INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE AND ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE**			
Course Code	**A30504**			
Regulation	**R13 - JNTUH**			
Course Structure	Lectures	Tutorials	Practicals	Credits
	4	-	-	4
Course Coordinator	Mr. Y Subba Rayudu, Assistant Professor, CSE			
Team of Instructors	Ms. E Uma Shankari, Assistant Professor, CSE			

I. COURSE OVERVIEW:

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. PREREQUISITE(S):

Level	Credits	Periods/ Week	Prerequisites
UG	4	4	Basic Mathematics, Computer Fundamentals

III. MARKS DISTRIBUTION:

Sessional Marks	University End Exam marks	Total marks
Midterm Test There shall be two midterm examinations. Each midterm examination consists of essay paper, objective paper and assignment. The essay paper is for 10 marks of 60 minutes duration and shall contain 4 questions. The student has to answer 2 questions, each carrying 5 marks. The objective paper is for 10 marks of 20 minutes duration. It consists of 10 multiple choice and 10 fill-in-the blank questions, the student has to answer all the questions and each carries half mark. First midterm examination shall be conducted for the first two and half units of syllabus and second midterm examination shall be conducted for the remaining portion. Five marks are earmarked for assignments. There shall be two assignments in every theory course. Assignments are usually issued at the time of commencement of the semester. These are of problem solving in nature with critical thinking.	75	100

Sessional Marks	University End Exam marks	Total marks
Marks shall be awarded considering the average of two midterm tests in each course.		

IV. EVALUATION SCHEME:

S. No	Component	Duration	Marks
1.	I Mid Examination	80 minutes	20
2.	I Assignment	-	5
3.	II Mid Examination	80 minutes	20
4.	II Assignment	-	5
5.	External Examination	3 hours	75

V. COURSE OBJECTIVES:

At the end of the course, the students will be able to:

I. Be familiar with the basic terminology of functions, relations, and sets and demonstrate knowledge of their associated operations.
II. Be familiar with the practical applications the use of basic counting principles of permutations, combinations, inclusion/exclusion principle and the pigeonhole methodology.
III. Master to solve advanced mathematical problems, apply various methods of mathematical proof, and communicate solutions in writing.
IV. Master to comprehend advanced mathematics, and present the material orally and in writing.
V. Be familiar with the graph theory basics in solving computer science problems.

VI. COURSE OUTCOMES:

After completing this course the student must demonstrate the knowledge and ability to:

1. **Apply** logic expressions for a variety of applications.
2. **Visualize** data numerically and/or graphically.
3. **Evaluate** mathematical principles and logic design.
4. **Understand a**nd be able to use the notions of propositions and predicate formulae, satisfiability, and formal proof.
5. **Apply** logical reasoning to solve a variety of problems to build an Expert System.
6. **Apply**, adapt, and design elementary deterministic and randomized algorithms to solve computational problems.
7. **Illustrate** the knowledge of mathematical modeling.
8. **Demonstrate** effectively mathematical ideas/results verbally or in writing.
9. **Utilize** the knowledge of computing and mathematics appropriate to the discipline.
10. **Understand** the functions concepts and distinguish different types of functions.
11. **Identify** and describe various types of relations.
12. **Develop** the ability to solve the recurrence relations by using various methods.
13. 13. **Explain** trees and graphs to formulate computational problems.

VII. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Level	Proficiency assessed by
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	H	Assignments, Tutorials
PO2	**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.	H	Assignments Tutorials
PO3	**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.	S	Assignments
PO4	**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.	S	Assignments
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	S	Assignments
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	N	--
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	N	--
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	N	--
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	N	--
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	N	--
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	N	--
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	S	Assignments

N - None **S - Supportive** **H - Highly Related**

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Level	Proficiency assessed by
PSO1	**Professional Skills:** The ability to research, understand and implement computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient analysis and design of computer-based systems of varying complexity.	H	Lectures, Assignments
PSO2	**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.	H	Tutorials
PSO3	**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.	S	Guest Lectures

N - None **S - Supportive** **H - Highly Related**

IX. SYLLABUS:

UNIT-I

Mathematical Logic: Statements and notations, Connectives, Well-formed formulas, Truth Tables, tautology, equivalence implication, Normal forms, Quantifiers, universal quantifiers.

Predicates: Predicative logic, Free &Bound variables, Rules of inference, Consistency, proof of contradiction, Automatic Theorem Proving.

UNIT – II

Relations: Properties of Binary Relations, equivalence, transitive closure, compatibility and partial ordering relations, Lattices, Hasse diagram. Functions: Inverse Function Composition of functions, recursive Functions, Lattice and its Properties.

Algebraic structures: Algebraic systems Examples and general properties, Semi groups and monads, groups sub groups' homomorphism, Isomorphism.

UNIT – III

Elementary Combinatorics: Basis of counting, Combinations & Permutations, with repetitions, Constrained repetitions, Binomial Coefficients, Binomial Multinomial theorems, the principles of Inclusion – Exclusion. Pigeonhole principles and its application.

UNIT – IV

Recurrence Relation: Generating Functions, Function of Sequences Calculating Coefficient of generating function, Recurrence relations, Solving recurrence relation by substitution and Generating funds. Characteristics roots solution of in homogeneous Recurrence Relation

UNIT – V

Graph Theory: Representation of Graph, DFS, BFS, Spanning Trees, and planar Graphs. Graph Theory and Applications, Basic Concepts Isomorphism and Sub graphs, Multi graphs and Euler circuits, Hamiltonian graphs, Chromatic Numbers.

Text books:

1. C L Liu, D P Mohapatra, "Elements of Discrete Mathematics- A Computer Oriented Approach", 3e, Tata McGraw Hill.
2. J. L. Mott, A. Kandel, T.P. Baker, "Discrete Mathematics for Computer Scientists & Mathematicians", PHI .

References:

1. Kenneth H. Rosen, "Discrete Mathematics and its Applications", 5e, TMH.
2. Malik and Sen, "Discrete Mathematical structures Theory and application", Cengage Learmomg.
3. Thomas Koshy, "Discrete Mathematics with Applications", Elsevier.
4. Grass Man and Trembley, "Logic and Discrete Mathematics", Pearson Education.

X. COURSE PLAN:

At the end of the course, the students are able to achieve the following course learning outcomes:

Lecture No.	Topics to be covered	Course Learning Outcomes	Reference
1 – 3	Statements and notations, connectives	**Interpret t**he mathematical statements and notations	T1:1.16,1.17
4 – 6	Well-formed formulas, truth tables, tautology	**Build** well-formed formulas of Truth Tables	T1:1.11,1.12
7	Equivalence implications, DNF, CNF, PDNF, PCNF, universal quantifiers, existential quantifiers.	**Define** and illustrate normal forms and quantifiers.	T1:1.13,1.14, 1.16,1.17
8 – 14	Predicative logic, free and bound variables, rules of inference, consistency	**Illustrate** the rules of inference and predicate logic	T1:1.15 -1.18
15 – 20	Proof of contradiction, automatic theorem proving, properties of binary relations, equivalence, transitive closure, compatibility and partial ordering relations	**Recall** automatic theorem and outline relations	T1:1.14, 3.1,3.3 – 3.8, 3.10,3.11
21 – 25	Lattices, Hasse diagram inverse function composition of functions, recursive functions lattice and its properties	**Construct** real situations using lattices and functions	T1:3.11 -3.15
26 – 29	Algebraic systems, examples and general properties, semi groups and monads, groups and subgroups.	**Demonstrate** the properties of algebraic systems and groups	T1:10.1-10.3, 10.8-10.10
30 – 35	Permutations, with repetitions, constrained repetitions, binomial coefficients binomial multinomial theorems, the principles of inclusion – exclusion pigeonhole principles and its application	**Apply** and calculate permutations and combinations.	T1:2.2-2.6, 3.16 T2:2.6-2.8
36 – 38	Generating functions, function of sequences calculating coefficient of generating function.	**Describe** the relationship between sequences and generating function	T2:3.1-3.3
39 – 44	Recurrence relations, solving recurrence relation by substitution and generating funds, Characteristics roots solution of In homogeneous Recurrence Relation	**Solve** first, second and n^{th} order recurrence relations and systems using appropriate generating functions	T2:3.3-3.5
45 – 48	Representation of graph, DFS, BFS, spanning trees, planar graphs	**Demonstrate** trees and graphs	T2:3.5,3.6, 5.6,5.7, 4.14,4.15
49 – 54	Graph theory and applications, basic concepts isomorphism and sub graphs	**Describe** and implement the algorithms to find the components of a graph and the strongly connected components of a digraph.	T2:5.2,5.3
55 – 59	Multi graphs, Euler circuits, Hamiltonian graphs	**Describe** and implement Algorithms for finding an Euler trail and Hamiltonian in a graph or digraph	T2:4.3,4.4, 4.10-4.12
60 – 62	Chromatic numbers	**Explain** chromatic numbers	T2:4.15

XI. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I	H	H											H	H	H
II	H	S	S										S	H	S
III	S	H	S										H	S	H
IV	S	S	H	S									H	H	H
V	H	S	H	S									H	S	H

S – Supportive **H - Highly Related**

XII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	H	H	S	H									H	H	H
2	S	H	S										S	S	H
3	H	S	H	H	S								H	H	H
4	H	H	H										H	H	H
5	S	H	H	H									S	S	H
6	H	H	H	H	S								H	S	
7	S	S	H	H									S	H	
8	S	H	H	S									H	S	
9		S											S	H	
10	H	S	H	S									S	H	S
11	H	H	H										H	S	
12	S	S	H	H									S	H	
13	S	H	H	S									H	S	

S – Supportive **H - Highly Related**

Prepared by **:** Mr. Y Subba Rayudu, Assistant Professor, CSE

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