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FILE STRUCTURES LABORATORY WITH MINI PROJECT (18ISL67)
REPORT
ON

"STUDENT COURSE MANAGEMENT SYSTEM"

Submitted in the partial fulfilment of the requirements for the award of the degree of

BACHELOR OF ENGINEERING
IN
INFORMATION SCIENCE AND ENGINEERING

For the Academic Year 2022-2023

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2022-2023

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CERTIFICATE

This is to certify that FILE STRUCTURES LABORATORY WITH MINI PROJECT (18ISL67) Report entitled "**STUDENT COURSE MANAGEMENT SYSTEM**" is a Bonafide work carried out by **Nishanth R [1JS20IS062], Nikhil S [1JS20IS059]** in partial fulfilment for the award of degree of Bachelor of Engineering in Information Science and Engineering of Visvesvaraya Technological University Belagavi during the year 2022- 2023.

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ACKNOWLEDGEMENT

The satisfaction and euphoria that accompany the successful completion of any task would be incomplete without the mention of the people who made it possible. So with gratitude, we acknowledge all those whose guidance and encouragement crowned our efforts with success.

First and foremost, we would like to thank his **Holiness Jagadguru Sri Shivarathri Deshikendra Mahaswamiji** for his divine blessings**,** without which the work wouldn't have been possible.

It's my pleasure in thanking our principal **Dr. Bhimasen Soragaon**, Principal, JSSATE, Bangalore for providing an opportunity to carry out the Project Work as a part of our curriculum in the partial fulfilment of the degree course.

We express our sincere gratitude for our beloved Head of the department, **Dr. Rekha P.M**, for her co-operation and encouragement at all the moments of our approach.

It is our pleasant duty to place on record our deepest sense of gratitude to our respected guide, **Mrs. Sahana V**, Assistant Professor, Dept. of Information Science and Engineering for the constant encouragement, valuable help and assistance in every possible way.

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ABSTRACT

This abstract presents a summary of a mini project on a student course management system using B-trees. The project aims to develop a robust and efficient system for managing student course information, including course registration, tracking, and administration.

The student course management system utilizes B-trees as the underlying data structure for efficient storage, retrieval, and manipulation of course records. B-trees offer balanced search and insertion operations, ensuring optimal performance even with a large number of courses and students.

The key features of the student course management system include course registration, course search, student enrolment, and administrative functions. The system provides a user-friendly interface for students to register for courses, view their enrolled courses, and drop courses if necessary. Administrators have access to additional functionalities such as adding new courses, modifying course details, and generating reports.

The B-tree structure allows for quick and accurate retrieval of course information based on various search criteria, such as course code, course name, or instructor name. This enables efficient course enrolment and provides a seamless user experience for both students and administrators.

The mini project also incorporates data validation and error handling mechanisms to ensure the integrity and reliability of the system. It emphasizes data security by implementing appropriate access controls and user authentication.

Throughout the development process, software engineering principles such as modular design, code reusability, and documentation are followed to facilitate maintainability and future enhancements of the system.

In conclusion, the student course management system mini project utilizing B-trees provides a comprehensive and efficient solution for managing student course information. By leveraging the power of B-trees, the system offers fast and reliable operations for course registration, tracking, and administration, contributing to an effective learning environment.

CHAPTER 1

INTRODUCTION

OVERVIEW

The student course management system is a comprehensive software application designed to facilitate the efficient and organized management of student course-related information within an educational institution. It serves as a centralized platform that enables students, instructors, and administrators to perform various tasks related to course management.

For students, the system provides features such as course registration, allowing them to view available courses, select their desired classes, and manage their course schedules. It may offer course search functionality, course descriptions, prerequisites, and real-time course availability updates. Students can also access course materials, submit assignments, track their grades, and communicate with instructors and peers.

Instructors benefit from the system by being able to manage course offerings, create and update course materials, track student progress, and communicate important course-related information. They can upload lecture slides, assignments, and reading materials, as well as grade student submissions and provide feedback.

Administrators have access to administrative functionalities like managing course catalogs, scheduling classes, assigning instructors, and generating reports related to course enrollment, attendance, and academic performance. They can oversee administrative tasks such as adding or removing courses, managing prerequisites, and monitoring student course load.

Overall, the student course management system streamlines course-related processes, improves communication and collaboration, and enhances the overall efficiency and effectiveness of course management within the educational institution.

PROBLEM STATEMENT

Develop a Student Course Management System using file structures to address the challenges of manual method. The system should allow the user to add, delete, modify, search, and display the Course details efficiently.

The entire manual process is time consuming as the complainant has to physically go to the police station numerous times. The same also consumes a whole lot of money and energy.

Previously, this has been a paper-based process, and paper records were easily manipulated or lost.

By implementing this system, the aim is to design a well-organized Student course management system that helps to maintain and access the records effectively and providing a user-friendly software solution that enables users to register new course, delete records, modify, search for specific record, and display course details.

ORGANIZATION OF THE REPORT

Chapter 1 provides the Overview of the project and explains the Problem statement. In **Chapter 2,** we discuss the File Structures concepts, types, Operations, Advantages and Disadvantages. In **Chapter 3**, we discuss about B-trees and its types, Purpose, Advantages and Disadvantages of B-trees. In **Chapter 4,** we discuss the software and hardware requirements to design and implement the above concepts in our project. **Chapter 5,** gives the idea of the system design and Functionalities. **Chapter 6,** gives a clear picture about the project and its actual implementation. In **Chapter 7,** we discuss the system testing. **Chapter 8,** discusses the results and discussions of the program. **Chapter 9,** concludes by giving the direction for future enhancements.

CHAPTER 2

INTRODUCTION TO FILE STRUCTURES

INTRODUCTION

File structures, also known as data structures for files, are methods or techniques used to organize and manage data stored in computer files. They define how data is stored, accessed, and modified within a file, aiming to optimize data storage efficiency and retrieval performance.

In computing, files are used to store and organize data on various storage media such as hard drives, solid-state drives (SSDs), or other types of storage devices. A file structure provides a logical representation of the data within a file, allowing for efficient storage, retrieval, and manipulation of information.

File structures encompass different techniques and data organization methods, including:

Sequential Files: In a sequential file structure, data is stored in a sequential manner, one after another. Each record in the file contains a fixed number of fields, and the records are accessed sequentially from the beginning to the end. Sequential files are simple and suitable for applications that require frequent access to all records in a specific order.

Indexed Files: Indexed file structures introduce an index, a separate data structure that allows direct access to specific records within a file. The index contains key-value pairs, where the key is typically a field or a combination of fields from the records. The index facilitates quick searches and retrieval of records based on the specified key.

Hashed Files: Hashed file structures use a hash function to map keys to specific locations within the file. The hash function generates a hash value based on the key, which is used to determine the storage location. Hashed files provide rapid access to records but may suffer from collisions (multiple records mapped to the same location) if not properly handled.

B-Trees: B-Trees are balanced tree structures that allow efficient insertion, deletion, and searching operations in large files. B-Trees are particularly useful for managing large amounts of data, as they maintain balance and keep the tree height relatively small, resulting in fast access times.

Directories: Directories are file structures used to organize and manage files within a file system. They provide a hierarchical structure, allowing files to be organized into directories and subdirectories for better organization and management. Directories typically maintain metadata about the files, such as names, sizes, and permissions.

File structures play a crucial role in data management, providing efficient and optimized methods for storing and retrieving data from files. The choice of file structure depends on the specific requirements of an application, including the type and size of data, access patterns, and desired performance character.

HISTORY

Early work with files presumed that files were on tape, since most files were. Access was sequential and the cost of access grew in direct proportion to the size of the file. The indexes made it possible to keep a list of keys and pointers in a smaller file that could be searched more quickly. With the key and pointer, the user had direct access to the large, primary file.

Unfortunately, simple indexes had some of the same sequential flavour as the data files, and as the indexes grew, they too became difficult to manage, especially for dynamic files in which the set of keys changes. Then in the early 1960's, the idea of applying tree structures emerged.
Unfortunately, trees can grow very unevenly as records are added and deleted.

In 1963 researchers developed the tree, an elegant, self-adjusting binary tree structure, called AVL tree, for data in memory. The problem was that even with a balanced binary tree, dozens of accesses were required to find a record in even moderate sized files.

It took nearly ten more years of design work before a solution emerged in form of the B-tree. AVL trees grow from top down as records are added, B-trees grow from the bottom up.
B-trees provided excellent access performance, but there was a cost: no longer could a file be

accessed sequentially with efficiency. Fortunately, this problem was solved almost immediately by adding a linked list structure at the bottom level of the B-tree. The combination of a B-tree and a sequential linked list is called a B+ tree.

Being able to retrieve information with just three or four accesses is pretty good. But the goal of being able to get what we want with a single request was satisfied by hashing. From early on, hashed indexes were used to provide fast access to file. After the developed of B-trees, researchers turned to work on systems for extendible, dynamic hashing that could retrieve information with one or, at most, two disk accesses no matter how big the file became.

TYPES OF FILES

As we know that computers are used for storing the information for a permanent time or the files are used for storing the Data of the users for a long time period. And the files can contain any type of information which means that they can store text, any images or pictures or data in any format. So that there must be some mechanism which are used for storing the information.

Accessing the information and also performing some operations on the files. When we store a file in the system, then we have to specify the name and the type of file. The name of file will be any valid name and type means the application with which the file is linked. When we say that every file has some type, it means that every file belongs to a special type of application software. When we provide a name to a file, we also specify the extension of the file because the system will retrieve the contents of that file into application software.

1. **Ordinary file or Simple file:** Ordinary file may belong to any type of application. For example, notepad, paint, C program, music[mpeg] etc. All the files that are created by a user are ordinary files. Ordinary files are used for storing information about the user programs. With the help of ordinary files, we can store the information which contain text, database, images or any other type of information.

2. **Directory File:** Directory files are nothing but a place/area/location where details of files are stored. It contains details about file names, ownership, file size and time when they are created and last modified.

3. **Special Files:** The special files are also called as device files. The special files are those which are not created by the user or the files which are necessary to run a system. These are the files that are created by the system. All the files of an operating system are referred to as special files. There are many types of special files and they are, system files or windows files, input/output files. System files are stored using .sys extension.

4. **FIFO Files:** The first in first Out Files are used by the system for executing the processes in a particular order. Which means that the files which comes first, will be executed first and the system maintains a order known as Sequence order. When a user requests for a service from the system, then the requests of the users are arranged into some files and all the requests will be performed by the system.

OPERATIONS ON FILE STRUCTURES

File structures support various operations that enable efficient management of data stored within files. These operations include:

1. **Creation:** The creation operation involves establishing a new file structure on a storage medium. During this process, the file structure is initialized, and necessary metadata structures, such as file headers or indexes, are set up. This operation prepares the file structure for subsequent data storage and retrieval operations.

2. **Opening and Closing:** Opening a file structure involves establishing a connection or access point to an existing file on the storage medium. Opening a file grants the ability to perform read, write, and other operations on the file's data. After completing operations on a file, it is essential to close the file to release system resources and ensure data integrity.
3. **Reading:** The reading operation allows retrieving data from a file structure. It involves accessing specific records or blocks of data within the file and transferring the data into the

application's memory space. Reading operations may involve sequential access, direct access using indexes, or hashed access based on keys.

4. **Writing:** The writing operation involves adding new data or modifying existing data within a file structure. It requires specifying the location or position in the file where the data should be stored or updated. Writing operations may involve appending data at the end of the file, overwriting existing data, or inserting new records at specific positions.

5. **Updating:** The updating operation involves modifying the existing data within a file structure. It allows changing specific fields or attributes of records without completely rewriting the entire record. Updating operations are typically performed by locating the desired record within the file and applying the necessary changes to the identified fields.

6. **Deleting:** The deleting operation involves removing data or records from a file structure. Deletion can be performed on individual records or multiple records at once. Deleting operations may involve marking the deleted record as inactive or physically removing the record from the file structure, depending on the specific file organization method.

7. **Searching:** The searching operation enables locating specific records or data within a file structure based on given criteria. Searching operations may involve sequential scanning of records, direct access using indexes, or utilizing search algorithms such as binary search or hashing techniques for efficient retrieval of data.

8. **Indexing:** Indexing operations involve creating and maintaining index structures to facilitate faster access to data within a file structure. Indexes are used to map key values to specific locations in the file, allowing for direct access to records without the need for sequential scanning.

9. **File Maintenance:** File maintenance operations involve tasks such as reorganizing the file structure to improve performance, resizing the file to accommodate more data, compressing or decompressing data, and performing integrity checks to ensure data consistency.

These operations collectively enable effective data management within file structures, providing the necessary functionalities for storing, accessing, updating, and manipulating data in a structured manner. The specific operations and their implementation depend on the chosen file structure and the requirements of the application.

ADVANTAGES OF FILE STRUCTURES

1. **Simplicity:** File structures are relatively simple and easy to understand compared to complex database management systems. They provide a straight-forward way of organizing and managing data within files.

2. **Direct Access:** Certain file structures, such as indexed files or hashed files, offer direct access to specific records based on key values. This allows for quick retrieval of data without the need for sequential scanning, resulting in faster access times.

3. **Low Overhead:** File structures typically have low overhead in terms of memory and processing resources. They require minimal system resources to manage and maintain the file organization, making them efficient for handling small to moderate amounts of data.

4. **Flexibility:** File structures provide flexibility in terms of data formats. They can handle a variety of data types, including text, numbers, images, and more, allowing for diverse data storage and retrieval requirements.

5. **Portability:** File structures are portable across different platforms and systems. Files can be easily transferred or shared between different computers or software applications, ensuring data interoperability.

DISADVANTAGES OF FILE STRUCTURES

1. **Limited Data Integrity:** File structures do not offer built-in mechanisms for enforcing data integrity rules and constraints. It is the responsibility of the application or user to ensure data consistency and accuracy. Without proper validation and error-checking mechanisms, data

integrity can be compromised.

2. **Lack of Concurrent Access:** File structures often lack built-in support for concurrent access by multiple users or processes. Simultaneous access to the same file by multiple users can lead to data inconsistencies or conflicts unless explicit locking mechanisms are implemented.

3. **Lack of Query Language:** Unlike database management systems, file structures do not provide a dedicated query language for complex data retrieval and manipulation. Retrieving specific data requires manual implementation of search algorithms or iteration over the file contents.

4. **Limited Scalability:** File structures may face challenges in handling large volumes of data efficiently. As the size of the file increases, sequential scanning and direct access operations may become slower, impacting overall performance.

5. **Data Redundancy:** File structures can result in data redundancy if the same information is stored in multiple files or multiple locations within a file. This redundancy can lead to increased storage requirements and potential inconsistencies if updates are not properly synchronized.

6. **Lack of Data Sharing and Integration:** File structures do not inherently support data sharing or integration between different applications or systems. Sharing data stored in file structures often requires manual data export/import processes or file transfer mechanisms.

It's worth noting that while file structures have certain limitations compared to more advanced database systems, they still serve as effective solutions for managing data in smaller-scale applications or scenarios where simplicity and direct access are prioritized over complex data management capabilities.

CHAPTER 3

INTRODUCTION TO B-Trees

B-trees are a type of self-balancing tree data structure that are widely used in computer science and database systems. They are specifically designed to efficiently organize and manage large amounts of data, particularly in disk-based or secondary memory environments.

The name "B-tree" is derived from the "balanced" property it maintains. Unlike binary search trees, B-trees are balanced and ensure that the depth of the tree remains relatively constant regardless of the number of elements stored. This balance is achieved by allowing each node to have a variable number of child nodes, typically denoted as the "order" or "degree" of the tree.

The primary motivation behind using B-trees is to reduce disk I/O operations, which can be time-consuming compared to in-memory operations. By organizing data in a balanced tree structure, B-trees minimize the number of disk accesses required to locate a specific data item. This makes them highly efficient for scenarios where the data size is too large to fit entirely in main memory.

B-trees are commonly used in file systems, database management systems, and other applications that handle large datasets. They are particularly useful for indexing and managing data in secondary storage devices, such as hard drives or solid-state drives, where the cost of disk I/O operations is significantly higher compared to accessing data in primary memory.

The balanced nature of B-trees ensures that operations like search, insertion, and deletion have a time complexity of O(log n), where n is the number of elements in the tree. This logarithmic time complexity allows for efficient data retrieval and modification, even as the dataset grows.

Overall, B-trees play a crucial role in optimizing the performance of systems that deal with large amounts of data, especially in disk-based environments. By maintaining balance and efficient storage utilization, B-trees enable fast and reliable access to data, making them a fundamental data structure for managing and organizing data in various applications.

TYPES OF B-TREES

B-trees are a type of self-balancing search tree data structure that is commonly used for efficient storage and retrieval of data. There are different types of B-trees, each with its own variations and characteristics. Here are some of the commonly known types of B-trees:

1. B-tree: The standard B-tree is a balanced tree structure where each node can have multiple child nodes. It is typically used for disk-based storage systems and databases. The B-tree maintains a balance by ensuring that each node contains a minimum number of keys and a maximum number of keys.

2. B+ tree: The B+ tree is an extension of the B-tree and is widely used in database management systems. In a B+ tree, all the keys are present in the leaf nodes, while the internal nodes act as pointers to the leaf nodes. This structure allows for efficient range queries and sequential access of data.

3. B* tree: The B* tree is another variation of the B-tree that aims to reduce the number of node splits and merges during tree operations. It achieves this by allowing a higher fill factor for the nodes, resulting in fewer levels in the tree and improving overall performance.

4. B- tree: The B- tree is a variant of the B-tree that allows for underflow in internal nodes. This means that internal nodes can have fewer keys than the minimum required, reducing the tree's height and improving performance in certain scenarios.

5. 2-3 tree: The 2-3 tree is a precursor to the B-tree and is a type of balanced search tree where each internal node can have either two or three child nodes. It maintains balance by redistributing keys between nodes during insertions and deletions.

6. 2-3-4 tree: The 2-3-4 tree is an extension of the 2-3 tree where each internal node can have two, three, or four child nodes. It provides better balance and improved performance by allowing for more keys in each node, reducing the height of the tree.

PURPOSE OF B-TREES

The purpose of B-trees is to efficiently organize and manage large amounts of data, particularly in disk-based or secondary memory environments. B-trees achieve this purpose through the following key objectives:

- Fast Search Operations: B-trees provide fast search operations by maintaining a balanced structure. The balanced nature of B-trees ensures that the height of the tree remains relatively constant, resulting in efficient search times. This property allows for quick retrieval of data items, making B-trees ideal for scenarios where fast search operations are essential.

- Efficient Storage Utilization: B-trees optimize storage utilization by allowing each node to have a variable number of child nodes. This flexibility ensures that the tree can adapt to changes in data size while minimizing wasted space. By efficiently organizing data within nodes, B-trees maximize storage efficiency and reduce the overall storage requirements.

- Support for Range Queries: B-trees are well-suited for range queries, where a range of values needs to be retrieved from the data. The structure of B-trees facilitates efficient traversal of the tree to retrieve data within a specified range. This capability is particularly valuable in scenarios where data needs to be analyzed or processed based on specific intervals or criteria.

- Scalability: B-trees are designed to handle large datasets efficiently. As the number of data items increases, the performance of B-trees remains relatively stable, as the tree's height is balanced. This scalability makes B-trees suitable for applications that involve managing and processing massive volumes of data.

- Support for Insertion and Deletion Operations: B-trees provide efficient insertion and deletion operations. The balanced structure ensures that these operations maintain the balance of the tree and result in the minimal restructuring of the tree. As a result, B-trees offer fast and reliable insertion and deletion operations even as the dataset grows.

- Disk-Based Operations: B-trees are particularly effective in disk-based or secondary memory environments. Disk I/O operations are significantly slower compared to accessing data in primary memory, and B-trees minimize the number of disk accesses required to locate data items. This makes them well-suited for scenarios where the data size exceeds the available memory.

The purpose of B-trees is to optimize data access and storage efficiency, making them a fundamental data structure for managing and organizing large datasets. By achieving fast search operations, efficient storage utilization, and support for range queries, B-trees provide a reliable and scalable solution for handling data in various applications, such as file systems, databases, and other disk-based systems.

ADVANTAGES OF B-TREES

B-trees offer several advantages in managing and organizing data efficiently. Here are some key advantages of B-trees:

1. Balanced Structure: B-trees maintain a balanced structure, ensuring that the height of the tree remains relatively constant regardless of the number of elements stored. This balance allows for efficient search, insertion, and deletion operations with a time complexity of O(log n), where n is the number of elements in the tree. As a result, B-trees provide fast access to data even as the dataset grows.

2. Efficient Disk-Based Operations: B-trees are particularly effective in disk-based or secondary memory environments. Disk I/O operations are significantly slower compared to accessing data in primary memory, and B-trees minimize the number of disk accesses required to locate data items. This makes B-trees well-suited for scenarios where the data size exceeds the available memory, optimizing data access times and reducing disk I/O overhead.

3. Range Queries: B-trees facilitate efficient range queries, where data within a specific range needs to be retrieved. The structure of B-trees allows for easy traversal and retrieval of data within a specified range, making them ideal for scenarios that involve analysing or processing data based on specific intervals or criteria. Range queries can be performed with a time complexity of O(log n + k), where k is the number of retrieved elements.

4. Storage Utilization: B-trees optimize storage utilization by allowing each node to have a variable number of child nodes. This flexibility ensures that the tree can adapt to changes in data size while minimizing wasted space. B-trees efficiently organize data within nodes, maximizing storage efficiency and reducing the overall storage requirements compared to other data structures.

5. Scalability: B-trees offer excellent scalability as the number of elements in the tree grows. The balanced nature of B-trees ensures that the performance remains relatively stable, maintaining efficient search and retrieval times. This scalability makes B-trees suitable for applications that involve managing and processing massive volumes of data.

6. Support for Insertion and Deletion: B-trees provide efficient insertion and deletion operations. The balanced structure ensures that these operations maintain the balance of the tree and result in minimal restructuring. This property allows for fast and reliable insertion and deletion operations, ensuring data integrity and maintaining the efficient performance of the tree.

7. Indexing: B-trees are widely used for indexing purposes in database systems. They can efficiently index and organize large amounts of data, allowing for fast lookup and retrieval based on key values. B-trees provide efficient support for maintaining sorted order and performing range-based queries, making them suitable for indexing large datasets.

8. Concurrent Access: B-trees can support concurrent access by using locking mechanisms or other concurrency control techniques. This enables multiple processes or threads to access and modify the tree simultaneously while maintaining data consistency and integrity.

Overall, B-trees offer a balanced structure, efficient disk-based operations, support for range queries, storage utilization optimization, scalability, efficient insertion and deletion, indexing capabilities, and support for concurrent access. These advantages make B-trees a powerful data structure for managing and organizing data in various applications, particularly in disk-based or large-scale data scenarios.

DISADVANTAGES OF B-TREES

While B-trees offer many advantages, there are also some potential disadvantages associated with their use. Here are a few disadvantages of B-trees:

1. Complexity: B-trees can be more complex to implement and understand compared to simpler data structures like binary search trees. The balancing and restructuring operations required to maintain the balanced structure of B-trees can make the implementation more challenging.

2. Overhead: B-trees have some inherent overhead due to the need to maintain the tree structure and additional pointers. This overhead increases the storage requirements compared to simpler data structures. However, the overhead is generally considered reasonable given the benefits provided by B-trees.

3. Slower Operations: While B-trees offer efficient average-case performance for search, insertion, and deletion operations, they may have slower worst-case performance compared to other data

structures like AVL trees or red-black trees. In rare cases where the tree becomes highly unbalanced, the worst-case time complexity of B-trees can degrade to O(n), where n is the number of elements in the tree.

4. Increased Memory Access: B-trees require more memory accesses compared to simpler data structures. Since B-trees are often used in disk-based or secondary memory environments, this can lead to increased disk I/O operations, which are slower compared to accessing data in primary memory. However, the performance trade-off is generally acceptable given the benefits of efficient disk-based operations provided by B-trees.

5. Complexity of Operations: The complexity of operations like splitting or merging nodes in B-trees can make the implementation more complex and potentially slower compared to simpler data structures. These operations are required to maintain the balanced nature of B-trees and can introduce additional overhead.

6. Higher Constant Factors: B-trees have higher constant factors associated with each operation compared to simpler data structures. This means that the overhead for individual operations may be higher in B-trees, although the overall average-case performance is efficient.

7. Difficulty in Concurrent Modifications: Concurrent modifications to B-trees can be more challenging to handle compared to simpler data structures. Ensuring data integrity and managing concurrent access and modifications can require more sophisticated locking or concurrency control mechanisms.

Despite these potential disadvantages, B-trees remain widely used and highly effective for managing and organizing large datasets, particularly in disk-based environments. The advantages provided by B-trees generally outweigh these disadvantages, making them a popular choice for various applications that require efficient storage utilization, scalability, and fast access to data.

CHAPTER 4

SYSTEM SPECIFICATION

HARDWARE SPECIFICATION

- Processor: intel 3 or AMD 3
- RAM: 4 GB RAM minimum
- Hard Disk: 20 GB or grater
- Monitor: VGA/SVGA
- Keyboard: 104 keys standard
- Mouse: 2/3 button. Optical/Mechanical

SOFTWARE SPECIFICATION

- Operating System: Microsoft Windows (64 bit)
- Tech Stach : Turbo C++
- IDE: VS CODE
- File: NOTEPAD (.txt File, .py File, .idx File)

C++

C++ is a powerful and widely used programming language that was developed in the late 1970s as an extension of the C programming language. It was created by Bjarne Stroustrup, who aimed to add object-oriented programming features to C while maintaining its efficiency and flexibility. C++ has since become one of the most popular languages for software development, used extensively in various domains such as system programming, game development, embedded systems, and high-performance applications. One of the key features of C++ is its support for object-oriented programming (OOP), which allows developers to organize code into reusable objects or classes. This paradigm promotes modularity, encapsulation, and code reusability, making it easier to design and maintain complex software systems. Page | 8 C++ also provides low-level programming capabilities inherited from C, such as direct memory manipulation and

pointer arithmetic. This makes it suitable for tasks that require fine-grained control over hardware resources or performance optimization.

Fig 4.1: C++ logo

TURBO C++

Turbo C++ is an integrated development environment (IDE) and compiler for the C++ programming language. It was developed by Borland as an extension of the popular Turbo C IDE, which was widely used for C programming in the 1990s. Turbo C++ provides a user-friendly interface and a set of tools for creating, compiling, and debugging C++ programs.

Fig 4.2: Turbo C++ Logo

Some key features of Turbo C++ include:

1. **IDE Environment**: Turbo C++ offers a user-friendly and intuitive integrated development environment. It provides a text editor for writing code, a compiler for translating the code into machine-readable format, and a debugger for finding and fixing errors in the program.

2. **Compiler**: Turbo C++ includes a fast and efficient compiler that translates C++ source code into machine code. The compiler follows the ANSI/ISO C++ standards and supports a wide range of C++ features and syntax.

3. **Library Support**: Turbo C++ comes with a comprehensive library of functions and classes that can be used to enhance and simplify C++ programming. The library includes standard C++ libraries as well as additional libraries specific to Turbo C++.

4. **Integrated Debugger**: Turbo C++ includes a built-in debugger that allows developers to step through their code, set breakpoints, and inspect variables and memory during program execution. The debugger helps in identifying and resolving programming errors or bugs.

5. **Graphics and UI Development**: Turbo C++ provides support for graphics and user interface development through its Graphics Library (BGI). This allows developers to create graphical applications and games using various graphics functions and commands.

6. **Compatibility**: Turbo C++ is compatible with older versions of the Windows operating system, such as Windows 98 and Windows XP. It also supports DOS-based development, allowing programmers to write C++ programs for DOS environments.

It's worth noting that Turbo C++ is an older IDE that was popular in the past but has since been superseded by more modern development tools. While it may still be used for educational purposes or legacy systems, it may not offer the same level of features, performance, and compatibility as contemporary C++ development environments

VS CODE

VS Code, short for Visual Studio Code, is a popular source code editor developed by Microsoft. It is designed to be lightweight, highly customizable, and optimized for modern programming languages and workflows.

Fig 4.2: VS Code Logo

Here is a brief overview of VS Code:

1. Features and Functionality

VS Code provides a rich set of features to enhance the coding experience. It offers support for syntax highlighting, code completion, code navigation, and debugging capabilities. It also includes built-in Git integration, terminal access, and a wide range of extensions that can be installed to extend its functionality further.

2. Cross-Platform Compatibility

VS Code is available for Windows, macOS, and Linux, making it a versatile choice for developers working on different platforms. It maintains consistent performance and functionality across these operating systems.

3. Lightweight and Fast

VS Code is built to be lightweight and optimized for speed. It starts up quickly and consumes minimal system resources, ensuring a smooth and responsive coding experience even when working with large codebases.

4. Customization and Extensions

One of the standout features of VS Code is its extensive customization options. Users can personalize the editor's appearance, keyboard shortcuts, and settings according to their preferences. Additionally, the VS Code marketplace offers a vast selection of extensions created by the community, enabling users to enhance their coding environment with additional language support, productivity tools, and integrations with various development frameworks and technologies.

5. Integrated Development Environment (IDE) Features

While VS Code is primarily a code editor, it provides several IDE-like features to streamline development workflows. These include integrated terminal support, built-in Git version control, debugging tools, task automation, and more. These features help developers manage their entire development process within a single environment.

Overall, VS Code offers a powerful, customizable, and lightweight coding environment that caters to the needs of developers across different programming languages and platforms. Its extensive feature set, flexibility, and active community make it a popular choice for developers worldwide.

CHAPTER 5

SYSTEM FUNCTIONALITIES

System functionalities refer to the capabilities and features provided by a computer system or software application to perform specific tasks or operations. These functionalities enable users to interact with the system, perform desired actions, and achieve their objectives.

The Login records are stored in the file Course, Student records are stored using the B-trees. The B-trees is done by considering the USN as the primary key.

Course management has the following functionalities:

1. Add Record into the file

A Record can be registered by using providing the course ID, Name, Course, and USN. The record will be stored in the txt file.

2. Search for record using B-tree

A USN can be searched by entering the unique USN and Course_id. The details of the record are displayed if the record exists otherwise displays the message- “No such record exist”.

3. Modify Record

User can modify the status of the case by entering the Course ID,USN after modification the details of the modified will be displayed on the screen.

4. Delete Record

User can enter the Course ID,USN of the particular Student which he/she wants to delete. The record will be deleted from the txt file and the index file will be modified. This ensures the system's flexibility by the deletion of specific record, providing user with efficient data management capabilities.

5. Display all records using B-trees

This operation is used to display all the existing records stored in the txt file to ensure the updation in file after each operation. The Display Course feature presents the complete list of course records in a structured format, enabling users to review and analyse the existing records easily.

CHAPTER 6

SYSTEM IMPLEMENTATION

Implementation is the stage where the theoretical design is turned into a working system. The most crucial stage in achieving a new successful system and in giving confidence on the new system for the users that it will work efficiently and effectively.

The system can be implemented only after thorough testing is done and if it is found to work according to the specification. It involves careful planning, investigation of existing systems and its constraints on implementations, design of methods to achieve the change. Two major tasks of preparing the implementation are education and training of the users and testing of the system.

The implementation phase consists of several activities. The required hardware and software acquisition is carried out. The system may require the need to develop a software. For this purpose, programs are written and tested.

PSEUDO CODES

B-TREES

```
COURSE std;
 int found=0,i;
 block *dp;
 fstream file("COURSE.DAT",ios::in);
 file.seekg(ios::beg);
 dp=bt.search(key,found);
 if(found==0)
cout<<"\n\n\t Record not found...!\n";
 else
 {
```

```
found=0;
for(i=0;i<dp->cnt;i++)
 if(strcmpi(key,dp->keys[i])==0)
 {
found = 1;
file.seekg(dp->disp[i],ios::beg);
std.Unpack(file);
cout<<"\n\n\t Record found : ";
std.Display();
}
 if(found==0) cout<<"\n\n\t Record not found ";
 }
 file.clear();
 file.close();
}
void append()
{
 COURSE std;
 int flag=1, pos;
 fstream file("COURSE.DAT",ios::app);
 std.Input(0);
 file.seekp(0,ios::end);
 pos=file.tellp();
 flag=s.Insert(std.COURSE_ID,pos);
 if(flag && std.Pack(file)) cout << "\n\t Done...\n";
 else cout << "\n\t Failure.";
 file.clear();
 file.close();
```

INSERT RECORD:

```
void createRecord() {
    std::string studentName;
    std::string studentUSN;
    std::cout << "Enter the student name: ";
    std::getline(std::cin >> std::ws, studentName);
    std::cout << "Enter the student USN: ";
    std::getline(std::cin >> std::ws, studentUSN);
    std::ifstream file("courses.txt");
    std::string line;
    bool duplicateUSNFound = false;
    while (std::getline(file, line)) {
        std::istringstream iss(line);
        std::string existingUSN;
        if (iss >> existingUSN) {
            if (existingUSN == studentUSN) {
                duplicateUSNFound = true;
                break;
            }
        }
    }
    file.close();
    if (duplicateUSNFound) {
        std::cout << "Duplicate USN found! Record not created." << std::endl;
        return;
    }
    std::cout << "Enter the number of courses opted: ";
    int numCourses;
    std::cin >> numCourses;
    std::set<int> courseIDs;
```

```
    bool duplicateCourseIDFound = false;
    std::ofstream outputFile("courses.txt", std::ios_base::app);
    for (int i = 0; i < numCourses; i++) {
        std::string courseName;
        int courseId;
        std::cout << "Enter the course ID for course " << i + 1 << ": ";
        std::cin >> courseId;
        if (courseIDs.count(courseId) > 0) {
            duplicateCourseIDFound = true;
            break;
        }
        courseIDs.insert(courseId);
        std::cout << "Enter the course name for course " << i + 1 << ": ";
        std::getline(std::cin >> std::ws, courseName);
        std::replace(courseName.begin(), courseName.end(), '\t', ' ');
        outputFile << studentUSN << '\t' << studentName << '\t' << courseId << '\t' << courseName
<< std::endl;
    }
    outputFile.close();
    if (duplicateCourseIDFound) {
        std::cout << "Duplicate course ID found for the same student! Record not created." <<
std::endl;
        std::ofstream("courses.txt", std::ios_base::app | std::ios_base::out | std::ios_base::trunc);
        return;
    }
    std::cout << "Record created successfully!" << std::endl;
}
```

SEARCH RECORD:

```
void searchRecord() {
    std::string searchUSN;
    std::cout << "Enter the student USN to search: ";
```

```
    std::getline(std::cin >> std::ws, searchUSN);
    std::ifstream file("courses.txt");
    std::string line;
    bool found = false;
    while (std::getline(file, line)) {
        std::istringstream iss(line);
        std::string studentUSN;
        std::string studentName;
        int courseId;
        std::string courseName;
        if (iss >> studentUSN >> studentName >> courseId >> courseName) {
            if (studentUSN == searchUSN) {
                found = true;
                std::cout << "Student USN: " << studentUSN << "\tStudent Name: " << studentName
                        << "\tCourse ID: " << courseId << "\tCourse Name: " << courseName <<
std::endl;
            }
        }
    }
    file.close();
    if (!found) {
        std::cout << "Student USN not found!" << std::endl;
    }
}
```

MODIFY RECORD:

```
void updateRecord() {
    std::string updateUSN;
    std::cout << "Enter the student USN to update: ";
    std::getline(std::cin >> std::ws, updateUSN);
    std::ifstream inputFile("courses.txt");
    std::ofstream outputFile("temp.txt");
    std::string line;
```

```
    bool found = false;
    std::string studentUSN;
    std::string studentName;
    int courseId;
    std::string courseName;
    while (std::getline(inputFile, line)) {
        std::istringstream iss(line);
        if (iss >> studentUSN >> studentName) {
            if (studentUSN == updateUSN) {
                found = true;
                std::cout << "Updating record for student USN: " << studentUSN << std::endl;
                std::cout << "Student Name: " << studentName << std::endl;
                std::vector<std::pair<int, std::string> > courses;
                int numCourses;
                std::cout << "Enter the number of courses to update: ";
                std::cin >> numCourses;
                while (iss >> courseId >> courseName) {
                }
                for (int i = 0; i < numCourses; i++) {
                    std::cout << "Enter the course ID for course " << i + 1 << ": ";
                    std::cin >> courseId;
                    std::cout << "Enter the course name for course " << i + 1 << ": ";
                    std::cin.ignore();
                    std::getline(std::cin, courseName);
                    courses.push_back(std::make_pair(courseId, courseName));
                }
                for (std::vector<std::pair<int, std::string> >::iterator it = courses.begin(); it !=
courses.end(); ++it) {
                        outputFile << studentUSN << " " << studentName;
                    outputFile << " " << it->first << " " << it->second<<std::endl;
                }
                outputFile << std::endl;
            } else{
                outputFile << line << std::endl;
            }
        }
    }
    inputFile.close();
    outputFile.close();
    if (found) {
        std::remove("courses.txt");
        std::rename("temp.txt", "courses.txt");
```

```
        std::cout << "Record updated successfully!" << std::endl;
        found=false;
    }
}
```

DELETE RECORD:

```
void deleteRecord() {
    std::string deleteUSN;
    std::cout << "Enter the student USN to delete: ";
    std::getline(std::cin >> std::ws, deleteUSN);
    std::ifstream inputFile("courses.txt");
    std::ofstream outputFile("temp.txt");
    std::string line;
    bool found = false;
    while (std::getline(inputFile, line)) {
        std::istringstream iss(line);
        std::string studentUSN;
        std::string studentName;
        int courseId;
        std::string courseName;
        if (iss >> studentUSN >> studentName >> courseId >> courseName) {
            if (studentUSN != deleteUSN) {
                outputFile << line << std::endl;
            } else {
                found = true;
            }
        }
    }
    inputFile.close();
    outputFile.close();
    if (found) {
        std::remove("courses.txt");
        std::rename("temp.txt", "courses.txt");
        std::cout << "Record deleted successfully!" << std::endl;
    } else {
        std::remove("temp.txt");
        std::cout << "Student USN not found!" << std::endl;
    }
}
```

DISPLAY RECORD:

```
void viewRecords() {
    std::ifstream file("courses.txt");
    std::string line;
    while (std::getline(file, line)) {
        std::istringstream iss(line);
        std::string studentUSN;
        std::string studentName;
        int courseId;
        std::string courseName;
        if (iss >> studentUSN >> studentName >> courseId >> courseName) {
            std::cout << "Student USN: " << studentUSN << "\tStudent Name: " << studentName
                    << "\tCourse ID: " << courseId << "\tCourse Name: " << courseName << std::endl;
        }
    }
    file.close();
}
```

CHAPTER 7

SYSTEM TESTING

Software testing is defined as an activity to check whether the actual results match the expected results and to ensure that the software system is defect free.

UNIT TESTING

It focuses on smallest unit of software design. In this we test an individual unit or graph of inter related units. It is often done by programmer by using sample input and observing its corresponding outputs.

Example:

a. In a program we are checking if loop, method or if a function is working correctly.
b. Incorrect or misunderstood arithmetic procedures.
c. Incorrect initialization.

In this project we have implemented and tested for different inputs like USN., Username, Password, Student names etc.

INTEGRATION TESTING

When a software test case covers more than one unit, it is considered an integration test. When developing a software test case, the lines between units can quickly evolve into integration tests. The dependency itself will not need to be tested and the integration to it will be mocked or faked. It is of two types: (i) Top down (ii) Bottom up

Example:

a. **Black Box testing** –It is used for validation. Here we ignore internal working mechanism and focus on what the output would be.
b. **White Box testing -**It is used for verification. Here we focus on internal mechanism i.e., how the output is obtained.

SYSTEM TESTING

In this the software is tested such that it works fine for different operating systems. It is covered under the black box testing technique. In this we focus on required inputs and outputs without focusing on internal working.

Sl. No	Functionality	Action	Expected Result	Actual Result	Test Result
1	Inserting User Credentials to b-tree content file	Signing up by entering Course_id, Name, Course Name.	Should insert record to B-tree content file and render the page to Main menu.	Inserts record to B-tree content file and renders to main menu.	PASS
2	Inserting Course details into the file.	Entering Course_id, Course_id, Name, Course Name.	Should insert record in Course file	Inserts record Into the course file	PASS
3	Searching of records from the files	Search the record according to the entered Course_id, Name and Course Name.	Should display the result after searching	Display the result accordingly.	PASS
4	Retrieval of all records from thefiles	Displays all records fromthe Course files	Should display all records from the course files.	Displays all records from the course files.	PASS
5	Modifying Index file after insertion or deletion	Changing index of the record	Should change the index.	Changes the index after insertion or deletion	PASS

6	Modifying of records from thefiles	Modify the record according to the entered Course_id, Name, Course Name.	Should modify the USN after searching	Modify the record accordingly.	PASS
7	Deleting of records from thefiles	Delete the record according to the entered Course_id, Name, Course Name.	Should Delete the record after searching	Delete the record accordingly.	PASS
8	Returning to Main menu on clicking 'quit Program'	Clicking on 'quit Program' button to return to Main menu	Should Render the Current view to Main menu	Renders Current view to Main menu	PASS

CHAPTER 8

RESULTS AND DISCUSSIONS

1. Main screen of Student Course Management System:

Fig 8.1: Main Menu of Portal

The Fig 8.1 shows the Main Menu of Course Portal where user can choose any of the displayed options to perform the operation on the file.

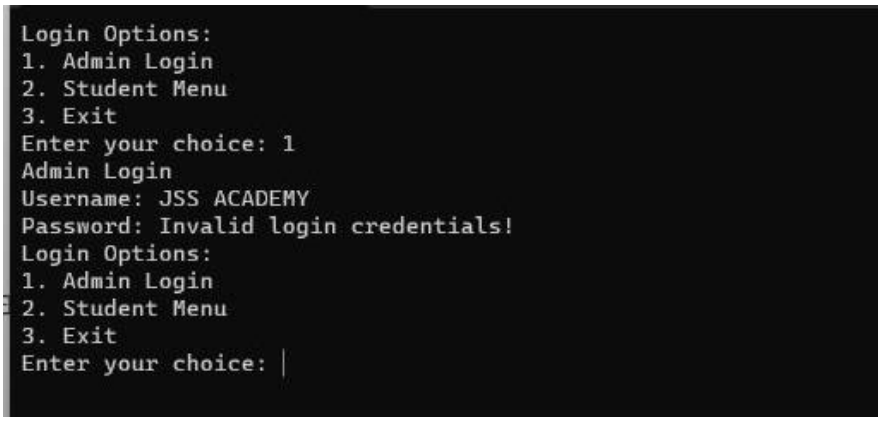

Fig 8.1.1: Failed attempt

The error message is displayed on entering incorrect Username and Password as shown in the Fig 8.1.1.

2. Add records onto Course Management System

On choosing the ‘Add records’ option from the Main Menu the User can add a course by clicking on ‘Add Course Details’ button as shown in the Fig 8.2.And it basically uses Course_id and USN as the primary key and plays the major role in this Student course management system.

```
Admin Menu:
1. Create Student Record
2. View Student Records
3. Search Student Record
4. Update Student Record
5. Delete Student Record
6. Logout
Enter your choice: 1
Enter the student name: Nikhil
Enter the student USN: 059
Enter the number of courses opted: 2
Enter the course ID for course 1: 1
Enter the course name for course 1: FS
Enter the course ID for course 2: 2
Enter the course name for course 2: CN
Record created successfully!
```

Fig 8.2: To Add records to Course Portal

3. Search Records

```
Admin Menu:
1. Create Student Record
2. View Student Records
3. Search Student Record
4. Update Student Record
5. Delete Student Record
6. Logout
Enter your choice: 3
Enter the student USN to search: 1JS20IS062
Student USN: 1JS20IS062 Student Name: Nishanth  Course ID: 101  Course Name: 102
Student USN: 1JS20IS062 Student Name: Nishanth  Course ID: 102  Course Name: DAA
Student USN: 1JS20IS062 Student Name: Nishanth  Course ID: 103  Course Name: ADE
```

Fig 8.3: To Search Record

On choosing the Search USN option from the Main Menu the user can search a student by clicking on “Search Student Details” button as shown in the Fig 8.3.

4. Update Record

```
Admin Menu:
1. Create Student Record
2. View Student Records
3. Search Student Record
4. Update Student Record
5. Delete Student Record
6. Logout
Enter your choice: 4
Enter the student USN to update: 059
Updating record for student USN: 059
Student Name: Nikhil
Enter the number of courses to update: 2
Enter the course ID for course 1: 1
Enter the course name for course 1: ST
Enter the course ID for course 2: 2
Enter the course name for course 2: SCM
Record updated successfully!
```

Fig 8.4: Update Record

On choosing the Update Record option from the Main Menu the user can update a Record by clicking on "Update Record Details" button as shown in the Fig 8.4.

5. Display Student Records in Admin Menu

```
Admin Menu:
1. Create Student Record
2. View Student Records
3. Search Student Record
4. Update Student Record
5. Delete Student Record
6. Logout
Enter your choice: 2
Student USN: 1JS20IS062 Student Name: Nishanth  Course ID: 101  Course Name: 102
Student USN: 1JS20IS062 Student Name: Nishanth  Course ID: 102  Course Name: DAA
Student USN: 1JS20IS062 Student Name: Nishanth  Course ID: 103  Course Name: ADE
```

Fig 8.6: Student Records Display

On choosing the Display/View All records of course, student option from the Main Menu the user can view all existing records on the screen as shown in the Fig 8.6.

6. Files after Modification

```
062     Nishanth        1       DS
062     Nishanth        2       DM
055     Tolha           1       DSA
055     Tolha           2       CC
059     Nikhil          1       FS
059     Nikhil          2       CN
```

Fig 8.7: Course File

Course files are auto-generated as shown in Fig 8.7 respectively.

7. Delete Record

```
Admin Menu:
1. Create Student Record
2. View Student Records
3. Search Student Record
4. Update Student Record
5. Delete Student Record
6. Logout
Enter your choice: 5
Enter the student USN to delete: 1JS20IS062
Record deleted successfully!

Admin Menu:
1. Create Student Record
2. View Student Records
3. Search Student Record
4. Update Student Record
5. Delete Student Record
6. Logout
Enter your choice: 6
Logged out!
```

Fig 8.8 : Delete Record

On choosing the Delete Record option from the Main Menu the user can delete a record by clicking on "Delete Course Details" button as shown in the Fig 8.8

8. Creating and Deleting in the Student Menu

```
Student Menu:
1. Create Student Record
2. Logout
Enter your choice: 1
Enter the student name: Bhuvan B
Enter the student USN: 059
Duplicate USN found! Record not created.

Student Menu:
1. Create Student Record
2. Logout
Enter your choice: 1
Enter the student name: Bhuvan
Enter the student USN: 029
Enter the number of courses opted: 1
Enter the course ID for course 1: 3
Enter the course name for course 1: M1
Record created successfully!
```

Fig 8.9: Student Menu

In order to display the records, we have to provide the correct Course_id. The particulars of the index file are displayed as shown in Fig8.9

CHAPTER 9

CONCLUSION AND FUTURE ENHANCEMENTS

CONCLUSION

The mini project entitled “Student Course Management System” presents a easy to use computerized version of Course data that will not only help to overcome the difficulties of manual process but will also help in ease of administration. In conclusion, the implementation of a “Student Course Management System” using B-trees has proven to be a highly effective solution for efficiently organizing and managing large volumes of student and course-related data. The B-tree data structure's balanced nature allows for fast search and retrieval operations, making it well-suited for handling the complexities of educational institutions and their vast datasets.

Moreover, B-trees facilitate range queries, which are invaluable for tasks like generating reports based on specific date ranges, course categories, or student demographics. This capability enhances the system's functionality, providing valuable insights for decision-making and planning.

Additionally, integrating data compression techniques can optimize storage requirements and address the increasing demands for data storage capacity. By introducing multi-level indexing and efficient cache management strategies, the system's scalability and responsiveness can be enhanced, accommodating the ever-growing volume of student and course information in the

"Student Course Management System". Security measures, including encryption and access control mechanisms, the system's functionalities enable streamlined record management, accurate record-keeping, and easy access to records stored.

In conclusion, the B-tree-based "Student Course Management System" offers a robust, efficient, and scalable solution for educational institutions to streamline administrative tasks, optimize data access, and provide valuable insights. By embracing future enhancements, the system can continuously evolve to meet the changing needs of educational environments, contributing to improved efficiency, data security, and user satisfaction.

FUTURE ENHANCEMENTS

1. Real-time Collaboration: Implement features that allow students and instructors to collaborate in real-time within the course management system. This could include discussion boards, chat functionality, and group project management tools, fostering engagement and improving the learning experience.

2. Adaptive Learning: Incorporate adaptive learning algorithms into the system to personalize the learning experience for students. By analyzing student performance and preferences, the system can dynamically recommend relevant courses, resources, and assignments tailored to each student's needs.

3. Integration with Learning Analytics: Integrate the course management system with learning analytics platforms to leverage data-driven insights. By analyzing student engagement, progress, and performance data, administrators can identify areas of improvement, implement targeted interventions, and enhance teaching methodologies.

4. Automated Course Evaluation: Develop automated course evaluation mechanisms within the system, allowing students to provide feedback on courses, instructors, and overall learning experiences. This feedback can be used to improve course offerings, assess teaching effectiveness, and maintain high-quality education standards.

5. Integration with Learning Management Systems (LMS): Integrate the course management system with popular learning management systems, such as Moodle or Canvas. This integration allows for seamless data exchange between the systems, enabling centralized management of course materials, assignments, grades, and student enrollment.

7. Integration with External Tools and APIs: Enable integration with external educational tools and APIs, such as plagiarism detection software, online assessment platforms, or virtual lab

environments. This integration expands the system's capabilities and provides a comprehensive ecosystem for educational activities.

8. Integration with Student Support Services: Integrate the course management system with student support services, such as academic advising, career services, or counselling. This integration ensures seamless communication and coordination between different support systems, enhancing student success and well-being.

By incorporating these future enhancements into the B-tree-based student course management system, educational institutions can foster collaborative learning environments, personalize education experiences, and leverage data analytics to continuously improve teaching and learning outcomes**.**

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