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| AIUB-Logo  American International University-Bangladesh (AIUB) | **AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH (AIUB)**  Faculty of Science and Technology (FST)  Department of Computer Science (CS)  Undergraduate Program |



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| **COURSE PLAN** | **Fall 2019-2020** SEMESTER |

**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.

I. Course Core and Title

**CSC 2211: Algorithms**

II. Credit

**3 credit hours (2 hours theory and 3 hours Lab per week)**

III. Nature

**Core Course for CS, CSE, COE, CSSE, SE, CIS** IV. Prerequisite **CSC 2105**

**CSC 2105: Data Structure**



**VII - Course Description:**

The design and analysis of algorithms is the core subject matter of Computer Science. Designing an algorithm for a computational problem involves knowledge of the problem domain, a thorough knowledge of the data structures that are available and suitable and no small measure of creativity. This course concentrates on the above problems, studying useful algorithmic design techniques, and methods for analyzing algorithms.

* Discuss the principles and objectives of Algorithms along with its purpose and necessity in the program domain.
* Distinguish computational problems with respect to inputs and outputs in addition to their solutions in efficient ways.
* Simplify in different ways to find out solutions of fundamental computational problems, their solutions and performances.
* Justify the necessary and sufficient condition behind a solution of any widely accepted or self-developed algorithm.
* Demonstrate well known algorithmic solutions of different problems as essential parts of study along with recent improvements.
* Discuss efficiencies of different types algorithms on different problem domains.
* Analyze time and space complexities of any widely accepted or self-developed algorithm.
* Apply appropriate data structures to implement the efficient algorithms.
* Explain classical tools and techniques for algorithms analysis and design.
* Judge creativity in designing algorithms.

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**VIII – Course outcomes (CO) Matrix:**

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

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| **CO** | **CO Definition** | **Blooms Level** | **Blooms Learning Level** | | | **PO Map** | **Assessment Method** |
|  | | | **C** | **P** | **A** |  | |
| CO1 | Outline terminologies and methods of classical algorithms analysis and design to solve some conventional/real life algorithmic problems. | 1 | C |  |  | 1 | Quiz |
| CO2 | Demonstrate the selective well known and self-developed (if any) algorithms in efficient ways.to solve some engineering problems. | 3 | C |  |  | 1 | Mid / Final Term |
| CO3 | Break down some complex realistic problems into modular problems and their solutions. | 4 |  |  | A | 2 | Assignment 1 |
| CO4 | Justify the usage of the algorithms and their data structures to solve some complex realistic problems along with complexity analysis. | 5 |  |  | A | 2 | Assignment 2 |
| *C: Cognitive; P: Psychomotor; A: Affective; S: Soft-skills (CT: Critical Thinking, TS: Teamwork)*  *\*The numbers under the ‘Level of Domain’ columns represent the level of Bloom’s Taxonomy each CO corresponds to.*  *\*\* The numbers under the ‘PO Assessed’ column represent the PO each CO corresponds to.* | | | | | | | |
| PO1 | 1.1 Apply the knowledge of mathematics, science, engineering fundamentals to the solution of complex engineering problems. | | | | | | |
| 1.2 Apply the knowledge of an engineering specialization to the solution of complex engineering problems. | | | | | | |
| PO2 | 2.1 Identify, Research and Formulate complex engineering problems. | | | | | | |
| 2.2 Analyse and Reach substantiated conclusions using the principle of mathematics, the natural sciences and the engineering sciences | | | | | | |



**IX – Topics to be covered in Theory class\*:**

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| **TOPICS** | **Specific Objective(s)** | **Time Frame** | **Suggested Activities** | **Teaching Strategy(s)** | **CO mapped** |
| Mission & Vision of AIUB;  Analyzing & Designing Algorithms, | Knowing Mission & Vision of AIUB.  Mission & vision of AIUB, Formalize the students in thinking about designing and analyzing algorithms, gentle introduction to how we specify algorithms, some of the design strategies, many of the fundamental ideas used in algorithm analysis (RAM model, Basic asymptotic notations, Lower bounds), Logarithmic-time, Linear-time, Polynomial- time, Exponential- time, NP-complete and Np-hard problems. | Week 1 | Lecture and  Lab:  Review of different problems as basic data structure review, and their time complexities.  Bubble Sort,  Linear Search and Binary Search.  **(Brainstorming on Vertex cover, Set cover and Independent set problem to get an idea on hardness of algorithms-only for discussion)** | Lecture, Notes/PPT Slides, Student Feedback,  Board work,  Exercise Solving, Question/  Answer Session. | CO1 |
| Searching & Sorting | Design & Analysis of different searching & sorting algorithms. Importance on space complexities. | Week 2 | Lecture and Lab:  Selection Sort, Insertion Sort, Counting Sort.  ***QUIZ 1*** | Lecture, Notes/PPT Slides, Student Feedback,  Board work,  Exercise Solving, Question/  Answer Session | CO1, CO2 |
| Recurrences &  Master Method | Forming Recurrence equations and how to solve them using repeated (backward) substitution method, substitution method, recursion-trees, master method. (Divide and conquer) | Week 3 | Lecture and  Lab:  Restricting and Sorting Data  Merge Sort, Quick Sort. (**Ackermann Function, Tower of Hanoi,** **Radix Sort and Finding Kth largest element from a sorted array- only for discussion.)**  ***Lab Assessment 1*** | Lecture, Notes/PPT Slides, Student Feedback,  Board work,  Exercise Solving, Question/  Answer Session. | CO1, CO2 |
| Greedy strategy | Basic understanding about greedy strategy**, a**ctivity selection Problem, task scheduling problem, fractional knapsack problem, coin change, etc. | Week 4 | Lecture and Lab: Knapsack (Fractional and 0/1) problems and other relevant Problems.  ***QUIZ 2*** | Lecture, Notes/PPT Slides, Student Feedback,  Board work,  Exercise Solving, Question/  Answer Session | CO1, CO2 |
| Dynamic Programming | Definition and improvement of Dynamic Programming, Fibonacci problem, 0-1 Knapsack problem | Week 5 | Lecture and Lab:  Fibonacci Sequence and other Relevant Problems  ***Lab Assessment 2*** | Lecture, Notes/PPT Slides, Student Feedback,  Board work,  Exercise Solving, Question/  Answer Session | CO1, CO2 |
| Discussion, Open problems and Brainstorming  Session | Review, Discussion, Open problems and Brainstorming | Week 6 | Session with open problems and  Lab:  ***Viva*** | Lecture, Notes/PPT Slides, Student Feedback,  Board work,  Exercise Solving, Question/  Answer Session | CO3, CO4 |
| Midterm Week  Week 7 | | | | | |
| **Dynamic Programming** | Matrix Chain Multiplication Problem, Longest Common Subsequence problems, etc. | Week 8 | Lecture and Lab: Rod cutting, matrix chain multiplication, LCS. | Lecture, Notes/PPT Slides, Student Feedback,  Board work,  Exercise Solving, Question/  Answer Session | CO2, CO3, CO4 |
| **Graphs and Tress** | Basics of graphs and tress along with their applications. Representation of Graphs,  Basic search & traversal techniques,  Depth-first Search, Breadth-first Search  Topological Sort,  Strongly Connected Component. | Week 9 | Lecture and  Lab:  Link List, Adjacency Matrix, Adjacency List, BST, In order, Preorder and Post order traversal, Heap Sort.  ***Assignment-1*** | Lecture, Notes/PPT Slides, Student Feedback,  Board work,  Exercise Solving, Question/  Answer Session | CO2, CO3, CO4 |
| **Graphs Algorithms** | Depth-first Search, Breadth-first Search  Topological Sort,  Strongly Connected Component. | Week 10 | Lecture and  Lab:  BFS, DFS, Topological Sort.  ***Lab Assessment Test-1 & QUIZ 1*** | Lecture, Notes/PPT Slides, Student Feedback,  Board work,  Exercise Solving, Question/  Answer Session | CO2, CO3, CO4 |
| **Greedy Graph Algorithm** | Minimum Spanning Tree, Prim-Jarnik Algorithm, Kruskal's Algorithm. | Week 11 | Lecture and  Lab:  MST- Kruskal’s and Prim’s algorithms.  ***Assignment 2*** | Lecture, Notes/PPT Slides, Student Feedback,  Board work,  Exercise Solving, Question/  Answer Session | CO2, CO3, CO4 |
| **Shortest Path Algorithms** | Single Source Shortest Path (Dijkstra’s Algorithm, Bellman-Ford Algorithm), All Pair Shortest Path (Floyd-Warshall Algorithm). | Week 12 | Lecture and  Lab:  Shortest Path-Dijkstra’s and Warshall’s algorithms.  ***Quiz 2*** | Lecture, Notes/PPT Slides, Student Feedback,  Board work,  Exercise Solving, Question/  Answer Session | CO2, CO3, CO4 |
| Discussion, Open problems and Brainstorming  Session | Review, Discussion, Open problems and Brainstorming | Week 13 | Session with open problems and  Lab:  Lab Exam  ***Viva*** | Lecture, Notes/PPT Slides, Student Feedback,  Board work,  Exercise Solving, Question/  Answer Session | CO3, CO4 |
| Final term Week  Week 14 | | | | | |

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

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**XI- Course Requirements**

At least **80% class attendance** is necessary to sit for the exam. If there is any assignment given to the students, they have to submit it before the deadline decided by the course teacher.

**XII – Evaluation & Grading System**

The following grading system will be followed but may vary on the components based upon OBE Rubrics.

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| **Marking system for Theory Classes**  **(Midterm and Final term)** | |
| Quiz | 20% |
| Attendance | 15% |
| Assignment  Performance | 15%  20% |
| Midterm/Final term exam | 30% |
| **Total** | 100% |
| **Final Grade/ Grand Total** | |
| Midterm: | 40% |
| Final Term: | 60% |

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| **Marking system for Laboratory Classes**  **(Midterm and Final term)** | |
| Lab Report | 15% |
| Attendance | 15% |
| Viva and Performance | 20% |
| Midterm/Final term Test | 50% |
| **Total** | 100% |
| **Final Grade/ Grand Total** | |
| Midterm: | 40% |
| Final Term: | 60% |

**\*\* Since there is no assignment in Midterm, marks of the assignment component will be adjusted with Quiz and Performance components (5 marks with Quiz and 10 marks with Performance).**

**Grand Total - - - - - - - - 40% of Midterm + 60% of Final Term**

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| **Letter** | **Grade Point** | **Numerical** |
| 90-100 | A+ | 4.00 |
| 85 - < 90 | A | 3.75 |
| 80 - < 85 | B+ | 3.50 |
| 75 - < 80 | B | 3.25 |
| 70 - < 75 | C+ | 3.00 |
| 65 - < 70 | C | 2.75 |
| **60 - < 65** | **D+** | **2.50** |
| 50 - < 60 | D | 2.25 |
| < 50 | F | 0.00 |
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The evaluation system will be strictly followed as per the AIUB grading policy.

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**XIII – Teaching Methods**

Maximum topics will be covered from the textbook. For the rest of the topics, reference books will be followed. Some Class notes will be uploaded on the web. White board will be used for most of the time.

For some cases, multimedia projector will be used for the convenience of the students.

Students must study up to the last lecture before coming to the class and it is suggested that they should go through the relevant chapter before coming to the class. Just being present in the class is not enough- students must participate in classroom discussions.

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**XIV – Textbook/ References**

1. ***Introduction to Algorithms, Third Edition, Thomas H. Cormen, Charle E. Leiserson, Ronald L. Rivest, Clifford Stein (CLRS).***
2. *Fundamental of Computer Algorithms, Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran (HSR)*
3. *Helpful link for Problem Solving :* [***http://acm.uva.es/problemset/***](http://acm.uva.es/problemset/)
4. *Lectures and Laboratory works will be provided online at the course website weekly.*



**XV - List of Faculties Teaching the Course**

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| 1) Md. Manzurul Hasan, Assistant Professor  2) Kaniz Fatema, Assistant Professor  3) Faria Nawshin, Lecturer  4) Asma Fariha, Lecturer  5) Md. Kishor Morol, Lecturer  6) Md. Asiful Islam, Lecturer  7) Dr. Shohag Barman, Assistant Professor |



**XVI – Verification:**

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| Prepared by  ---------------------------------  Md. Manzurul Hasan  Course Convener  Date- | Checked and certified by:  .............................................................  (Asso Prof. Dr. M. M. Mahbubul Syeed)  (Head of Department, CS)  Date:................................................ | Approved by:  .............................................................  Asso. Prof. Mashiour Rahman (Asso. Dean of Faculty of FST)  Date:................................................... |
|  | Moderated by :  …………………….  Date : ……………………….. | Moderated by :  ……………………….  Date : ……………………….. |