Bangladesh University of Business and Technology (BUBT)
Faculty of Engineering& Applied Sciences (FEAS)
Department of Computer Science and Engineering (CSE)

THEORY COURSE OUTLINE

1	**Program**	B.Sc. Engg. in CSE
2	**Course Code**	CSE 231
3	**Course Title**	Data Structures
4	**Course Type**	Core Course
5	**Academic Sessio**	Spring 2023
6	**Credit Hour**	3.0
7	**Intake**	49
8	**Section**	9
9	**Pre-requisites**	CSE 121 Object Oriented Programming Language
10	**Campus**	Permanent Campus
11	**Course Teacher**	**Name:** Mehedi Hasan Bijoy — **Designation**: Lecturer **Specialization**: Meta-Learning, Natural Language Processing, Computer Vision **Room No. 503/B3** — **Email: mbijoy**@bubt.edu.bd — **Cell No**. 01770297744
14	**Course Objective**	This course introduces fundamental concepts of design, analysis and implementation of different data structures. The course is designed for students to perform various data structure operations and their applications. The student will learn to select appropriate data structure according to engineering problem. This course enables students to get acquainted with the concepts of time-space complexity.
15	**Course Synopsis**	Basic data structures & operations; ADT; Time space Trade-off, Asymptotic Notation & Functions, Complexity Analysis; Control Structures; String, String Operations & Process, Pattern Matching Algorithms; Array, Array Operations; Searching and Sorting Techniques : Binary Search, Linear Search, Bubble Sort, Insertion Sort, Selection Sort, Merge Sort, Radix Sort, Quick Sort; Linked List, Linked List Operations, Dynamic Memory Allocations; Stack, Queue & Application; Tree : Binary Tree, Extended Binary Tree, Complete Binary Tree, Tree Traversing, Binary Search Tree, Heap Tree, Huffman Tree, AVL Tree ; Graph: Graph Representation, Graph Traversing etc
16	**Text Book**	1. Data Structures (Schaum's Outlines Series) - Seymour Lipschutz
17	**Reference Book**	1. Data Structures Using C - ISRD Group 2. Advanced Data Structure – Peter Brass

18 Course Outcome (COs)

Upon completing this course, students will be able to:

CO1: **Understand** basic data structures and their area of usage

CO2: Explain the operations and manipulations of different data structures and their memory organization.

CO3: **Apply** appropriate data structures for solving computational problems.

CO4: Analyze the efficiency of various data structures in given situations.

Mapping of COs to POs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√											
CO2	√											
CO3			√									
CO4		√										

CO No.	PO No.	Bloom's Domain / Level	Delivery Methods / Activities	Assessment Tools
CO1	PO1	Cognitive / Understanding	Class Lecture	Midterm
CO2	PO1	Cognitive / Understanding	Class Lecture	Midterm and Final
CO3	PO3	Cognitive / Applying	Class Lecture	Midterm and Final
CO4	PO2	Cognitive/ Analyzing	Class Lecture	Final

19 Teaching Strategy

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. Multimedia projector and a PC will be used for the convenience of the students to understand codes practically. Students must participate in classroom discussions for case studies, problems solving.

20 Assessment and Marks Distribution:

Class Participation	:	10%
Assignment/Presentation	:	10%
Class Test	:	10%
Midterm Examination	:	30%
Final Examination	:	40%

21 Lecture Plan (Weekly Schedule)

Week	Lecture#	Selected Topics	Chapter#	COs	Assessment
1	1	Introduction to Data, Information, Structures, Data Structure Operations	(Seymour Lipschutz) Ch-1	**CO1**	
	2	ADT, Time Space Trade-off	"	**CO1**	
2	3	Mathematical Notations & functions, Control Structures, Complexity of algorithms, Big Oh notation and other Asymptotic notations	Ch-2	**CO1**	
	4	Discussion of Sub algorithm, local & global concepts	"	**CO1**	
3	5	String, String Operations, Word processing	Ch-3	**CO2**	
	6	First Pattern Matching Algorithm, Second Pattern Matching Algorithm,	" [**CT-1]**	**CO3**	**Mid-term Exam (30)**
4	7	Array, Array Operations (Insertion, Deletion, Sorting, Searching, Bubble Sort)	Ch-4	**CO2**	
	8	Linear Search, Binary Search & complexity	"	**CO2**	
5	9	Pointers & complexity, Matrices and their operations	"	**CO2**	
	10	Insertion Sort, Selection Sort and complexity	Ch-9	**CO3**	
6	11	Merge Sort, Radix Sort & Complexity	"	**CO3**	
	12	Sorting Complexity and Comparison ***Review class for Mid-Term Examination***	"	**CO3**	
7		**Mid Term Examination**			
8	13	Introduction to Linked List, Usage of linked list, Create Linked Lists etc.	Ch-5	**CO2**	
	14	Linked list Operations (traversing, Insertion, Deletion, etc.)	"	**CO2**	
9	15	Linked list Operations continue	"	**CO2**	
	16	Dynamic Memory Allocation, Linked list Vs. Array Representation, Hashing, Collision resolution, Methods	[**CT-2]**	**CO3**	
10	17	Stacks and its operations, Applications of Stack: Polish Notation, Polish Notations using stack, Recursion	Ch-6	**CO3**	
	18	Queues & Applications, Dequeues, Priority Queues, Tower of Hanoi	"	**CO3**	**Final Exam (40)**
11	19	Tree's terms & Definition, Types of tree	Ch-7	**CO2**	
	20	B-Trees, Tree traversing order	"	**CO2**	
12	21	Binary Search-Trees	"	**CO2**	
	22	Heap, Heapify	"	**CO2**	
13	23	Heap Sort	"	**CO2**	

	24	Huffman Coding, AVL Tree	[**CT-3]**	**CO2**	
14	25	Graph theory terminology, Adjacency matrix, Path matrix.	Ch-8	**CO2**	
	26	Shortest Path, Linked representation of graphs	"	**CO4**	
15	27	Traversing a graph; BFS, DFS	"	**CO4**	
	28	Data Structure Problem Analysis, modification & Related Solution methods ***Review class for Semester Final Examination***	"	**CO4**	
16		**Final Examination**			

22 Overall CO Assessment Criteria

Assessment methods of COs are given below:

Assessment Area	**CO**				**Assessment Area Mark**
	CO1	**CO2**	**CO3**	**CO4**	
Class Participation					
Assignment/Presentation					
Class Test					
Midterm Exam	10	10	10		30
Final Exam		10	20	10	40
Total Mark	**10**	**20**	**30**	**10**	**70**

23 Rubrics

COs (Bloom's Level)	**Excellent (80%-100%)**	**Good (70%-79%)**	**Satisfactory (60%-69%)**	**Poor (40%-59%)**	**Unsatisfactory (0-39%)**	**Marks (70)**
CO1 (Understanding)	Answer is complete and sufficient detail provided to support issues related to the question. And also deals fully with the entire question.	Answer is brief with sufficient detail provided to support issues were introduced. And most of the basic details are included but some are missing.	Answer is brief with insufficient detail provided to support issues were introduced.	Answer is incomplete and excessive discussion of unrelated issues. And serious gaps in the basic details.	None of the relevant details were included or didn't answer.	
CO2 (Understanding)	Answer is complete and sufficient detail provided to support issues related to the question. And also deals fully with the entire question.	Answer is brief with sufficient detail provided to support issues were introduced. And most of the basic details are included but some are missing.	Answer is brief with insufficient detail provided to support issues were introduced.	Answer is incomplete and excessive discussion of unrelated issues. And serious gaps in the basic details.	None of the relevant details were included or didn't answer.	
CO3 (Applying)	The question is answered appropriately by applying the	The question is answered briefly by applying the suggested method in the question.	The question is answered correctly by applying the suggested	The question is answered incompletely by applying the suggested	No attempt to implement the suggested method.	

			suggested method in the question.		method in the question but some steps are missing.	method in the question but some steps are correct.		
		CO4 (Analyzing)	A clear, complete, and properly ordered chain of analyzing steps (i.e. proper explanation of the procedure) is followed to answer the question.	The chain of analyzing steps is complete and correctly ordered but lack of expected explanation.	One or more intermediate analyzing steps are missing or unclear, but the correctness of the analysis is not compromised.	One or more intermediate analyzing steps are missing or unclear to answer the question.	The stated chain of analysis does not lead to the stated question.	

24 Grading Policy

The following chart will be followed for grading. This has been customized from the guideline provided by the School of Engineering and Computer Science.

A+	A	A-	B+	B	B-	C+	C	D	F
≥ 80	75-<80	70-<75	65-<70	60-<65	55-<60	50-<55	45-<50	40-<45	<40

25 Additional Course Policies

Assignments	There will be at least two assignments. Average marks of the assignments will be counted. No late homework will be accepted. ***Any kind of copy/manipulation in assignment will carry zero mark.*** Two or more copied assignments will carry zero mark in all assignments. **Zero tolerance will be shown in this regard.** Solutions to assignment problems will be provided through web and on hand.
Class Test	There will be at least three class tests (CT). Best two of three or best three of four CTs will be counted. Both of regular and surprise CTs can be conducted.
Exams	CT, Mid-term and final exam will be closed book, closed notes. Mobile phone is strictly prohibited in exam hall. Students are insisted to carry their own watch and synchronize time during exam hours.
Test Policy	If a student is absent from class test anyway and made no report to the class teacher personally beforehand, his/her score for that test will be zero. No make-up for the class test will be allowed as 2 of 3 or 3 of 4 CTs are being considered. No make-up for Mid-exam will be entertained without physical presence and recommendation of the guardian along with written permission of the department. Make-up of Mid-exam may be much harder than the regular one.

26 Additional Information

a. Academic Calendar Summer 2020: http://www.bubt.edu.bd/academics/academic-calendar.
b. Academic Policies: http://www.bubt.edu.bd/academics/academic-rules-a-regulations.
c. Grading & Evaluation: http://www.bubt.edu.bd/academics/academic-rules-a-regulations.
d. Proctorial Rules: http://www.bubt.edu.bd/administrator/proctors-office.

27 Bloom's Taxonomy for Teaching-Learning

Bloom's Taxonomy is a set of three hierarchical models used to classify educational learning objectives into levels of complexity and specificity. The three lists cover the learning objectives in Cognitive, Affective and Psychomotor domains. The Cognitive domain list has been the primary focus of most education and is frequently used to structure curriculum learning objectives, assessments and activities. The three domains and respective levels are illustrated below.

Cognitive [C] (Knowledge-based)	**Affective [A]** (Emotion-based)	**Psychomotor [P]** (Action-based)
1. Remembering	1. Receiving	1. Imitating
2. Understanding	2. Responding	2. Manipulating
3. Applying	3. Valuing	3. Précising
4. Analyzing	4. Organizing	4. Articulating
5. Evaluating	5. Characterizing	5. Naturalizing
6. Creating	--- --- ---	--- --- ---

28 **Descriptions of Cognitive Domain (Anderson and Krathwohl's Taxonomy 2001):**

The **cognitive domain** involves the development of our mental skills and the acquisition of knowledge.

Level	Category	Meaning	Keywords
C1	Remembering	Recognizing or recalling knowledge from memory. Remembering is when memory is used to produce or retrieve definitions, facts, or lists, or to recite previously learned information.	Define, describe, draw, find, identify, label, list, match, name, quote, recall, recite, tell, write
C2	Understanding	Constructing meaning from different types of functions be they written or graphic messages or activities like interpreting, exemplifying, classifying, summarizing, inferring, comparing, or explaining.	Classify, compare, exemplify, conclude, demonstrate, discuss, explain, identify, illustrate, interpret, paraphrase, predict, report
C3	Applying	Carrying out or using a procedure through executing, or implementing. Applying relates to or refers to situations where learned material is used through products like models, presentations, interviews or simulations.	Apply, change, choose, compute, dramatize, implement, interview, prepare, produce, role play, select, show, transfer, use
C4	Analyzing	Breaking materials or concepts into parts, determining how the parts relate to one another or how they interrelate, or how the parts relate to an overall structure or purpose. Mental actions included in this function are differentiating, organizing, and attributing, as well as being able to distinguish between the components or parts. When one is analyzing, he/she can illustrate this mental function by creating spreadsheets, surveys, charts, or diagrams, or graphic representations.	Analyze, characterize, classify, compare, contrast, debate, deconstruct, deduce, differentiate, discriminate, distinguish, examine, organize, outline, relate, research, separate, structure
C5	Evaluating	Making judgments based on criteria and standards through checking and critiquing. Critiques, recommendations, and reports are some of the products that can be created to demonstrate the processes of evaluation.	Appraise, argue, assess, choose, conclude, critique, decide, evaluate, judge, justify, predict, prioritize, prove, rank, rate, select, Monitor

C6	Creating	Putting elements together to form a coherent or functional whole;reorganizing elements into a new pattern or structure through generating, planning, or producing. Creating requires users to put parts together in a new way, or synthesize parts into something new and different creating a new form or product. This process is the most difficult mental function.	Construct, design, develop, generate, hypothesize, invent, plan, produce, compose, create, make, perform, plan, produce

29 Graduate Attributes (Program Outcomes) for B.Sc. in Engineering Program based on Washington Accord

Program Outcomes (POs) are narrower statements that describe what students are expected to know and be able to do by the Time of graduation. These relate to the knowledge skills and attitudes that students acquire while progressing through the program. The students of the B.Sc. in EEE program are expected to achieve the following graduate attributes or program outcomes at the time of graduation.

PO1–Engineering knowledge (Cognitive): Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO2–Problem analysis (Cognitive): Identify, formulate, research the literature and analyze complex engineering problems and reach substantiated conclusions using first principles of mathematics, the natural sciences and the engineering sciences.

PO3–Design/development of solutions (Cognitive, Affective): Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety as well as cultural, societal and environmental concerns.

PO4–Investigation (Cognitive, Psychomotor): Conduct investigations of complex problems, considering design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.

PO5–Modern tool usage (Psychomotor, Cognitive): 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.

PO6–The engineer and society (Affective): Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

PO7–Environment and sustainability (Affective, Cognitive): Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development.

PO8–Ethics (Affective): Apply ethical principles and commit to professional ethics, responsibilities and the norms of the engineering practice.

PO9–Individual work and teamwork (Psychomotor, Affective): Function effectively as an individual and as a member or leader of diverse teams as well as in multidisciplinary settings.

PO10–Communication (Psychomotor, Affective): Communicate effectively about complex engineering activities with the engineering community and with society at large. Be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions.

PO11–Project management and finance (Cognitive, Psychomotor): Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work as a member or a leader of a team to manage projects in multidisciplinary environments.

PO12–Life-long learning (Affective, Psychomotor): Recognize the need for and have the preparation and ability to engage in independent, life-long learning in the broadest context of technological change.

30 Social & Moral Capital

Our promises are based on the three cardinal principles:

(a) What we do believe (b) What we do practice, and (c) What we will promote

However, students are advised to undertake the following commitments for moral development.

	1. To be punctual and attentive in class 2. To maintain inclusive learning environment 3. To ensure mutual respect 4. To be cooperative in group learning. 5. To be innovative and Creative 6. To follow dress code and wearing ID card 7. To be always proactive	8. Try to follow and review day to day class 9. To avoid conspiracy 10. To prioritize honesty & faith 11. To be motivated for asking question and encourage feedback 12. To develop attitude for speaking in English 13. Do not ignore to carry out any assignments or commitments 14. To be clean and decent in all levels.	15. To be sincere for class preparation 16. Do not forget to switch-off the cell phone in class 17. Do not forget to carry course pack and learning stuffs in class 18. To maintain loyalty and trust to the university 19. Must avoid unfair means and plagiarism in exam, reports and assignments 20. Must maintain eco-friendly environment in the campus.

Prepared by: **Checked by:** **Approved by:**