AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH (AIUB)

Faculty of Science and Technology (FST)
Department of Computer Science (CS)
Undergraduate Program

COURSE PLAN	SEMESTER: Fall 2024-2025
I. Course Core and Title CSC 2211: Algorithms **II. Credit** 3 credit hours (2 hours of theory and 3 hours Lab per week) **III. Nature** Core Course for CSE **IV. Prerequisite** CSC 2105: Data Structure	**V. Vision:** Our vision is to be the preeminent Department of Computer Science through creating recognized professionals who will provide innovative solutions by leveraging contemporary research methods and development techniques of computing that is in line with the national and global context. **VI. Mission:** The mission of the Department of Computer Science of AIUB is to educate students in a student-centric dynamic learning environment; to provide advanced facilities for conducting innovative research and development to meet the challenges of the modern era of computing, and to motivate them towards a life-long learning process.

VII - Course Description

- Analyze the asymptotic performance of algorithms.
- Demonstrate major algorithmic approaches and data structures.
- Apply important algorithmic design paradigms and methods to analyze real life problems.
- Synthesize efficient algorithms in common engineering design situations with application.

VIII – Course outcomes (CO) Matrix

By the end of this course, students should be able to:

COs *	Description	Domain Level ***			PO Assessed ****
		C	P	A	
CO1 **	**Determine** complexities of well-known algorithms using different methods.	3			PO-a-1
CO2 **	**Demonstrate** the selective well known and self-developed (if any) algorithms and their complexity analysis in efficient ways to solve some computer science engineering problems.	3			PO-a-2
CO3	**Simplify** and break-down the techniques to solve some complex realistic problems into modular problems and their solutions.	4			PO-b-2
CO4 **	**Determine** the usage of the algorithms and their data structures to solve some complex realistic problems.	5			PO-b-3
CO5 **	**Classifying** and **comparing** the different techniques within typical algorithms which can be analyzed for the accurate and proper solution. .	4			PO-b-4
CO6 **	**Determining** and **explaining** algorithms throughout optimizations for supporting and evaluating techniques as apply algorithmically.	5			PO-d-3

C: Cognitive; P: Psychomotor; A: Affective Domain
* *CO assessment method and rubric of COs assessment is provided in later section*
** *COs will be mapped with the Program Outcomes (POs) for PO attainment*
*** *The numbers under the 'Level of Domain' columns represent the level of Bloom's Taxonomy each CO corresponds to.*
**** *The numbers under 'PO Assessed' column represent the POs each CO corresponds to.*

IX – Topics to be covered in the class: *

Time Frame	CO Mapped	Topics	Teaching Activities	Assessment Strategy(s)
Week 1	CO1, CO2	Algorithms basics and their importance, Time and Space complexity analysis, and asymptotic notations, Searching: Linear search, binary search. (algorithm, simulation and complexity analysis)	Lecture, Question-answer, Lab Practice	Quiz, Term Exam
	CO1, CO2	Sorting: Bubble sort, selection sort, insertion sort. (algorithm, simulation and complexity analysis)	Lecture, Question-answer, Lab Practice	Quiz, Term Exam
Week 2	CO1, CO2	Sorting: Counting sort, Merge sort (algorithm, simulation and time complexity analysis)	Lecture, Question-answer, Lab Practice	Quiz, Term Exam
Week 3	CO1, CO2	Sorting: Quick sort (algorithm, simulation and time complexity analysis) Recurrences, the Repeated backward substitution method.	Lecture, Question-answer, Lab Practice	Quiz, Term Exam
Week 4	CO1, CO2	Recurrences continuation, Recursion-trees, and the Master theorem/method. Examples: Merge sort(recap), Quick Sort(recap), Binary Seach(recap)	Lecture, Question-answer, Lab Practice	Quiz, Term Exam
Week 5	CO1, CO2	Greedy Strategy basics, Example: fractional knapsack problem	Lecture, Question-answer, Lab Practice	Quiz, Term Exam
Week 6	CO1, CO2	Greedy Strategy continuation, Huffman encoding *Coin changing problem, *Job Scheduling– not mandatory (if teachers feel interested).	Lecture, Question-answer, Lab Practice	Quiz, Term Exam
Midterm (Week 7) Dec 2-8				
Week 8	CO2, CO3	Dynamic Programming, Fibonacci sequence problem, Longest Common Subsequence Problem, *0-1 Knapsack problem (not mandatory).	Lecture, Question-answer, Lab Practice	Quiz, Term Exam
Week 9	CO2, CO3	DP Continuation: Matrix Chain Multiplication Problem	Lecture, Question-answer, Lab Practice	Quiz, Term Exam
Week 10	CO1, CO3	Graphs and Trees (basics of graphs and trees and their applications, Depth-first Search, Breadth-first Search, Topological Sort)	Lecture, Question-answer, Lab Practice	Quiz, Term Exam
Week 11	CO3, CO4	Graphs Algorithms (Strongly Connected Component), Greedy Graph Algorithm (Minimum Spanning Tree, Prim-Jarnik Algorithm, and Kruskal's Algorithm)	Lecture, Question-answer, Lab Practice	Quiz, Term Exam
Week 12	CO3, CO5	Shortest Path Algorithms, Single Source Shortest Path - Dijkstra's Algorithm, Bellmen-Ford's algorithm	Lecture, Question-answer, Lab Practice	Quiz, Term Exam
Week 13	CO3, CO5	All Pair Shortest Path – Floyd-Warshall Algorithm	Lecture, Question-answer, Lab Practice	Quiz, Term Exam
Week 14	CO2, CO3	P, NP, NP-complete, NP-hard, proofs of NP-complete and NP-hard (idea)	Lecture, Question-answer, Lab Practice	Quiz, Term Exam
Final Term (Week 15)				

** The faculty reserves the right to change, amend, add, or delete any of the contents.*

X – Mapping of PO/PLO and K, P, A of this course:

PO Indicator ID	PO Indicators Definition (As per the requirement of WKs)	Domain	K	P	A
PO-a-1	Apply information and concepts in natural science with the familiarity of issues.	Cognitive Level 3 (Applying)	K1		
PO-a-2	Apply information and concepts of mathematics with the familiarity of issues.	Cognitive Level 3 (Applying)	K2		
PO-b-2	Formulate solutions, procedures, and methods using first principles of mathematics for engineering sciences.	Cognitive Level 4 (Analyzing)	K2		
PO-b-3	Analyze solutions for complex engineering problem reaching substantiated conclusion.	Cognitive Level 5 (Evaluating)	K3	P1 P3 P7	
PO-b-4	Research literature of engineering science and analyze the validity and accuracy of existing solution for complex engineering problems.	Cognitive Level 4 (Analysis)	K4	P1 P2 P6	
PO-d-3	Investigate solution of complex engineering problem by synthesis of information to provide valid conclusions.	Cognitive Level 5 (Evaluating)	K8	P1 P4 P5	

XI – K, P, A Definitions

Indicator	Title	Description
K1	Theory based natural science	A systematic, theory-based understanding of the natural sciences applicable to the discipline
K2	Conceptual based mathematics	Conceptually based mathematics, numerical analysis, statistics and the formal aspects of computer and information science to support analysis and modeling applicable to the discipline
K3	Theory based engineering fundamentals	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline
P1	Depth of knowledge required	Cannot be resolved without in-depth engineering knowledge at the level of one or more of K3, K4, K5, K6 or K8 which allows a fundamentals-based, first principles analytical approach
P2	Range of conflicting requirements	Involve wide-ranging or conflicting technical, engineering, and other issues
P3	Depth of analysis required	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models
P4	Familiarity of issues	Involve infrequently encountered issues
P5	Extent of applicable codes	Are outside problems encompassed by standards and codes of practice for professional engineering
P6	Extent of stakeholder involvement and conflicting requirements	Involve diverse groups of stakeholders with widely varying needs
P7	Interdependence	Interdependence

XII – Mapping of CO Assessment Method and Rubric

The mapping between Course Outcome(s) (COs) and The Selected Assessment method(s) and the mapping between Assessment method(s) and Evaluation Rubric(s) is shown below:

COs	Description	Mapped POs	Assessment Method	Assessment Rubric
CO1	Determine complexities of well-known algorithms using different methods.	PO-a-1	Term Exam	Rubric for Exam
CO2	Demonstrate the selective well known and self-developed (if any) algorithms and their complexity analysis in efficient ways to solve some engineering problems.	PO-a-2	Term Exam	Rubric for Exam
CO3	Use break-down techniques to solve some complex realistic problems into modular problems and their solutions.	PO-b-2	Term Exam	Rubric for Exam
CO4	Determine the usage of the algorithms and their data structures to solve some complex realistic problems.	PO-b-3	Term Exam	Rubric for Exam
CO5	Classifying and comparing the different techniques within typical algorithms which can be analyzed for the accurate and proper solution.	PO-b-4	Term Exam	Rubric for Exam
CO6	Determining and explaining algorithms throughout optimizations for supporting and evaluating techniques as apply algorithmically.	PO-d-3	Term Exam	Rubric for Exam

XIII – Evaluation and Assessment Criteria

CO1: Determine complexities of well-known algorithms using different methods.

Assessment Criteria	Not Attended/ Incorrect (0)	Inadequate (1-2)	Average (3)	Good (4)	Excellent (5)
Evaluation Criteria	**Evaluation Definition**				
Selection of Method	Explaining suitable method to derive complexity of the given algorithms.				
Complexity Function	Derive mathematical function using the appropriate method in the first step.				
Appropriate Complexity Notation	Use standard complexity notations like Big O, Big Ω and Big Θ to compute complexity.				

CO2: *Demonstrate the selective well known and self-developed (if any) algorithms and their complexity analysis in efficient ways to solve some engineering problems.*

Assessment Criteria	Not Attended/ Incorrect (0)	Inadequate (1-2)	Average (3)	Good (4)	Excellent (5)
Evaluation Criteria	**Evaluation Definition**				
Problem Analysis	Understand the problem context and nature of the problem. Describe appropriate algorithmic approach/paradigm to analyze the problem.				
Selection of Algorithms	Linking the type of problem to available selected algorithms and how different techniques work for solving the problem.				
Complexity Comparison	Apply suitable algorithms to the given problem showing variations in performance in terms of time complexity.				

CO3: *Simplify and break down the techniques to solve some complex realistic problems into modular problems and their solutions.*					
Assessment Criteria	**Not Attended/ Incorrect (0)**	**Inadequate (1-2)**	**Average (3)**	**Good (4)**	**Excellent (5)**
Evaluation Criteria	**Evaluation Definition**				
Problem Analysis	Understand the problem context and nature of the problem. Describe appropriate algorithmic approach/paradigm to analyze the problem.				
Problem Decomposition	Break down the problem in such a way that each component can be solved independently and later merged to get final output.				
Efficiency	Describe details of the proposed technique with performance efficiency.				

CO4: *Determine the usage of the algorithms and their data structures to solve some complex realistic problems.*					
Assessment Criteria	**Not Attended/ Incorrect (0)**	**Inadequate (1-2)**	**Average (3)**	**Good (4)**	**Excellent (5)**
Evaluation Criteria	**Evaluation Definition**				
Problem Analysis	Understand the problem context and nature of the problem. Describe appropriate algorithmic approach/paradigm to analyze the problem.				
Algorithm Selection based on time and space complexity	Explore different dimensions of problems in terms of time and space complexity considering the platforms where the implementation will be done.				
Analysis of drawbacks and future enhancement	To draw a conclusion describing the usage of the proposed techniques including the drawbacks and future scope.				

CO5: *Classifying and comparing the different techniques within typical algorithms which can be analyzed for the accurate and proper solution*.					
Assessment Criteria	**Not Attended/ Incorrect (0)**	**Inadequate (1-2)**	**Average (3)**	**Good (4)**	**Excellent (5)**
Evaluation Criteria	**Evaluation Definition**				
Problem Analysis	Understand the problem context and nature of the problem. Describe appropriate algorithmic approach/paradigm to analyze the problem.				
Performance analysis based on comparison and efficiency.	Break down problems of algorithms in different dimensions and compare with similar categorize techniques which analyze for its efficiency.				
Simplifying of applicable techniques for complex algorithms.	Ability to break down the problem into smaller sub-problems or steps throughout integration and benchmarking for more complex algorithms.				

CO6: *Determining and explaining algorithms throughout optimizations for supporting and evaluating techniques as apply algorithmically.*					
Assessment Criteria	**Not Attended/ Incorrect (0)**	**Inadequate (1-2)**	**Average (3)**	**Good (4)**	**Excellent (5)**
Evaluation Criteria	**Evaluation Definition**				
Problem Analysis	Ability to accurately understand and define the problem, including constraints and edge cases.				

Justifying the supporting techniques that applied on typical algorithms.	Justification for selecting a particular algorithm over others, based on algorithms problem context to find the proper solutions.
Find best solution strategies for optimization.	Selecting a clear and efficient strategy for solving the problem, including the choice of data structures and algorithms.

XIV- Course Requirements

- Students are expected to attend at least 80% of the class.
- Students are expected to participate actively in the class.
- For both terms, there will be at least 2 quizzes based on the theoretical knowledge and conceptual understanding of the topic covered discussed in the classes.
- Submit report based on the given course related problems.
- Submission of assignments and projects should be in due time.

XV – Evaluation & Grading System*

The following grading system will be strictly followed in this course.

Mid-term	**Final term**
Class Attendance and Performance: 10% Quizzes: 20% Lab Evaluation: 30% Term Exam: 40%	Class Attendance and Performance: 10% Quizzes: 20% Lab Evaluation: 30% Term Exam: 40%
Total Midterm Marks: 40%	**Total Final term marks: 60%**
Grand Total: 100 Marks	

Letter	Grade Point	Numerical %
A+	4.00	90-100
A	3.75	85 - < 90
B+	3.50	80 - < 85
B	3.25	75 - < 80
C+	3.00	70 - < 75
C	2.75	65 - < 70
D+	2.50	60 - < 65
D	2.25	50 - < 60
F	0.00	< 50
I		Incomplete
W		Withdrawal
UW		Unofficially Withdrawal

** The evaluation system will be strictly followed as par the AIUB grading policy.*
** CO attainment will be achieved with 60% of the evaluation marks.*

XVI – Textbook/ References

- Introduction to Algorithms, Third Edition, Thomas H. Cormen, Charle E. Leiserson, Ronald L. Rivest, Clifford Stein (Clrs).
- Fundamental of Computer Algorithms, Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran (Hsr)
- Data Structures and Algorithms Made Easy in Java Author: Narasimha Karumanchi

- Algorithms, 4th Edition by Robert Sedgewick and Kevin Wayne.

XVII - List of Faculties Teaching the Course

FACULTY NAME	SIGNATURE
NUZHAT TABASSUM	
DR. MOHAMMAD RABIUL ISLAM	
DR. MD. MANZURUL HASAN	
DR. MOUSHUMI ZAMAN BONNY	
MD. FARUK ABDULLAH AL SOHAN	
RAHUL BISWAS	
AIMAN LAMEESA	
AKIB AHMED	
MAHMUDUL HASAN	
MD. MUSTAK UN NOBI	

XVIII – Verification

Prepared by: ---------- **Nuzhat Tabassum** *Course Convener*  Date: 28/10/2024	**Moderated by:** ---------- **Dr. M. Mahmudul Hasan** *Point Of Contact* *OBE Implementation Committee* Date:.....	**Checked by:** ---------- **Dr. Akinul Islam Joney** *Head (Undergraduate Program)* *Department of Computer Science* Date:.....
Verified by: ..... **Dr. Md. Abdullah-Al-Jubair** *Director* *Faculty of Science & Information Technology* Date:.....	**Certified by:** ..... **Prof. Dr. Dip Nandi** *Associate Dean,* *Faculty of Science & Information Technology* Date:.....	**Approved by:** ..... **Mr. Mashiour Rahman** *Dean,* *Faculty of Science & Information Technology* Date:.....