound (LUB) to represent a defined finite set in multi-dimension applications.	PO 3	2
ACSB04.12	CLO 12	Explain about the properties and types of lattices (bounded and distributive lattice).	PO 1	3
ACSB04.13	CLO 13	Construct different algebraic structures by using concepts of groups, sub groups, monoids and rings.	PO 1, PO 3	3

ACSB04.14	CLO 14	Understand binomial and multinomial theorems to compute the coefficients for the given expansions.	PO 4	1
ACSB04.15	CLO 15	Understand the concept of homomorphism and isomorphism of semi-groups.	PO 1	3
ACSB04.16	CLO 16	Analyze the given sets by using inclusion and exclusion principle.	PO 2	3
ACSB04.17	CLO 17	Identify the different counting techniques (permutations) related to mathematics and computer science.	PO 1, PO 4	2
ACSB04.18	CLO 18	Solve discrete probability and set problems by using permutations and combinatorics.	PO 2	3
ACSB04.19	CLO 19	Identify the series of expansion to represent the sequence by using generating functions.	PO 1, PO 4	2
ACSB04.20	CLO 20	Identify the general solution for first-order and second-order linear homogeneous recurrence relations.	PO 1, PO 4	2
ACSB04.21	CLO 21	Identify the roots of second and higher order linear non-homogeneous recurrence relations.	PO 1, PO 4	2
ACSB04.22	CLO 22	Understand the use of graphs and trees as representation tools in a variety of context.	PO 2	3
ACSB04.23	CLO 23	Identify Euler's and Hamilton rule for a simple connected graph in NP-complete problems.	PO 1, PO 2	3
ACSB04.24	CLO 24	Construct a spanning tree by using search techniques (Depth First Search and Breadth First Search).	PO 2, PO 3	3
ACSB04.25	CLO 25	Construct a minimal spanning tree by using Kruskal's and Prim's algorithm in order to obtain a solution for a real time problem.	PO 2, PO 3	3
ACSB04.26	CLO 26	Possess the knowledge and skills for employability and to succeed in national and international level competitive exams.	PO 1, PO 4	2

3 = High; 2 = Medium; 1 = Low

XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes(POs)				Program Specific Outcomes (PSOs)		
	PO 1	PO 2	PO 3	PO 4	PSO1	PSO2	PSO3
CO 1	3	2				3	
CO 2	2				2		
CO 3	3	3	1			3	
CO 4	2	2	2	1	2		1
CO 5	3		3	1		2	1

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XII. MAPPING COURSE LEARNING OUTCOMES LEADING TO THEACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFICOUTCOMES:

(CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1		3											2	3	
CLO 2	3	3												3	
CLO 3	3													3	1
CLO 4		3		1										3	
CLO 5	3	3											2		
CLO 6		3	2											3	1
CLO 7	3	3											2		
CLO 8			2											3	
CLO 9		3											2		1
CLO 10		3		1										3	
CLO 11			2										2		1
CLO 12	3												2	3	
CLO 13	3		2											3	1
CLO 14				1									2	3	
CLO 15	3													3	
CLO 16		3											2		1
CLO 17	3			1										3	
CLO 18		3											2		
CLO 19	3			1									2		1
CLO 20	3			1										3	
CLO 21	3			1											1
CLO 22		3											2		
CLO 23	3	3												3	
CLO 24		3	2										2		1
CLO 25		3	2											3	
CLO 26	3			1											1

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XIII. ASSESSMENT METHODOLOGIES –DIRECT

CIE Exams	PO 1, PO 2, PO 3, PO 4, PSO 1, PSO 2, PSO 3	SEE Exams	PO 1, PO 2, PO 3,PO 4, PSO 1,PSO 2, PSO 3	Assignments	PO 1, PO 2, PSO 2	Seminars	PO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XIV. ASSESSMENT METHODOLOGIES -INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XV. SYLLABUS

MODULE I	MATHEMATICAL LOGIC AND PREDICATES
Mathematical logic: Statements and notations, connectives, well-formed formulas, truth tables, tautology, equivalence implication; Normal forms: Disjunctive normal forms, conjunctive normal forms, principle disjunctive normal forms, principle conjunctive normal forms. **Predicate calculus:** Predicative logic, statement functions, variables and quantifiers, free and bound variables, rules of inference, consistency, proof of contradiction, automatic theorem proving.	
MODULE II	**RELATIONS, FUNCTIONS AND LATTICES**
Relations: Properties of binary relations, equivalence, compatibility and partial ordering relations, lattices, Hasse diagram; **Functions:** Inverse function, composition of functions, recursive functions. **Lattices:** Lattices as partially ordered sets; Definition and examples, properties of lattices, sub lattices, some special lattices.	
MODULE III	**ALGEBRAIC STRUCTURES AND COMBINATORICS**
Algebraic structures: Algebraic systems, examples and general properties, semi groups and monoids, groups, sub groups, homomorphism, isomorphism, rings. **Combinatory:** The fundamental counting principles, permutations, disarrangements, combinations, permutations and combinations with repetitions, the binomial theorem, multinomial theorem, generalized inclusion exclusion principle.	
MODULE IV	**RECURRENCE RELATION**
Recurrence relation: Generating functions, function of sequences calculating coefficient of generating function, recurrence relations, solving recurrence relation by substitution and generating functions, characteristics roots solution of homogeneous recurrence relation.	
MODULE V	**GRAPHS AND TREES**
Graphs: Basic concepts of graphs, isomorphic graphs, Euler graphs, Hamiltonian graphs, planar graphs, graph coloring, digraphs, directed acyclic graphs, weighted digraphs, region graph, chromatic numbers **Trees:** Trees, spanning trees, minimal spanning trees.	
Text Books:	
1. J. P. Tremblay, R. Manohar, "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw Hill, India, 1st Edition, 1997. 2. Joe L. Mott, Abraham Kandel, Theodore P. Baker, "Discrete Mathematics for Computer Scientists and Mathematics", Prentice Hall of India Learning Private Limited, New Delhi, India, 2nd Edition, 2010.	
Reference Books:	
1. Kenneth H. Rosen, "Discrete Mathematics and Its Applications", Tata Mcgraw-Hill, NewDelhi, India, 6th Edition, 2012. 2. DSChandrashekaraiah,"MathematicalFoundationsofComputerScience(DiscreteStructures)", Prism Books Pvt. Ltd., 2nd Reprint,2007.	

3. C.L.Liu, D.P.Mohapatra, "ElementsofDiscreteMathematics", TataMcgraw-Hill, India, 3rd Edition, 2008.
4. RalphP.Grimaldi, B.V.Ramana,"Discreteand Combinatorial Mathematics-AnApplied Introduction", Pearson Education, India, 5th Edition,2011.
5. D. S. Malik, M. K. Sen, "Discrete Mathematical Structures: Theoryand Applications",Thomson Course Technology, India, 1st Edition,2004.

XVI. COURSEPLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-3	Interpret statements and notations, connectives	CLO 1	T1:1.1, 1.2
4-6	Build well-formed formulas, truth tables, tautology	CLO 2	T1: 1.2.7, 1.2.8
7	Define equivalence implications, DNF, CNF, PDNF, and PCNF.	CLO 3	T1:1.2.9, 1.2.11, 1.3
8 – 14	Illustrate predicative logic, statement functions, variables and quantifiers, free and bound variables, rules of inference, consistency	CLO 4	T1:1.5, 1.4.2, 1.4.3
15-20	Recall proof of contradiction, automatic theorem proving, properties of binary relations, equivalence, transitive closure, Compatibility and partial ordering relations.	CLO4, CLO5, CLO 6	T1:1.4.3, 1.4.4, 2.3.1, 2.3.2
21-25	Construct Lattices, Hasse diagram, and inverse function composition of functions, recursive functions, Lattices as partially ordered sets; Definition and examples, properties of lattices, lattices as algebraic systems, sub lattices, direct product and homomorphism, some special lattices.	CLO8, CLO9, CLO10	R2:4.3 T1:2.4.1, 2.4.2, 2.4.3, 4.1
26-29	Demonstrate Algebraic systems, examples and general properties, semi groups and monoids, groups and subgroups, homomorphism, isomorphism, rings.	CLO 13	T1:3.1,3.2 R2:6.2-6.8
30-35	Apply the fundamental counting principles, permutations, disarrangements, combinations, permutations and combinations with repetitions, the binomial theorem, multinomial theorem, generalized inclusion exclusion principle.	CLO14, CLO15, CLO16, CLO18	R2: 7.1-7.6
36-38	Describe generating functions, function of sequences calculating coefficient of generating function.	CLO 19	R2:8.1
39-44	Solve recurrence relations, solving recurrence relation by substitution and generating funds, Characteristics roots solution of homogeneous recurrence relation	CLO20, CLO21	R2:8.2, 8.3
45-48	Define basic concepts of graphs, isomorphic graphs.	CLO 22	R2: 9.1-9.3
49-54	Describe Euler graphs, Hamiltonian graphs, planar graphs, graph coloring.	CLO 23	R2: 9.8, 9.9, 10.1,10.2
55-59	Describe digraphs, directed acyclic graphs, weighted digraphs, region graph, and chromatic numbers.	CLO 23	T2:5.5, 5.9, 5.10
60	Define trees, spanning trees, minimal spanning trees.	CLO24, CLO25	R2:10.4, 10.6,10.7

XVII.GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSIONREQUIREMENTS:

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Modular arithmetic, RSA algorithm	Seminars / NPTEL	PO 1, PO 2	PSO 1
2	Pigeon hole principle, vector implementation of sets, cardinality of finite sets Peano postulates	Seminars / NPTEL	PO 2	PSO 2
3	Encourage students to do innovate problems with real time examples	NPTEL	PO 1,PO 3	PSO 2

Prepared by:
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