INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)

Dundigal, Hyderabad -500 043

COMPUTER SCIENCE AND ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**DESIGN AND ANALYSIS OF ALGORITHMS**			
Course Code	A40508			
Regulation	R15			
Course Structure	Lectures	Tutorials	Practicals	Credits
	4	1	-	4
Course Coordinator	Mr. Y Subba Rayudu			
Team of Instructors	Dr. L V Narasimha Prasad Professor, Mr. Y Subba Rayudu Assistant Professor Mrs. G.Vasavi Assistant Professor			

I. COURSE OVERVIEW:

The primary objective of this course is to introduce the concept of algorithm as a precise mathematical concept, and study how to design algorithms, establish their correctness, study their efficiency and memory needs. The course consists of a strong mathematical component in addition to the design of various algorithms.

II. PREREQUISITES:

Level	Credits	Periods / Week	Prerequisites
UG	4	5	Basic Data Structures, Basic discrete mathematics.

III. COURSE ASSESSMENT METHODS:

Session Marks	University End Exam Marks	Total Marks

Mid Semester Test There shall be two midterm examinations. Each midterm examination consists of subjective type and objective type tests. The subjective test is for 10 marks of 60 minutes duration. Subjective test of shall contain 4 questions; the student has to answer 2 questions, each carrying 5 marks. The objective type test is for 10 marks of 20 minutes duration. It consists of 10 Multiple choice and 10 objective type 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. **Assignment** Five marks are earmarked for assignments. There shall be two assignments in every theory course. Marks shall be awarded considering the average of two assignments in each course.	75	100

IV. EVALUATION SCHEME:

S. No	Component	Duration	Marks
1	I Mid Examination	90 minutes	20
2	I Assignment	-	5
3	II Mid Examination	90 minutes	20
4	II Assignment	-	5
5	External Examination	3 hours	75

V. COURSE OBJECTIVES:

1. **Calculate** performance of algorithms with respect to time and space complexity.
2. **Illustrate** the graph traversals and tree traversals to solve the problems.
3. **Demonstrate** the concepts greedy method and dynamic programming for several applications like knapsack problem, job sequencing with deadlines, and optimal binary search tree, TSP.
4. **Apply** the methods of backtracking and branch bound techniques to solve the problems like n-queens problem, graph coloring and TSP respectively.
5. **Understand** the concept of deterministic and non-deterministic algorithms.

VI. COURSE OUTCOMES:

1. **Analyze** the running time and space complexity of algorithms.
2. **Use** the mathematical techniques required to prove the time complexity of a program/algorithm and understand tree traversals, Graph traversals and spanning trees.
3. **Apply** divide and conquer to binary search, quick sort, merge sort, strassens matrix multiplication.
4. **Apply** greedy method to knapsack problem, job sequencing with deadlines, prims, kruskal algorithms.
5. **Apply** dynamic programming to optimal binary search trees,0/1 knapsack problem, All pairs shortest path problem etc.

6. **Apply** Backtracking ton-queen problem, sum of subsets problem, graph coloring and branch and bound to Travelling sales person problem, 0/1 knapsack problem etc.
7. **Describe** the notions of P, NP, NP-complete, and NP-hard.

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
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	Mini Projects
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	Projects
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	Mini Projects
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	Projects

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	Projects
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

Introduction: Algorithm, Pseudo code for expressing algorithms, Performance Analysis-Space complexity, Time complexity, Asymptotic Notation- Big oh notation, Omega notation, Theta notation and Little oh notation, Probabilistic analysis, Amortized complexity
Divide and conquer: General method, applications-Binary search, Quick sort, Merge sort, Strassen's matrix multiplication.

UNIT II

Searching and traversal techniques: Efficient non-recursive binary tree traversal algorithms, Disjoint set operations, union and find algorithms, spanning trees, Graph traversals-Breadth first search, Depth first search, AND/OR Graphs, game trees, connected components, Bi-connected components.

UNIT III

Greedy method: General method, applications-Job sequencing with deadlines, 0/1 knapsack problem, Minimum cost spanning trees, Single source shortest path problem.
Dynamic Programming: General method, applications-Multi stage Graphs, Optimal binary search trees, 0/1 knapsack problem, All pairs shortest path problem, Travelling sales person problem, Reliability design.

UNIT IV

Backtracking: General method, applications-n-queen problem, sum of subsets problem, graph coloring, Hamiltonian cycles.
Branch and Bound: General method, applications - Travelling sales person problem,0/1 knapsack problem-LC Branch and Bound solution, FIFO Branch and Bound solution.

UNIT V

NP-Hard and NP-Complete problems: Basic concepts, Non-deterministic algorithms, NP - Hard and NP Complete classes, NP Hard problems, Cook's theorem.

TEXT BOOKS:

1. Fundamentals of Computer Algorithms, 2 nd edition Ellis Horowitz, Satraj Sahni and Sanguthevar Rajasekharan.
2. Foundations of algorithms,4 th edition,R.Neapolitan and K.jones and Barlett Learning
3. Design analysis of an algorithms ,P.H.Dave,H.B.Dave Pearson education 2008

REFERENCES:

1. Introduction to the Design And Analysis of Algorithms A Levitin pearson education

2. Algorithm Design foundations Analysis and Internet examples, M.T.Goodrich and R Tomassia john wileyn and sons
3. Computer algorithms introduction to design and analysis 3e Sara base, Allen, van, Gelder, Pearson edition

X. COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Lecture No	Course Learning Outcomes	Topics to be covered	Reference
1	**Define** an algorithm and express into pseudo code	Algorithm, Pseudo code for expressing algorithm	T1:1.1-1.2
2-5	**Define** space and time complexity and Calculate performance	Space complexity, time complexity Asymptotic Notation- Big oh notation, Omega notation, Theta notation and Little oh notation	T1:1.3
6-7	**Define** probabilistic and amortized analysis	Probabilistic analysis, Amortized complexity	T1: 1.4
8-15	**Define** Divide and Conquer. Illustrate with examples those can be solved by using divide and conquer.	Divide and conquer – general method applications Binary search, Quick sort, Merge sort, Strassen's matrix multiplication	T1:3.1,3.3, T1:3.5-3.6, T1:3.8
16-17	**Illustrate** different tree traversal	non-recursive binary tree traversal	T1 :6.1
18-19	**Explain** sets, operations	Disjoint set operations, union and find algorithms	T1: 2.5
20-22	**Illustrate** spanning trees, DFS,BFS traversals	spanning trees, Graph traversals-Breadth first search, Depth first search	T1: 6.2
23-24	**Demonstrate** AND/OR graphs, Game trees	AND/OR graphs, Game trees	T1:11.3
25-26	**Explaining** Connected components, Bi-connected components	Connected components, Bi-connected components	T1: 6.3,6.4
27-32	**Define** greedy method and Demonstrate examples where greedy method can be applied.	Greedy Method: applications Job sequencing with deadlines, 0/1 knapsack problem Minimum cost spanning trees, Single source shortest path problem	T1: 4.1 T1:4.3,4.5 T1:4.6,4.9
33-43	**Define** dynamic programming Demonstrate examples where Dynamic Programming can be applied.	Dynamic Programming: General method, applications Multi stage Graphs, Optimal binary search trees ,0/1 knapsack problem, All pairs shortest path problem, Travelling sales person problem, Reliability design	T1:5.1-5.3 T1:5.5 T1:5.7-5.9
44-51	**Define** backtracking Demonstrate examples where backtracking can be applied	Backtracking: General method, applications n-queen problem, sum of subsets problem graph coloring,Hamiltonian cycles	T1: 7.1-7.5
52-59	**Define** Branch and Bound Demonstrate examples where Dynamic Programming can be applied.	Branch and Bound: General method, applications : Travelling sales person problem0/1 knapsack problem- LC Branch and Bound solution FIFO Branch and Bound solution	T1: 8.1-8.3
60	**Define** NP-Hard and NP-Complete problems	NP-Hard and NP-Complete problems Basic concepts	T1:11.1
61-63	**Distinguish** non-deterministic	non-deterministic algorithms, NP - Hard	T1:11.1,11.

Lecture No	Course Learning Outcomes	Topics to be covered	Reference
	and deterministic algorithms	and NP Complete classes NP Hard problems	
64-65	**Demonstrate** Cook's theorem	Cook's theorem	T1:11.2

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

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
I	H	H										S	H	S	
II	H	H	S										H	S	
III	H	H	S	S									S	H	
IV	H	S											H	S	
V	S	H		S	S								H		

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XII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM 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	S	S										H	S	
2	H			S									S	H	
3	S	H	S		S								H	S	
4	H	H											H		
5	H	H	S										S		
6	H		S									S	H	S	
7	S	S											S		

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