The Islamia University of Bahawalpur

**University College of Engineering & Technology**

Course Outline: Data Structures and Algorithms

General Information:

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| **Course:** | Data structures and Algorithms |  | **Instructor** | Dr.Nadia Rasheed |
| **Course Code** | CS241 | **Office** |  |
| **Credit Hours** | 3 (Theory) + 1 (Lab) | **Email** | Nadia.rashid@iub.edu.pk |
| **Contact Hours** |  | **Contact No.** |  |
| **Pre-Requisite(s)** | Programming fundamentals and OOP | **Office Hours** |  |

Course Description:

This course Covers the design, analysis, and implementation of data structures and algorithms to solve engineering problems using an object‐oriented programming language. Topics include elementary data structures, (including arrays, stacks, queues, and lists), advanced data structures (including trees and graphs),the algorithms used to manipulate these structures, and their application to solving practical engineering problems.

Course Learning Outcomes (CLOs):

After completion of course, the student will be able to :

|  |  |  |  |
| --- | --- | --- | --- |
| **CLOs** | **Description** | **Domain** | **PLOs** |
| CLO1 | Formulate and apply object‐oriented programming, using C++, as a modern tool to solve engineering problems. | C-3 | PLO3 |
| CLO2 | Demonstrate an understanding of analysis of algorithms. Study an algorithm or program Code segment that contains iterative constructs and analyze the asymptotic time complexity of the algorithm or code segment | C-2 | PLO4 |
| CLO3 | Demonstrate an understanding of design of data structures and algorithms to solve engineering problems and evaluate their solutions. | C-2 | PLO3 |
| CLO4 | Demonstrate the ability to apply and use data structures and algorithms to solve engineering problems and evaluate their solutions. | C-3 | PLO4 |

Relation of CLOs to the Program Learning Outcomes (PLOs):

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
|  | **Engineering Knowledge** | **Problem Analysis** | **Design & Development of Solutions** | **Investigation** | **Modern Tool Usage** | **The Engineer and Society** | **Environment and Sustainability** | **Ethics** | **Individual and Team Work** | **Communication** | **Project Management** | **Life Long Learning** |
| **CLO1** |  |  | √ |  |  |  |  |  |  |  |  |  |
| **CLO2** |  |  |  | √ |  |  |  |  |  |  |  |  |
| **CLO3** |  |  | √ |  |  |  |  |  |  |  |  |  |
| **CLO4** |  |  |  | √ |  |  |  |  |  |  |  |  |
| **Total** |  |  | 2 | 2 |  |  |  |  |  |  |  |  |
| **Impact** |  |  | High | High |  |  |  |  |  |  |  |  |

**Justification of Program Learning Outcomes (PLO’s) Coverage:**

**PLO1 - Engineering Knowledge:**

The assignments, exams, and laboratory experiments require engineering knowledge to successfully complete the course. Students will have the knowledge of forward and inverse kinematics, AI techniques and the intelligent robot design paradigms.

**PLO2 - Problem Analysis**

The course shows the value of theory, by making it possible for the students examine the AI algorithms, perform kinematic and dynamics analysis. (High relevance to course).

**PLO3 - Design & Development of Solutions**

  Through the basic to moderate level knowledge (theory plus hands-on practice) of OOP and data structure , The student will to understand different data structures .

**PLO4-Investigation**

Through the basic to moderate level knowledge (theory plus hands-on practice) of OOP and data structure , the student will to design different data structures and will do algorithmic analysis.

**PLO5 - Modern Tool Usage**

This objective is not directly addressed in this course.

**PLO6 - The Engineer and Society**

This objective is not directly addressed in this course.

**PLO7 - Environment and Sustainability**

This objective is not directly addressed in this course.

**PLO8 - Ethics**

This objective is not directly addressed in this course.

**PLO9 - Individual and Team Work**

This objective is not directly addressed in this course.

**PLO10 – Communication**

This objective is not directly addressed in this course.

**PLO11- Project Management**

This objective is not directly addressed in this course.

**PLO12 - Life Long Learning**

This objective is not directly addressed in this course.

Assessment of CLOs:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | CLO1 | CLO2 | CLO3 | CLO4 |
| Assignments | √ | √ | √ | √ |
| Quizes | √ | √ |  | √ |
| Midterm Exam | √ | √ | √ |  |
| Finalterm Exam |  |  | √ | √ |
| Others (Projects/presentations) |  |  |  |  |

Textbook(s)/Reference Books:

1. Required Mark A. Weiss. Data Structures and Algorithm Analysis in C++. 4th Edition. Pearson 2014.  ISBN‐13: 978‐0‐13‐284737‐7
2. Schaum's Outline of Data Structures with C++.

**Lecture Plan:**

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| --- | --- | --- |
| Topics | **Hours** | **CLOs** |
| **Introductuion .**  Mathematics Review , Review :C++ Classes, Friend functions. Operator overloading. Exception handling. Memory allocation and Deallocation, Encapsulation. Inheritance. Polymorphism. Virtual Functions , Templates. Function and class templates.  (Chapter 1) | **Week 1-Week2** | **CLO1** |
| **Algorithm Analysis**  Mathematical Background Model , What to Analyze ,  Running-Time Calculations , A Simple Example ,General Rules , Solutions for the Maximum Subsequence Sum Problem , Logarithms in the Running Time , Limitations of Worst-Case Analysis  (Chapter 2) | **Week2-Week 4** | **CLO2** |
| **Basic Data structure**  Basic data structures. Arrays. Static arrays and Dynamic arrays. Explore how a generic Vector container is used to  manipulate data.  (Chapter 1 Sec. 1.8 ,Chapter 3 Sec 3.3) | **Week 5** | **CLO3, CLO4** |
| **List ADT.**  Implementation using arrays  (static and dynamic).  (Basic operations on a List)  (Chapter 3 Sec. 3.2.1) | **Week 6** | **CLO3, CLO4** |
| **Linked-List.**  Singly linked-lists.  Implementation using pointers. Basic  Operations  (Chapter 3 Sec. 3.2.2, 3.3, 3.5 | **Week 7** | **CLO3, CLO4** |
| **Stacks and Queues.**  Behavior of a Stack. Basic operations on a Stack. Array-based stacks. Linked-list based implementation.  Expression evaluation using a stack. Queues. Behavior of a queue. Basic queue operations Study implementations using an array and a linked-list.  (Chapter 3 Secs. 3.6 and 3.7 ) | **Week8-Week 10** | **CLO3, CLO4** |
| **Tree data structure.**  Binary and nonbinary trees. Structure of a binary tree.  Definitions and properties. Traversing a binary tree.  (Chapter 4 Secs. 4.1 and 4.2 ) | **Week 12-Week 13** | **CLO3, CLO4** |
| **Binary Search Tree (BST).**  Organizing data in a BST. Inserting and deleting  items in a BST. Traversing a BST. Non-binary (General) tree. General tree traversal.  (Chapter 4 Sec. 4.3, 4.6) | **Week 14** | **CLO3, CLO4** |
| **Searching and Hashing algorithms.**  Search algorithms – Sequential Search, Ordered  lists, binary search. Searching using  Hashing. Hash tables. Hash functions.  Some examples of hash functions. Collision resolution. Review  (Chapter 5,Chapter 9 ) | **Week-15-Week16** | **CLO3, CLO4** |

**Grading Policy vis-à-vis CLO Mapping**

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| --- | --- | --- |
| Assignments, Quizzes, Projects/presentations etc | 20% | CLO1 to CLO4 |
| Midterm | 30% | CLO1 to CLO3 |
| Final | 50% | CLO3 to CLO4 |

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