Course Description and Outcome Form
Department of Computer Science and Engineering
School of Data and Sciences
Brac University

A. Course General Information:

Course Code:	CSE 221
Course Title:	Algorithms
Credit Hours (Theory+Lab):	3 + 0
Contact Hours (Theory+Lab):	3 + 3
Category:	Program Core
Type:	Required, Engineering, Lecture + labs
Prerequisites:	CSE 220
Co-requisites:	None

B. Course Catalog Description (Content):

This course addresses the study of efficient algorithms, their analyses and effective algorithm design techniques. Standard algorithm design strategies, such as, Divide and Conquer paradigm, Greedy method, Dynamic programming, Backtracking, Basic search and traversal techniques, Graph algorithms, Elementary parallel algorithms, Algebraic simplification and transformations, Lower bound theory, NP-hard and NP-complete problems are discussed in the course. Examples of data structures and algorithms studied in details are Heaps; Hashing; Graph algorithms: Shortest paths, Depth-first and Breadth-first search, Network flow, Computational geometry, Minimum Spanning Tree; Integer arithmetic: GCD, primality; polynomial and matrix calculations; Sorting; Performance bounds, asymptotic analysis, worst case and average case behavior, correctness and complexity. The course includes a compulsory 3 hour laboratory work every week.

C. Course Objective: The objectives of this course are to :

a. introduce students to time and space complexity of algorithms
b. teach students different sorting and searching methods and make them understand which is effective to use.
c. make them familiar with different problem solving paradigms as described in the course catalog above

D. [Updated Summer '23] Course Outcomes (COs):

Upon successful completion of this course, students will be able to

Sl.	CO Description	Weightage (%)
CO1	**Demonstrate** knowledge, understanding and ability to identify usage of the classical algorithms	50%
CO2	**Analyze** or **Compare** accuracy, efficiency and complexity (time, space) of algorithms	15%
CO3	**Apply** suitable problem solving approaches such as sorting, searching, divide and conquer, graph theory, greedy, dynamic programming to propose solutions to unseen or real world problems	15%
CO4	**Convert** algorithms into executable computer programs using any preferred programming language	20%

E. [Updated Summer '23] Mapping of CO-PO-Taxonomy Domain & Level-Delivery-Assessment Tool:

Sl.	CO Description	POs	Bloom's taxonomy domain/level	Delivery methods and activities	Assessment tools
CO1	**Demonstrate** knowledge, understanding and ability to identify usage of the classical algorithms	**a**	Cognitive / Apply	Lecture + Lab Works	Mid, Final
CO2	**Analyze** or **Compare** accuracy, efficiency and complexity (time, space) of algorithms	**a**	Cognitive / Analyze	Lecture + Lab Works	Mid, Final
CO3	**Apply** suitable problem solving approaches such as sorting, searching, divide and conquer, graph theory, greedy, dynamic programming to propose solutions to unseen or real world problems	**e**	Cognitive / Apply	Lecture + Lab Works	Assignment, Mid, Final, Lab Tasks
CO4	**Convert** algorithms into executable computer programs using any preferred programming language	**a**	Cognitive / Apply	Lecture + Lab Works	Lab Tasks

F. [Updated Summer '23] Course Materials:

i. Text and Reference Books:

Sl.	Title	Author(s)	Publication Year	Edition	Publisher	ISBN
1	Introduction to Algorithms	Charles E. Leiserson, Clifford Stein, Ronald Rivest, and Thomas H. Cormen	2009	3rd edition	The MIT Press	ISBN: 9780262033848
2	Algorithm Design	Eva Tardos and John Kleinberg	(March 26, 2005)	1st edition	Pearson	ISBN-13: 978-03212 95354
3	Algorithms	Dasgupta, Vazirani, Papadimitriou	July 2006	1st edition	McGraw Hill	ISBN: 9780073523408

4	Algorithms Illuminated	Tim Roughgarden	2022	1st edition	Cambridge	ISBN: 9780999282984
5	Algorithms	Jeff Erickson	June 2019	1st edition		ISBN: 978-1-792-64483-2

ii. Other materials

a. Tutorials by Google (Tech Dev Guide): https://techdevguide.withgoogle.com/paths/data-structures-and-algorithms/
b. lecture note + slides
c. visualgo website for algorithms visualization: https://visualgo.net/

G. [Updated Summer '23] Lesson Plan:

Details here: https://docs.google.com/spreadsheets/d/1-UIIMMLclIIacVPSOqek4gSzGLl8P93-YQ2agMFdv7g

No	Topic	Week/Lecture	Related CO
1	Introduction & Algorithm Analysis; Time Complexity, Space Complexity Analysis; Recursion and Backtracking;	Week 0-1	CO1-4
2	Sorting and Searching: Bubble, Selection and Insertion Sorting; Linear and Binary Searching Algorithms and its variants with time complexity. Divide and Conquer Basics; Merge and Quick Sort with derivation of running time;	Week 2-3	CO1-4
3	Graph Basics: Types of Graphs, Data Structures used BFS , DFS, and applications: Edge classification, cycle detection, bipartite/bicolorable graph.	Week 4-5	CO1-4
Mid Exam			
4	DAG, Topological sort, Strongly Connected Components (Kosaraju, Tarjan) Shortest path Dijkstra, Negative cycle: Bellman-Ford	Week 7	CO1-4
5	Minimum spanning Tree using Kruskal's Algorithm; Disjoint Set Data Structure Minimum Spanning Tree using Prim's Algorithm;	Week 8	CO1-4
6	Introduction to greedy, time scheduling interval; Fractional knapsack, Huffman encoding decoding	Week 9	CO1-4
7	Dynamic Programming: Basics; Knapsack 0/1, LCS, Coin Change (how many ways, minimum no. of coins) Recursive and iterative DP formulation, comparison	Week 10-11	CO1-4
8	P vs NP	Week 12	CO1-2
Final Exam			

H. Assessment Tools:

Assessment Tools	Weightage (%)
Assignment	5%
Quiz	20%
Midterm Exam	20%
Lab	25%
Final Exam	30%

I. [Updated Summer ‘23] CO Assessment Plan:

Assessment Tools	Course Outcomes			
	CO1	CO2	CO3	CO4
Class Participation/Performance				
Quiz				
Assignment			√	
Midterm Exam	√	√	√	
Final Exam	√	√	√	
Lab			√	√

J. CO Attainment Policy:

As per BRAC University Policy.

K. Grading policy:

As per BRAC University Policy

L. **Course Coordinator:** Md. Imran Bin Azad, Senior Lecturer, imran.azad@bracu.ac.bd

Appendix-1: Program Outcomes (BAETE)

a	Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization as specified in K1 to K4 respectively to the solution of complex engineering problems.
b	Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences. (K1 to K4)
c	Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations. (K5)
d	Conduct investigations of complex problems using research-based knowledge (K8) and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
e	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 their limitations.
f	Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems. (K7)
g	Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts. (K7)
h	Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice. (K7)
i	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
j	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.
k	Demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l	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.

Appendix-2: Bloom's Taxonomy