INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

COMPUTER SCIENCE AND ENGINEERING

COURSE DESCRIPTOR

Course Title	**DESIGN AND ANALYSIS OF ALGORITHMS**				
Course Code	AITB05				
Programme	B.Tech				
Semester	IV	CSE | IT			
Course Type	Core				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	1.5
Chief Coordinator	Ms. G Geetha,Assistant Professor				
Course Faculty	Dr. K Suvarchala, AssociateProfessor Ms. E Uma shankari, Assistant Professor Ms. G Srileka, 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. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	ACSB01	II	Programming for problem solving	3
UG	ACSB03	III	Data Structures	3

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Design and Analysis of Algorithms	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✘	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	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 weightage 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 ARE ASSESSED:

Program Outcomes (POs)		Strength	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.	3	Assignments / Laboratory practices / AAT
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	3	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.	2	Seminars / Term Paper / 5 minutes video
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.	2	5 minutes Video/ Seminars

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**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.	3	Lectures,Assignments
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	Projects
PSO 3	**Successful Career and Entrepreneurship:** The ability to employ modern computer languages, environments, and platforms in creating innovative	2	Guest Lectures

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
	career paths, to be an entrepreneur, and a zest for higher studies.		

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES :

The course should enable the students to:	
I	Assess how the choice of data structures and algorithm design methods impacts the performance of programs.
II	Solve problems using data structures such as binary search trees, and graphs and writing programs for these solutions.
III	Choose the appropriate data structure and algorithm design method for a specified application.
IV	Solve problems using algorithm design methods such as the greedy method, divide and conquer, dynamic programming, backtracking, and branch and bound and writing programs for these solutions.

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Understand the concept of pseudo code for writing an algorithm and acquire ability to analyze the asymptotic performance of various algorithms	CLO 1	Describe Pseudo code for expressing algorithms.
		CLO 2	Summarize the concept of Space complexity, time complexity.
		CLO 3	Describe Big O notation, omega notation, theta notation, little o notation and amortized complexity.
		CLO 4	Use the concept of Divide and Conquer such as general method, binary search, quick sort.
		CLO 5	Describe the concept of merge sort, Strassen's matrix multiplication.
CO 2	Explore the concept of trees and graphs and get familiarity of analysis of various graph, tree traversal algorithms.	CLO 6	Determine disjoint set operations, union and find algorithms.
		CLO 7	Understand efficient non recursive binary tree traversal algorithms.
		CLO 8	Describe the concept of spanning trees with suitable examples.
		CLO 9	Use breadth first search and depth first search graph traversals.
		CLO 10	Describe connected components, biconnected components.
CO 3	Understand algorithm designing techniques such as Greedy approach Dynamic programming and explore to various related application problems.	CLO 11	Understand general method of greedy method, job sequencing with deadlines, knapsack problem.
		CLO 12	Analyze the concept of minimum cost spanning trees, single source shortest paths.
		CLO 13	Describe general method of dynamic programming, matrix chain multiplication.
		CLO 14	Understand optimal binary search trees, 0/1 knapsack problem, single source shortest paths.

COs	Course Outcome	CLOs	Course Learning Outcome
		CLO 15	Define all pairs shortest paths problem, the travelling salesperson problem.
CO 4	Synthesize efficient algorithm design paradigms back tracking , Branch & Bound in solving common analytical problems.	CLO 16	Discuss the concept of Backtracking, the 8 queens problem.
		CLO 17	Understand sum of subsets problem, graph coloring.
		CLO 18	Summarize the concept of Hamiltonian cycles, Branch and bound.
		CLO 19	Discuss 0/1 knapsack problem, least cost branch and bound solution.
		CLO 20	Apply the concept of first in first out branch and bound solution, travelling salesperson problem.
CO 5	Understand the variations among tractable and intractable problems and able to classify P and NP classes.	CLO 21	Knowledge about basic concepts of NP Hard and NP Complete, Non-deterministic algorithms.
		CLO 22	Apply Working with the classes NP - Hard and NP.
		CLO 23	Understand NP Hard problems, clique decision problem.
		CLO 24	Implement chromatic number decision problem.
		CLO 25	Discuss Cook's theorem in NP Hard and NP Complete problems.

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
AITB05.01	CLO 1	Describe Pseudo code for expressing algorithms.	PO1	3
AITB05.02	CLO 2	Summarize the concept of Space complexity, time complexity.	PO2	3
AITB05.03	CLO 3	Describe Big O notation, omega notation, theta notation, little o notation and amortized complexity.	PO2	3
AITB05.04	CLO 4	Use the concept of Divide and Conquer such as general method, binary search, quick sort.	PO2	3
AITB05.05	CLO 5	Describe the concept of merge sort, Strassen's matrix multiplication.	PO1, PO2	3
AITB05.06	CLO 6	Determine disjoint set operations, union and find algorithms.	PO2	3
AITB05.07	CLO 7	Understand efficient non recursive binary tree traversal algorithms.	PO2, PO3	2
AITB05.08	CLO 8	Describe the concept of spanning trees with suitable examples.	PO2	3
AITB05.09	CLO 9	Use breadth first search and depth first search graph traversals.	PO3	2
AITB05.10	CLO 10	Describe connected components, biconnected	PO2, PO3	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
		components.		
AITB05.11	CLO 11	Understand general method of greedy method, job sequencing with deadlines, knapsack problem.	PO2	3
AITB05.12	CLO 12	Analyze the concept of minimum cost spanning trees, single source shortest paths.	PO2, PO4	2
AITB05.13	CLO 13	Describe general method of dynamic programming, matrix chain multiplication.	PO2, PO4	3
AITB05.14	CLO 14	Understand optimal binary search trees, 0/1 knapsack problem, single source shortest paths.	PO2	3
AITB05.15	CLO 15	Define all pairs shortest paths problem, the travelling salesperson problem.	PO2, PO3	3
AITB05.16	CLO 16	Discuss the concept of Backtracking, the 8 queens problem.	PO1, PO2,	3
AITB05.17	CLO 17	Understand sum of subsets problem, graph coloring.	PO1, PO2,	3
AITB05.18	CLO 18	Summarize the concept of Hamiltonian cycles, Branch and bound.	PO2	3
AITB05.19	CLO 19	Discuss 0/1 knapsack problem, least cost branch and bound solution.	PO2	3
AITB05.20	CLO 20	Apply the concept of first in first out branch and bound solution, travelling salesperson problem.	PO1, PO2,	3
AITB05.21	CLO 21	Knowledge about basic concepts of NP Hard and NP Complete, Non-deterministic algorithms.	PO1, PO4	2
AITB05.22	CLO 22	Apply Working with the classes NP - Hard and NP.	PO4	2
AITB05.23	CLO 23	Understand NP Hard problems, clique decision problem.	PO1	3
AITB05.24	CLO 24	Implement chromatic number decision problem.	PO2	3
AITB05.25	CLO 25	Discuss Cook's theorem in NP Hard and NP Complete problems.	PO1	2

3= High; 2 = Medium; 1 = Low

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

Course Outcomes (COs)		Program Outcomes (POs)					
	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3
CO1	3	3			2	2	
CO2	3	3	2		2	2	
CO3		3	2	2	2	2	
CO4	3	3			2	2	
CO5	3	3		2		3	3

3= High; 2 = Medium; 1 = Low

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

Course Learning Outcomes (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												3		
CLO 2		3											3		
CLO 3		3												3	
CLO 4		3											3		
CLO 5	3	3											3		
CLO 6		3													
CLO 7		3	2											3	
CLO 8		3											3		
CLO 9			2												
CLO 10		3	2											3	
CLO 11		3												3	
CLO 12		3		2									3		
CLO 13		3		2										3	
CLO 14		3												3	
CLO 15		3	2										3	3	
CLO 16	3	3												3	
CLO 17	3	3	2											3	
CLO 18		3												3	
CLO 19		3											3		
CLO 20	3	3												3	
CLO 21	3			2											
CLO 22				2											
CLO 23	3														
CLO 24		3												3	
CLO 25	3														2

3 = High; 2 = Medium; 1 = Low

XIII. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1, PO2, PO3, PO4, PSO1,PSO 2,PSO3	SEE Exams	PO1, PO2, PO3,PO4, PSO1, PSO2, PSO3	Assignments	PO1,PO2, PSO1	Seminars	PO3,PO4
Laboratory Practices	PO1	Student Viva	-	Mini Project	PS02	Certification	-
Term Paper	PO3						

XIV. ASSESSMENT METHODOLOGIES – INDIRECT

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

XV. SYLLABUS

Module-I	**INTRODUCTION**
Algorithm: Pseudo code for expressing algorithms; Performance analysis: Space complexity, time complexity; Asymptotic notations: Big O notation, omega notation, theta notation and little o notation, amortized complexity; Divide and Conquer: General method, binary search, quick sort, merge sort, Strassen's matrix multiplication.	
Module-II	**SEARCHING AND TRAVERSAL TECHNIQUES**
Disjoint set operations, union and find algorithms; Efficient non recursive binary tree traversal algorithms, spanning trees; Graph traversals: Breadth first search, depth first search, connected components, biconnected components.	
Module-III	**GREEDY METHOD AND DYNAMIC PROGRAMMING**
Greedy method: The general method, job sequencing with deadlines, knapsack problem, minimum cost spanning trees, single source shortest paths. Dynamic programming: The general method, matrix chain multiplication optimal binary search trees, 0/1 knapsack problem, single source shortest paths, all pairs shortest paths problem, the travelling salesperson problem.	
Module-IV	**BACKTRACKING AND BRANCH AND BOUND**
Backtracking: The general method, the 8 queens problem, sum of subsets problem, graph coloring, Hamiltonian cycles; Branch and bound: The general method, 0/1 knapsack problem, least cost branch and bound solution, first in first out branch and bound solution, travelling salesperson problem.	
Module-V	**NP-HARD AND NP-COMPLETE PROBLEMS**
Basic concepts: Non-deterministic algorithms, the classes NP - Hard and NP, NP Hard problems, clique decision problem, chromatic number decision problem, Cook's theorem.	
Text Books:	
1. Ellis Horowitz, Satraj Sahni, Sanguthevar Rajasekharan, —Fundamentals of Computer Algorithms, Universities Press, 2nd Edition, 2015. 2. Alfred V. Aho, John E. Hopcroft, Jeffrey D, —The Design And Analysis Of Computer Algorithms, Pearson India, 1st Edition, 2013.	
Reference Books:	

1. Levitin A, ―Introduction to the Design and Analysis of Algorithms‖, Pearson Education, 3rd Edition, 2012.
2. Goodrich, M. T. R Tamassia, ―Algorithm Design Foundations Analysis and Internet Examples‖, John Wileyn and Sons, 1st Edition, 2001.
3. Base Sara Allen Vangelder, ―Computer Algorithms Introduction to Design and Analysis‖, Pearson, 3rd Edition, 1999.

XVI. COURSE PLAN:

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	Describe Pseudo code for expressing algorithms.	CLO 1	T1:1.1,1.2
2-3	Summarize the concept of Space complexity, time complexity.	CLO 2	T1:1.3
4-6	Describe Big O notation, omega notation, theta notation, little o notation and amortized complexity.	CLO 3	T1:1.3,1.4
7-10	Use the concept of Divide and Conquer such as general method, binary search, quick sort.	CLO 4	T1:3.1-3.3,3.5
11-13	Describe the concept of merge sort, Strassen's matrix multiplication.	CLO 5	T1:3.5,3.7
14-15	Determine disjoint set operations, union and find algorithms.	CLO 6	T1:2.5
16-17	Understand efficient non recursive binary tree traversal algorithms.	CLO 7	T1:3.6
18	Describe the concept of spanning trees with suitable examples.	CLO 8	T1:3.7
19-21	Use breadth first search and depth first search graph traversals.	CLO 9	T1:6.1
22-23	Describe connected components, biconnected components.	CLO 10	T1:2.6
24-27	Understand general method of greedy method, job sequencing with deadlines, knapsack problem.	CLO 11	T1:4.1-4.2
28-29	Analyze the concept of minimum cost spanning trees, single source shortest paths.	CLO 12	T1:4.5-4.8
30	Describe general method of dynamic programming, matrix chain multiplication.	CLO 13	T1:5.1-5.2
31-33	Understand optimal binary search trees, 0/1 knapsack problem, single source shortest paths.	CLO 14	T1:5.5,5.7
34-35	Define all pairs shortest paths problem, the travelling salesperson problem.	CLO 15	T1:5.8-5.9
36	Discuss the concept of Backtracking, the 8 queens problem.	CLO 16	T1:7.1-7.2
37	Understand sum of subsets problem, graph coloring.	CLO 17	T1:7.3-7.4
38	Summarize the concept of Hamiltonian cycles, Branch and bound.	CLO 18	T1:7.5,8.1.1
39	Discuss 0/1 knapsack problem, least cost branch and bound solution.	CLO 19	T1:8.2.1
39-40	Apply the concept of first in first out branch and bound solution, travelling salesperson problem.	CLO 20	T1:8.2.2, 8.3

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
41	Knowledge about basic concepts of NP Hard and NP Complete, Non-deterministic algorithms.	CLO 21	T1:11.1
42	Apply Working with the classes NP - Hard and NP.	CLO 22	T1:11.1
43	Understand NP Hard problems, clique decision problem.	CLO 23	T1:11.3
44	Implement chromatic number decision problem.	CLO 24	T1:11.3
45	Cook's theorem in np hard and np complete problems.	CLO 25	T1:11.2

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

S no	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To discuss Skip lists, Problem reductions, Polynomial time and intractability.	Seminars	PO1	PSO1
2	Implementation of String matching: Knuth-Morris- Pratt, Boyer-Moore, Edit distance, Longest increasing subsequence, Smith-Waterman algorithm	Seminars / NPTEL	PO4	PSO2
3	Encourage students to write programs based on the taught algorithms to solve problems.	NPTEL / Laboratory practices	PO 2	PSO1

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HOD, CSE