Rhythmix

A PROJECT REPORT

Submitted by

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CE-IT Department

CERTIFICATE

This is to certify that the Seminar Work entitled **“RHYTHMIX”** has been carried out by **PATEL HIT RAJNIKANT(22BECE30275)** under my guidance in fulfilment of the degree of Bachelor of Engineering in COMPUTER ENGINEERING Semester-6 of Kadi Sarva Vishwavidyalaya University during the academic year 2025-2026.

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Presentation-I for Project- II

1. Name & Signature of Internal Guide	
2. Comments from Panel Members	
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Presentation II - for Project- II

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"Rhythmix" (A music streaming app)

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Abstract

Rhythmix is an innovative music streaming platform designed to deliver a seamless, immersive, and highly personalized audio experience to users across multiple devices. The primary objective of this project is to build a responsive, scalable, and user-friendly web application that empowers music lovers to discover, organize, and enjoy songs effortlessly.

The application includes all essential features expected from a modern music streaming system, such as secure user registration and authentication, a rich music library, playlist creation and management, real-time audio playback, and advanced search capabilities. In addition, *Rhythmix* integrates intelligent recommendation mechanisms that analyze user preferences and listening habits to suggest personalized content, including curated playlists, albums, and artists—enhancing user engagement and satisfaction.

By combining modern technologies, personalized recommendations, and intuitive navigation, Rhythmix delivers a complete and enjoyable music streaming experience tailored for today's digital audience.

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Chapter:1. Introduction

1.1 Introduction

Rhythmix is a web-based music streaming application that allows users to explore, stream, and manage digital audio content over the internet. It offers a smooth and engaging platform for users to discover music from various genres, create personalized playlists, and enjoy high-quality audio playback. The system is developed using modern web technologies that ensure responsiveness, scalability, and a user-centric interface.

In today’s digital era, music consumption has shifted from traditional downloads to on-demand streaming platforms. Users now prefer accessible, cloud-based music services that provide real-time playback, curated recommendations, and the flexibility to listen across multiple devices. Rhythmix addresses this demand by offering a comprehensive set of features that enhance the listening experience.

The application is built using the MERN stack—MongoDB, Express.js, React.js, and Node.js—which enables seamless integration between the frontend and backend, efficient data handling, and a dynamic user interface. Cloud storage is used to manage media files, ensuring fast and reliable content delivery.

Rhythmix not only focuses on the core functionality of music streaming but also aims to create a personalized experience by analyzing user preferences and listening behavior. The ultimate goal is to deliver an intuitive, fast, and enjoyable music streaming platform that caters to modern user expectations.

1.2 Scope

The scope of the Rhythmix project is to develop a full-featured, web-based music streaming application that allows users to access and manage audio content in real-time. The system is designed to support a wide range of music-related functionalities, including user registration, playlist creation, genre-based browsing, audio playback, and personalized recommendations.

The application is intended to be scalable and responsive, allowing seamless access across various devices such as desktops, tablets, and smart phones. It uses cloud-based storage for hosting audio files and ensures secure and efficient access to media content using modern backend technologies.

Key features within the scope of Rhythmix include:

- User authentication and account management
- Browsing and searching music by genre, artist, or album
- Playlist creation, editing, and deletion
- Real-time audio streaming with playback controls
- Personalized music recommendations based on listening history
- Admin panel for managing music content
- Clean and responsive user interface built with modern frontend frameworks

The project does not aim to replace existing commercial platforms but focuses on building a student-level prototype that demonstrates practical implementation of a scalable, media-rich web application using the MERN stack. The scope also includes backend API development, frontend UI design, and integration of cloud services for media handling.

1.3 Project summery and purpose

Rhythmix is a full-stack web application developed as a music streaming platform that provides users with a rich and interactive music experience. The project aims to combine modern web technologies to create a responsive and user-friendly interface where users can explore, listen to, and manage their favorite songs with ease.

The system is built using the MERN stack — MongoDB for flexible database storage, Express.js and Node.js for backend API handling, and React.js for an efficient and dynamic frontend. Audio files are managed using cloud storage services to ensure fast streaming and high availability. The application provides essential features such as user registration, song browsing, playlist creation, real-time music playback, and content recommendations.

The purpose of this project is to demonstrate how real-time, media-heavy applications can be developed using full-stack web technologies. It provides an opportunity to apply theoretical knowledge in software engineering, database management, UI/UX design, and cloud integration into a single, practical solution.

This project also focuses on delivering a personalized user experience by analyzing listening behavior and preferences, enabling the system to offer tailored music recommendations. Overall, Rhythmix showcases the potential of modern development tools to build scalable, engaging, and functional web applications.

Rhythmix is a **cloud-based music streaming web application** that allows users to stream, manage, and interact with digital music entirely online. The system is designed with a strong emphasis on **accessibility**, **scalability**, **modularity**, and **user experience**, ensuring that users enjoy seamless audio playback across various platforms and devices.

The project is built using the **MERN stack — MongoDB, Express.js, React.js, and Node.js** — offering a full-stack JavaScript development environment that ensures consistency across all layers of the application. This stack allows for **rapid development**, **real-time interaction**, and **scalable architecture**.

The application provides a range of **core features**, including:

- **Secure user authentication** via JWT tokens to ensure privacy and data security.
- A powerful **music search and browsing system**, allowing users to find songs by genre, artist, mood, or popularity.
- **Playlist management**, enabling users to create, edit, and delete personalized music collections.

- **Real-time audio streaming** through an integrated music player with essential playback controls.
- **Behavioral analytics and recommendations**, using listening history and preferences to suggest new music.

The **frontend** is developed using **React.js**, enabling a responsive, modern, and component-based UI. The interface adapts across screen sizes, providing a smooth experience on desktops, tablets, and mobile browsers.

The **backend** uses **Express.js** and **Node.js** to build scalable REST APIs that handle business logic, route management, and communication with the database. These APIs enable fast, secure data transactions and interaction with users and administrators.

MongoDB is used as the primary database for storing:

- User profiles and credentials
- Song metadata (title, artist, genre, album, duration)
- Playlist structures
- Admin logs and system events

Cloud storage services (e.g., Cloudinary or AWS S3) are integrated to store and stream audio files efficiently, supporting high bandwidth usage and ensuring low-latency playback performance.

The project is **designed for future growth**, with planned enhancements such as:

- **Mobile app integration** (React Native or Flutter)
- **Voice command features**
- **Dark mode toggle**
- **Social sharing options** for songs and playlists
- **Collaborative playlists** where multiple users can add or manage songs together

1.5 Problem Definition

In the current digital age, users demand **on-demand access to music** that is **fast**, **personalized**, and **device-independent**. Traditional music players, whether offline software or basic streaming platforms, often lack the necessary flexibility, **cloud-based accessibility**, and **intelligent recommendation engines** that modern users expect.

Most existing music streaming solutions suffer from one or more of the following limitations:

- They are **platform-locked**, meaning users are tied to a specific device or operating system.
- They come with **high subscription costs**, limiting accessibility for casual or budget-conscious users.
- They do not offer **individual personalization**, resulting in a generic and less engaging experience.

Moreover, offline players lack features such as syncing across devices, access to user data for playback history, and social playlist sharing, making them outdated in today's connected world.

There is a clear need for a **web-based application** that delivers a **smooth**, **interactive**, and **personalized music streaming experience**, without requiring expensive subscriptions or high-end devices. Users should be empowered to:

- Explore music based on genres, moods, or personal preferences.
- Create, edit, and manage playlists.
- Track their listening history and access their favorite music anywhere, at any time, on any device**.**

Rhythmix addresses this critical gap by offering a comprehensive**,** cloud-enabled, and user-centric online music platform. It is built using modern web technologies to ensure fast performance, scalability, and a great user experience.

In addition to core streaming features, the system is designed with a vision for future integration of:

- **AI-based recommendations**
- **Voice control integration**
- **Collaborative playlists and social sharing**

Thus, Rhythmix not only solves the current limitations but also lays the foundation for a **next-generation music platform** that is **accessible**, **customizable**, and **future-ready**.

Chapter:2.Technology and Literature Review

2.1 About Tools and Technology

Creating **Rhythmix**, a full-featured online music streaming platform, requires a combination of **front-end and back-end technologies** to deliver a seamless, secure, and scalable user experience. The project architecture follows modern web development practices and leverages tools that support responsive design, real-time interaction, and efficient data handling.

Front-End Technologies

1. **HTML/CSS**
   These are the foundational technologies for web development.
   - **HTML** (Hyper Text Markup Language) is used for structuring the content of the web application.
   - **CSS** (Cascading Style Sheets) is used for designing and styling the user interface, ensuring a clean and responsive layout.
2. **JavaScript**
   JavaScript brings interactivity and dynamic behavior to the front end.
   - **React.js** is used in Rhythmix for building reusable UI components, managing state with hooks, and rendering views dynamically.
   - Additional technologies used alongside React include:
     - **Tailwind CSS** for utility-first styling
     - **Axios** for handling HTTP requests
     - **React Router** for navigation between pages

These tools ensure that the frontend is **user-friendly**, **responsive**, and capable of delivering real-time updates without page reloads.

Back-End Technologies

1. **Server-Side Programming (Node.js + Express.js)**
   - **Node.js** is a JavaScript runtime used to build scalable and fast server-side applications.
   - **Express.js** is a lightweight framework on top of Node.js that simplifies routing, middleware integration, and handling HTTP requests and responses.
   - Together, they manage backend logic such as authentication, session control, playlist management, and streaming access.
2. **Database Management System (MongoDB)**
   - **MongoDB** is a NoSQL, document-oriented database that stores data in flexible JSON-like documents.
   - Collections are created for **users**, **songs**, **playlists**, and **admins**, enabling quick data retrieval and updates using **Mongoose**, an ODM (Object Data Modeling) library for MongoDB.
3. **RESTful APIs**

- RESTful APIs serve as the communication bridge between the frontend and backend.
- They are used to perform actions such as user login/logout, song browsing, playlist creation, and music streaming.
- APIs are secured using **JWT tokens** and follow standard HTTP methods (GET, POST, PUT, DELETE).

2.2 Brief History of Work Done

The **evolution of music streaming** has significantly reshaped the way users discover, access, and enjoy audio content. In the early days, music consumption was largely dependent on **physical media** such as **cassette tapes, CDs, and MP3 files**, requiring manual downloads and offline storage. Users had to maintain personal libraries, manage file transfers, and face limitations related to device storage.

With the advancement in **internet infrastructure** and **bandwidth capabilities**, the industry saw a major shift from ownership-based access to **streaming-based models**. Platforms like **Spotify, Apple Music, and YouTube Music** emerged, allowing users to **instantly stream millions of tracks** without downloading them locally.

Over the past decade, music applications have continued to evolve and adopt new trends in technology and user experience:

- **Cloud-Based Song Storage:-**
  Songs and metadata are now stored in scalable cloud infrastructures, enabling high-speed content delivery, redundancy, and device-independent access.
- **Personalized Recommendations Using AI and Machine Learning:-**
  Streaming platforms utilize advanced recommendation algorithms that analyze listening habits, mood preferences, time of day, and even social behavior to curate personalized playlists and suggest new songs.
- **Social Features:-**
  Modern platforms encourage **community engagement** by enabling **playlist sharing**, **collaborative playlist editing**, and features like **live group listening sessions**.
- **Integration with Smart Devices:-**
  Music services are now integrated with **mobile platforms**, **voice assistants** (e.g., Alexa, Google Assistant), **smart TVs**, and **wearables**, expanding how and where users access music.
- The **Rhythmix** project draws inspiration from these technological advancements to build a **streamlined, academic-level streaming solution** that not only mimics standard industry practices but also promotes **innovation and learning**. The focus is on delivering a solution that is:
- **Modular and scalable**, using open-source tools.
- **Feature-rich**, offering playlist management, search, recommendations, and real-time playback.
- **Built on modern web technologies** like the **MERN stack**, which allows for efficient development, component reusability, and real-time capabilities.

Chapter:3. System Requirements Study

3.1 User Characteristics

The target audience for **Rhythmix** primarily includes **general music listeners** who prefer consuming audio content online through a modern, responsive, and feature-rich web application. The system is designed with **simplicity**, **accessibility**, and **usability** in mind, making it suitable for a wide range of users.

General User Requirements and Assumptions:

- Users are expected to have:
  - **Basic knowledge** of navigating and using **web-based applications**, such as signing up, browsing content, using search functions, and interacting with playlists.
  - **Access to a stable internet connection** to ensure smooth streaming, minimal buffering, and quick data retrieval from the cloud-based backend.
  - **Compatible devices**, including:
    - Smartphones (Android/iOS)
    - Tablets
    - Laptops
    - Desktop
    - computers

      All devices should have **modern web browsers** (e.g., Chrome, Firefox, Safari, Edge) that support the latest JavaScript and CSS standards.

User Roles in the System:

- **General Users:**
  - Can **register and authenticate** securely through the login system.
  - Have access to **browse and stream music** by genre, artist, album, or keyword.
  - Can **create, modify, and delete playlists** for personalized listening experiences.
  - Can receive **personalized song recommendations** based on their activity.
  - May update personal profile settings and view listening history in future versions.
- **Administrators (Admins):**
  - Have **elevated privileges** to maintain the quality and integrity of the platform.
  - Can **upload new songs**, including metadata such as title, artist, genre, album, and audio file.
  - Can **manage and moderate user accounts**, ensuring adherence to platform policies.
  - Can monitor **system activity**, view logs, and remove inappropriate or duplicate content.
  - May assist in curating featured playlists or managing content categories.

3.2 Hardware and Software Requirements

Hardware Requirements:

Component	Minimum Requirement	Remarks
Processor	Intel i3 or equivalent	Required to run development tools and local servers efficiently
RAM	4 GB or higher	Essential for running React development server and Node.js simultaneously.
Storage	500 MB for development	Additional space needed for storing music files and dependencies.
Display	Any modern HD display	To ensure proper rendering and testing of responsive UI.

(Table :1)

Software Requirements:

Component	**Details**	**Purpose**
Operating System	Windows 10 / Linux / macOS	Cross-platform compatibility for developers and end-users
Frontend Framework	React.js	Used to build dynamic, component-based UI with support for routing and state
Backend Framework	Node.js with Express.js	Manages REST API routing, user authentication, and server-side logic
Database	MongoDB	NoSQL database to store user profiles, playlists, and song metadata
Browser	Chrome / Firefox / Edge	Required for running and testing the web app interface
Code Editor	Visual Studio Code	Lightweight and popular

		code editor with extensions for MERN development
Tools & Utilities	Postman, Git, GitHub, Cloudinary	Improves development workflow, team collaboration, and cloud integration

(Table:2)

3.3 Constraints

3.3.1 Regulatory Policies

The **Rhythmix** project adheres to general principles of **data privacy**, **user information protection**, and **ethical content usage**. While it is developed solely for **academic and educational purposes**, the system design considers foundational compliance with common digital regulations.

- **User Data Privacy:**
  Basic user information such as email and password is stored securely using encryption and authentication standards like **JWT** and **bcrypt hashing**. Although not subject to full-scale compliance laws (e.g., GDPR, CCPA), the application follows best practices for protecting personally identifiable information (PII).
- **Content Usage Disclaimer:**
  The platform does not distribute or stream licensed or copyrighted music. All audio files used during development or demonstration are either:
  - Open-source/free music tracks
  - Developer-generated dummy files
  - Placeholder content meant for UI/UX testing only
- **Non-Commercial Intent:**
  Rhythmix is a **non-commercial academic project**, and it does not support monetization, paid subscriptions, or any commercial distribution of music content. As such, it is exempt from digital media licensing requirements.
- **Intellectual Property (IP):**
  All code, UI design, and database structures are original to the developers, or properly attributed if external libraries or tools are used. Any third-party APIs or cloud services integrated are used under free-tier educational terms.
- **Potential Future Compliance:**
  If Rhythmix is extended beyond academic boundaries, it will require adherence to formal regulations such as:
  - **DMCA** for content ownership
  - **GDPR/CCPA** for user data management
  - **Music Licensing** through organizations like ASCAP, BMI, or Creative Commons licensing platforms

3.3.2 Hardware Limitations

While **Rhythmix** is designed to be lightweight and responsive, there are certain **hardware-related limitations** that may impact performance, especially on lower-end or outdated systems.

- **Device Processing Power:**
  Users with **low-end CPUs** (e.g., older dual-core processors) may experience slower page load times, lag during playback, or unresponsive UI interactions. The frontend application, developed in **React.js**, performs best with modern multi-core processors that can handle dynamic component rendering and background API calls smoothly.
- **Limited RAM:**
  Devices with **less than 4 GB of RAM** may struggle with multi-tab browsing or concurrent background applications running alongside Rhythmix. Memory-intensive operations such as managing large playlists, fetching real-time suggestions, and loading media content can lead to occasional slowdowns or browser crashes.
- **Graphics Rendering and Display Issues:**
  Although the platform does not use heavy graphics or animations, older GPUs or integrated graphics chips may still have issues rendering responsive layouts, especially during animations like loading spinners or transitions.
- **MobileDevices:**
  On **entry-level smart phones**, the React-based frontend might consume noticeable resources, especially when playing high-quality audio while navigating other features like search or playlist editing.
- **Dependence on Network Speed:**
  Since audio content is streamed from **cloud storage**, slow or unstable internet connections (below 2 Mbps) can lead to **buffering**, **delayed playback**, or **incomplete media loading**. Fast, stable connectivity is recommended for uninterrupted streaming.

3.3.3 Interfaces to Other Applications

Rhythmix interacts with several external platforms and services to deliver a smooth, scalable, and integrated streaming experience. These external interfaces enable the application to offload heavy processing, manage media efficiently, and enhance cross-platform compatibility.

- **Cloud Storage Platforms**
  Rhythmix integrates with cloud-based media hosting services such as **Cloudinary**, **Firebase Storage**, or **AWS S3**. These platforms are used to:
  - Store and retrieve **audio files**
  - Serve music content over **CDNs (Content Delivery Networks)** for faster access
  - Handle image assets such as song thumbnails or user avatars
    These integrations ensure that the application does not rely on local server storage, improving performance and scalability.
- **Web Browser APIs**
  The application uses **native browser APIs**, particularly the **HTML5 `<audio>` element** and **Media APIs**, to:
  - Stream audio content directly in the browser

    - Control playback functions (play, pause, volume, seek)
    - Detect events like end of track or buffering for real-time UI updates These APIs enable **cross-browser compatibility** and eliminate the need for third-party audio players.
- **MongoDB Atlas**
  The backend is connected to **MongoDB Atlas**, a fully managed cloud version of MongoDB. It supports:
    - Scalable and secure **cloud-based data storage**
    - Real-time data access for users, playlists, and song metadata
    - Integration with **Mongoose** for defining data schemas, relationships, and validation MongoDB Atlas provides backup, monitoring, and performance optimization out of the box, making it ideal for a production-grade backend.

3.3.4 Parallel Operations

Rhythmix is designed to support smooth and efficient **parallel operations**, enhancing the user experience by allowing multiple actions to be performed simultaneously without interrupting media playback or degrading performance.

The system allows users to:

- **Browse the platform while music is playing**
    - The built-in **persistent audio player** remains fixed (usually at the bottom of the screen) and continues playing music even as users navigate between different pages or sections (e.g., Home, Browse, Profile).
    - This is achieved through **React component isolation** and **state management**, ensuring that the audio component is not unmounted during route changes.
- **Access multiple playlists**
    - Users can open or switch between different playlists without interrupting playback.
    - Playlists are rendered dynamically and can be previewed, edited, or queued for playback in parallel with ongoing listening.
- **Perform searches while playback is active**
    - The search function works independently of the music player.
    - Users can search for new songs, albums, or artists and even queue songs to playlists while a current track continues playing.
    - This feature leverages **asynchronous operations** (e.g., async/await with Axios) to avoid blocking the main thread or affecting media control.

3.3.5 Higher Order Language Requirements

The **Rhythmix** platform is developed using **JavaScript-based technologies**, specifically the **MERN stack** — **MongoDB**, **Express.js**, **React.js**, and **Node.js**. These technologies rely on **higher-order programming concepts** and modern development practices, which require a solid understanding of:

- **JavaScript ES6+ Syntax and Features**
  Developers must be familiar with:
  - Arrow functions, destructuring, template literals
  - Promises and async/await for handling asynchronous operations
  - Spread/rest operators and higher-order array functions like `.map()`, `.filter()`, and `.reduce()`
- **Asynchronous Programming**
  Since both frontend (React.js) and backend (Node.js) operations often involve **non-blocking code** (e.g., API calls, file uploads, and database queries), developers must understand:
  - Event-driven architecture
  - Callback functions and chaining
  - Async/await syntax and Promise-based workflows for RESTful API handling
- **Framework-Specific Concepts**
  - **React.js**: Component lifecycle, hooks (e.g., `useState`, `useEffect`), props, state management, and routing
  - **Node.js & Express.js**: Middleware, routing, request/response handling, JWT authentication, and error handling
  - **MongoDB & Mongoose**: Schema modeling, data validation, and aggregation pipelines
- **Tooling and Build Systems**
  Working with JavaScript at this scale also involves using tools like:
  - **Webpack**, **Babel**, and **ESLint** for code transpilation and linting
  - **NPM** or **Yarn** for managing dependencies
  - **Git** and **version control** for collaborative development

3.3.6 Reliability Requirements

To ensure a smooth and dependable user experience, **Rhythmix** is designed with strong reliability goals in mind. These requirements are critical for maintaining user trust and supporting uninterrupted streaming, especially during real-time usage.

- **The system should maintain consistent uptime and quick response time**
  - Rhythmix aims to achieve **high availability (99.9% uptime)** by using reliable cloud infrastructure (e.g., MongoDB Atlas, Vercel/Render for deployment).
  - Backend APIs are optimized to respond within milliseconds to user actions such as login, search, or playlist loading.
  - Load balancing and potential use of caching (e.g., Redis or CDN for static files) can help distribute requests and minimize latency during peak usage.
- **Music playback must continue without interruption during normal usage**
  - The integrated audio player uses **HTML5 Audio API** and is built to persist even when users navigate between pages, ensuring **continuous playback**.
  - Songs are streamed from **cloud storage services** using pre-buffering techniques to minimize buffering delays or drops.

- Error handling and fallback mechanisms are in place to manage scenarios like temporary audio file unavailability or poor internet connection, preventing the player from crashing.

Additional reliability measures include:

- **Robust error handling** on both frontend and backend
- **Retry mechanisms** for failed API or audio requests
- **System monitoring** tools (e.g., LogRocket, Sentry, or backend logs) to track crashes and uptime metrics

3.3.7 Criticality of the Application

While Rhythmix is an entertainment-based application, and therefore not considered critical in the same sense as medical, defense, or financial systems, it still holds a significant level of importance in terms **of** user expectations**,** engagement, and platform success**.**

- **Not Mission-Critical :**

  The application does not manage sensitive personal data (like health records or bank accounts), nor does it control any real-world physical systems. Therefore, failure or downtime does not result in life-threatening or financially disastrous outcomes.

- **User Experience is Crucial :**

  Despite not being mission-critical, system reliability**,** performance, and seamless playback are vital for:

  - User satisfaction and retention
  - App credibility and brand perception
  - Longer session durations and platform loyalty
  -

- **Availability and Responsiveness:**

  Entertainment applications like Rhythmix compete in **a** highly user-driven environment**,** where even short downtimes, lag, or unresponsive interfaces can drive users to alternative platforms. As such:

  - The system must provide consistent uptime
  - Playback and navigation must be fast and uninterrupted
  - Errors must be handled gracefully, without breaking the user journey
  -

- **Growth Impact:**

As the user base grows, **scalability** and **fault tolerance** become more critical. While the current academic version is not business-critical, a production-ready version must be built with **resilience** and **load-handling** in mind.

3.3.8 Safety and Security Consideration

Security is a vital aspect of **Rhythmix**, especially since the platform handles user authentication, account management, and interaction with cloud-based services. The system is designed with modern **web security practices** to ensure the protection of user data and prevent unauthorized access or misuse.

- **Secure Login using JWT**
  - The application uses **JSON Web Tokens (JWT)** for secure user authentication.
  - After successful login, the server issues a token that is stored securely (e.g., in HTTP-only cookies or localStorage) and attached to each request for verifying user identity.

- **All API Endpoints Are Protected**
  - Backend routes are guarded with **authentication middleware** to verify JWTs.
  - This prevents unauthorized users from accessing protected routes such as playlist management, profile updates, or song uploads.
  - Role-based access control ensures that admin-only routes are restricted from general users.

- **User Data is Encrypted and Not Exposed**
  - Sensitive data like **passwords** are encrypted using secure **hashing algorithms** (e.g., bcrypt) before being stored in the database.
  - Personal data such as email addresses and user activity is never exposed through frontend components or APIs unless authorized.
  - HTTPS is enforced (in production) to protect data during transmission.

- **The System is Designed to Prevent Unauthorized Access**
  - Input validation and sanitization are used to prevent attacks like **SQL Injection**, **Cross-Site Scripting (XSS)**, and **Cross-Site Request Forgery (CSRF)**.
  - Failed login attempts are tracked, and optional account lockout mechanisms can be added to prevent brute-force attacks.
  - Cloud assets (like audio files) are hosted with access control policies to prevent direct file access by unauthorized users.

3.4 Assumptions and Dependencies

The development and smooth functioning of **Rhythmix** are based on several assumptions and external dependencies. These conditions are essential for the application to operate as expected and deliver a consistent user experience.

- **A reliable internet connection is available to the user**
  - Since Rhythmix is a **cloud-based music streaming platform**, continuous internet connectivity is required for streaming audio, fetching playlists, and interacting with the database.
  - A minimum recommended bandwidth of **2 Mbps** ensures seamless playback without buffering.
- **Users will access the application via modern browsers**
  - The application is designed and tested on the latest versions of **Google Chrome**, **Mozilla Firefox**, and **Microsoft Edge**.
  - These browsers support essential technologies such as **HTML5**, **CSS Grid/Flexbox**, **Web APIs**, and **JavaScript ES6+**, which are used extensively in the frontend.
- **Cloud services are available and functional**
  - The system relies on third-party cloud services such as:
    - **Cloudinary** or **Firebase Storage** for hosting and serving audio files
    - **MongoDB Atlas** for database operations
    - **Render**, **Vercel**, or **Heroku** for backend and frontend deployment
  - It is assumed that these services are running without downtime and offer required free-tier or paid-tier resources during development and testing.
- **Media files uploaded are legally owned or for educational/demo purposes only**
  - Since this is an **academic project**, any music or audio uploaded is assumed to be:
    - Original or royalty-free content
    - Sourced with permission or used under fair-use/demo rights
  - No licensed or commercial music is intended for public distribution through the platform.
- **Application will be hosted on a platform like Render, Vercel, or Heroku**
  - The application assumes a **cloud hosting environment** that supports Node.js, static frontend deployment, environment variable management, and Git-based CI/CD integration.
  - Hosting providers are expected to handle SSL, domain routing, and basic scaling.
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Chapter:4. System Analysis

4.1 Study of Current System

Currently, users rely on a variety of **commercial music streaming applications** to access audio content. Popular platforms such as **Spotify**, **Apple Music**, **YouTube Music**, and **Amazon Music** offer users features like curated playlists, music categorization by genre or mood, and powerful search functionality. These systems are highly polished and user-friendly but come with several limitations that impact accessibility, personalization, and flexibility.

Key observations of existing systems:

- **Subscription-Based Access**
    - Most mainstream platforms follow a **freemium model**, offering limited features for free and requiring **monthly or annual subscriptions** for premium features such as ad-free streaming, offline downloads, high-quality audio, and unlimited skips.
    - For casual listeners or students, this cost becomes a barrier to full access.
- **Limited Customization**
    - While users can create and manage playlists, deeper customization — such as collaborative playlist editing, visual themes, or interface personalization — is often restricted or not offered at all.
    - Recommendation systems are typically opaque, offering limited control over what gets suggested or why.
- **Low User Control Over Content Flow**
    - Content recommendation and playback queues are **algorithmically driven**, and users have limited influence over how content is discovered, grouped, or promoted.
    - In many cases, personal preferences are overridden by commercial promotion or trending content.
- **Lack of Educational or Open-Source Alternatives**
    - There is a scarcity of academic or **open-source platforms** that students or developers can use to experiment with and learn the internals of a music streaming system.
    - Most commercial systems are proprietary and closed to external development.

4.2 Problems and Weaknesses of Current System

Despite the popularity of commercial music streaming platforms, there are several **inherent problems and weaknesses** in the current systems that affect user experience, accessibility, and personalization.

- **Lack of control over personal playlists and content management**
    - Users often have limited ability to organize their music beyond basic playlist creation.
    - Features like playlist folders, manual sorting, bulk edits, or collaborative tools are either absent or restricted behind paywalls.
- **Limited recommendation transparency**

    - Recommendation engines on platforms like Spotify and YouTube Music operate as "black boxes".
    - Users are not given clarity on **why certain tracks are suggested**, making personalization feel automated rather than user-driven.
- **Dependence on pre-curated content by algorithms**
    - Music discovery is largely controlled by AI algorithms which may prioritize commercial interests, trending content, or label-sponsored tracks.
    - This can limit exposure to diverse or niche music genres that a user might actually enjoy.
- **Restricted free access and advertisements**
    - Free-tier users face **interruptions through ads**, **limited skips**, and **no offline downloads**.
    - These restrictions often push users toward subscriptions, creating a barrier for casual or low-income users.
- **Inaccessibility of content across different platforms or regions**
    - Licensing agreements cause certain songs or albums to be **region-locked**, making them unavailable to users in specific countries.
    - Moreover, some platforms lack **cross-device synchronization**, forcing users to repeat actions on each device.
- **Complex and overloaded user interfaces in some systems**
    - Many modern apps are cluttered with **too many features**, banners, and promotions.
    - This can overwhelm users, especially those seeking a simple and clean interface for quick access to their music.

4.3 Requirements of New System

Rhythmix addresses the limitations of existing systems by offering a **clean, interactive, and user-focused platform** that enables users to manage and stream music with greater **freedom, flexibility, and control**. To ensure this, the system must meet a range of **functional and non-functional requirements**.

Functional Requirements:

- Users should be able to **register and log in securely** using email and password.
- The system must allow users to **browse music by genre, artist, album, or keyword search**.
- Users should be able to **create, update, and delete playlists** as per their preferences.
- Real-time **audio playback with controls** (play, pause, skip, shuffle, repeat) must be available.
- The platform should **recommend songs** based on user behavior and listening history.
- Admins should be able to **upload and manage songs**, moderate user activity, and handle reported content.

Non-Functional Requirements:

- The UI must be **clean, responsive, and intuitive**, ensuring a seamless experience across devices.
- The application should offer **consistent performance** even during high traffic or concurrent user activity.
- System response time should be **minimal**, especially during song streaming and search operations.
- The system must ensure **data privacy and security**, using techniques like JWT authentication and encrypted storage.
- Media streaming should be **reliable**, with minimal buffering, even under varying internet speeds.
- The platform should support **scalability**, allowing integration with mobile apps or advanced features in the future.

4.3.1 User Requirements

The **end-users** of Rhythmix expect an intuitive, reliable, and enjoyable music streaming experience. To meet these expectations, the system must fulfill the following key requirements:

- **Easy Registration and Login**
  - Users should be able to **quickly sign up** using their email and password.
  - The login process must be **secure**, using **JWT-based authentication** to protect user sessions.
  - Basic validation and feedback should be provided for incorrect credentials or input errors.
- **Search Functionality to Find Music by Genre, Artist, or Title**
  - The application must support a **real-time search bar** with filtering capabilities.
  - Users should be able to search by **song title**, **artist name**, **genre**, or even keywords.
  - Autocomplete or suggestion-based search can further enhance user experience.
- **Ability to Create, Update, and Delete Playlists**
  - Users should have full control over playlist management:
    - **Create** a new playlist by assigning a name and selecting songs
    - **Update** playlists by adding/removing tracks or renaming
    - **Delete** playlists when they are no longer needed
  - Playlists should be saved under the user's profile and accessible across sessions.
- **Audio Streaming with Standard Controls (Play, Pause, Skip, etc.)**
  - A built-in **audio player** should support essential controls like:
    - Play / Pause
    - Next / Previous track
    - Volume control and mute toggle
    - Seek/progress bar
  - Playback should remain active as the user navigates the platform.
- **Personalized Recommendations**
  - Based on listening history, liked songs, or user interactions, the system should suggest relevant tracks.

    - Recommendations may be grouped by genre, mood, or trending content.
- **Device-Responsive Interface**
    - The platform should provide a **responsive layout** that works across:
        - Desktops
        - Laptops
        - Tablets
        - Smartphones
    - UI components must adapt to screen sizes to maintain usability and visual appeal on all devices.

4.3.2 System Requirements

To ensure the robust functioning and future scalability of **Rhythmix**, the following **system-level requirements** must be fulfilled. These components form the technical foundation of the application and are essential for both user-side and admin-side operations.

- **RESTful API Endpoints for CRUD Operations**
    - The backend should expose a set of well-structured **RESTful APIs** that allow for:
        - **Create, Read, Update, and Delete (CRUD)** operations on users, songs, and playlists
        - Modular endpoints for actions like registering users, updating playlists, searching songs, and managing admin content
    - These APIs should follow standard **HTTP methods** (GET, POST, PUT, DELETE) and return structured **JSON responses**.
- **Cloud-Based Storage for Songs**
    - Audio files must be hosted on reliable **cloud storage platforms** like **Cloudinary**, **Firebase Storage**, or **AWS S3**.
    - This ensures fast delivery, global accessibility, and media optimization.
    - Uploaded songs should be accessible through secured URLs and organized in appropriate folders (e.g., by genre or artist).
- **User Session Management with Secure JWT Tokens**
    - Upon successful login or registration, users should receive a **JWT (JSON Web Token)** that is used to authenticate and authorize subsequent requests.
    - The system should include **middleware** to protect private routes and verify token validity for secure access to playlists, uploads, and user profiles.
- **Scalable Backend and Optimized Frontend**
    - The backend (built with **Node.js and Express.js**) must support horizontal scalability to accommodate growing user traffic.
    - The frontend (developed with **React.js**) should be optimized for performance through:
        - Code splitting
        - Lazy loading of components
        - Efficient state management using tools like Context API or Redux
    - Both layers should be container-friendly and easily deployable to platforms like Render, Vercel, or Heroku.
- **Admin Control Panel for Content Management**

- A dedicated **admin dashboard** should allow administrators to:
    - Upload or remove songs
    - View user activity or content reports
    - Moderate inappropriate content
    - Monitor overall platform health
- Admin access must be restricted using **role-based authentication**.

4.4 Feasibility Study

4.4.1 Does the system contribute to the overall objectives of the organization?

Yes, **Rhythmix** aligns with the goals of academic institutions and software engineering programs by:

- Serving as a **real-time, full-stack demonstration** of modern web development.
- Encouraging **practical learning** through the use of the **MERN stack** and cloud technologies.
- Allowing students to showcase **end-to-end software development skills** including UI/UX design, backend logic, API handling, cloud storage, and deployment.
- Providing a foundation for future enhancements like AI integration, mobile app conversion, and external API use.

Thus, the project fulfills educational objectives related to **technical skill development**, **team collaboration**, and **academic innovation**.

4.4.2 Can the system be implemented using the current technology and within the given cost and schedule constraints?

Yes, the system is **fully feasible** using current technologies and within academic project constraints:

- **Technologies Used:**
    - All components of the system are built using **open-source tools** (MongoDB, Express.js, React.js, Node.js), which are **freely available** and supported by large communities.
    - Deployment platforms like **Render**, **Vercel**, and **MongoDB Atlas** offer **free-tier hosting**, making the project **cost-effective**.
    - Tools like **Postman**, **GitHub**, and **Cloudinary** (under free limits) also reduce cost.
- **Cost Feasibility:**
    - Since all tools and platforms used fall under the **free tier or student license**, no additional budget is required for infrastructure.
- **Schedule Feasibility:**
    - The system has been designed, developed, and deployed within a **single semester** (~4-5 months).
    - The modular architecture allows for rapid development and iterative testing.
    - Agile or milestone-based task tracking ensures timely completion of core features.

4.4.3 Can the system be integrated with other system which are already in place?

Yes, Rhythmix is built with **modular and API-driven architecture**, which allows:

- **Future integration** with third-party services like:
  - Voice assistants (e.g., Alexa, Google Assistant)
  - Music recommendation APIs
  - Social media APIs for sharing playlists or login via OAuth
- Current integration includes:
  - **Cloudinary/Firebase Storage** for audio hosting
  - **MongoDB Atlas** for cloud database connectivity
  - **RESTful APIs** for frontend-backend communication
- The use of **standard protocols (HTTP, JSON, JWT)** ensures easy adaptation and communication with other systems or services in the future.

4.5 Requirements Validation

The **validation process** ensures that the final Rhythmix system **accurately fulfills the original requirements and user expectations** defined during the initial planning phase. The goal is to verify that the implemented features match what was promised in the system specifications and user stories.

- **Comparison with Initial Requirements and User Stories**
  - At the beginning of the project, **functional and non-functional requirements** were documented, including features like secure login, playlist management, real-time playback, and mobile responsiveness.
  - These were translated into **user stories** such as:
    - "As a user, I want to search for songs by genre or artist."
    - "As a user, I want to create and manage playlists."
  - After development, the final prototype was **manually reviewed** against these stories to ensure that all expected actions and flows were available and functioning.
- **API Validation using Postman**
  - **Postman** was used to test each **RESTful API endpoint**, including user registration/login, playlist creation, song retrieval, and admin actions.
  - Each endpoint was validated for:
    - Correct input/output structure (JSON format)
    - Appropriate status codes (200 OK, 400 Bad Request, 401 Unauthorized, etc.)
    - Proper authentication enforcement using JWT tokens
    - Expected data updates in the MongoDB database
- **Manual Frontend Walkthroughs**
  - The user interface was tested by performing **manual walkthroughs** on the deployed platform:
    - Creating an account, logging in/out

        - Browsing songs, creating playlists
        - Playing audio tracks using the integrated music player
    - These walkthroughs helped confirm that **functional requirements** were met and that the system provided a **smooth and intuitive user experience**.
- **Bug Reporting and Fixes**
    - During testing, any mismatches between expected and actual behavior were logged and addressed through code fixes and retesting.

4.6 Activity/Process in New System (Event Table)

Event	Trigger	**System Activity**
User login	User enters credentials	Authenticate and create session token
Search song	Keyword submitted	Filter music from database
Create playlist	User clicks “New Playlist”	Store playlist details in database
Play song	Click on play button	Fetch audio URL and stream from cloud
Logout	Logout click	Destroy session/token

(Table:3)

4.7 Features of New System

The **Rhythmix** platform is designed with a wide range of essential and modern features to provide a complete and user-friendly **online music streaming experience**. Below are the key features included in the new system:

- **User Registration/Login System**
    - Users can securely register and log in using email and password.
    - The system uses **JWT-based authentication** to manage user sessions, ensuring secure access and data protection.
    - Role-based access distinguishes between general users and administrators.
- **Music Browsing and Search**
    - Users can browse available songs based on **genres, artists, or album names**.
    - A **search bar with real-time filtering** allows users to find tracks quickly and efficiently.
    - Autocomplete suggestions can enhance the user experience during search.
- **Playlist Creation and Editing**

    - Users have the ability to **create custom playlists**, add or remove songs, rename them, and delete them as needed.
    - Each playlist is stored under the user's profile and saved in the cloud for persistent access across sessions.
- **Real-Time Audio Playback**
    - A built-in audio player supports real-time playback with standard controls such as **play, pause, skip, and seek**.
    - The music player remains **persistent across page navigation**, allowing uninterrupted listening.
    - Playback buffering is minimized using **cloud-hosted media files**.
- **Personalized Recommendations**
    - The system analyzes user activity such as recently played songs or playlist content to suggest **personalized music recommendations**.
    - In future enhancements, this feature can be extended using **machine learning models** to further improve accuracy.
- **Responsive User Interface**
    - The application is built with **React.js** and styled using **Tailwind CSS**, ensuring responsiveness across various screen sizes.
    - The UI is optimized for **mobile phones, tablets, and desktops**, providing a consistent experience across devices.
- **Cloud-Based Song Storage**
    - Songs are uploaded and stored using **cloud storage platforms** such as **Cloudinary** or **Firebase Storage**.
    - This enables **fast and scalable media streaming**, easy content management, and secure access control.

4.8 Class Diagram:

ELEMENTS IN CLASSDIAGRAM

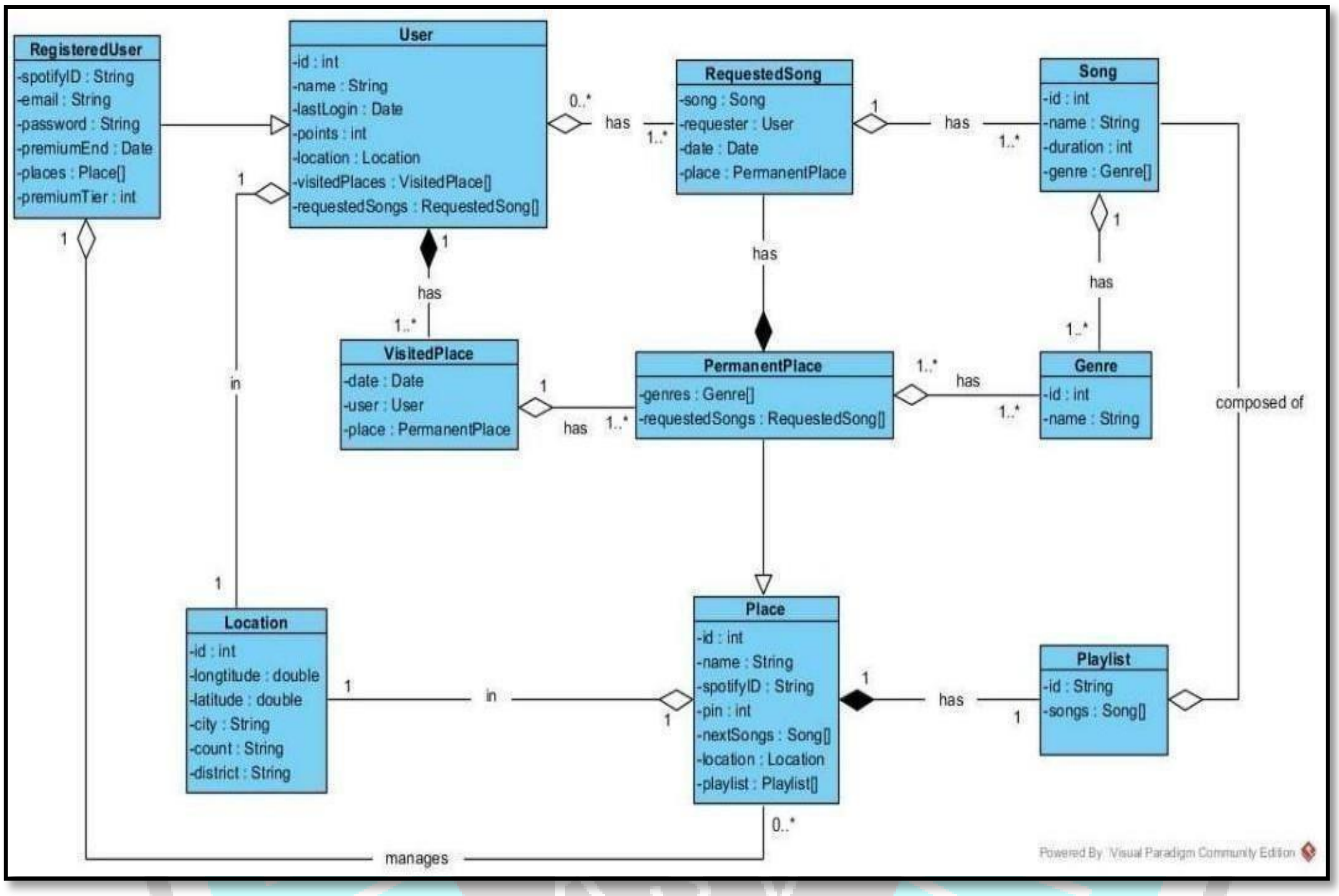
Class diagram contains the system classes with its data members, operations and relationships between classes.

Class

A set of objects containing similar data members and member functions is described bya class. In UML syntax, class is identified by solid outline rectangle with three compartments which contain

- Class name
- Attributes

- Operations



(Figure 1:MODEL CLASSES DIAGRAM)

<u>**4.9 System Activity (Use Case / Scenario Diagram):**</u>

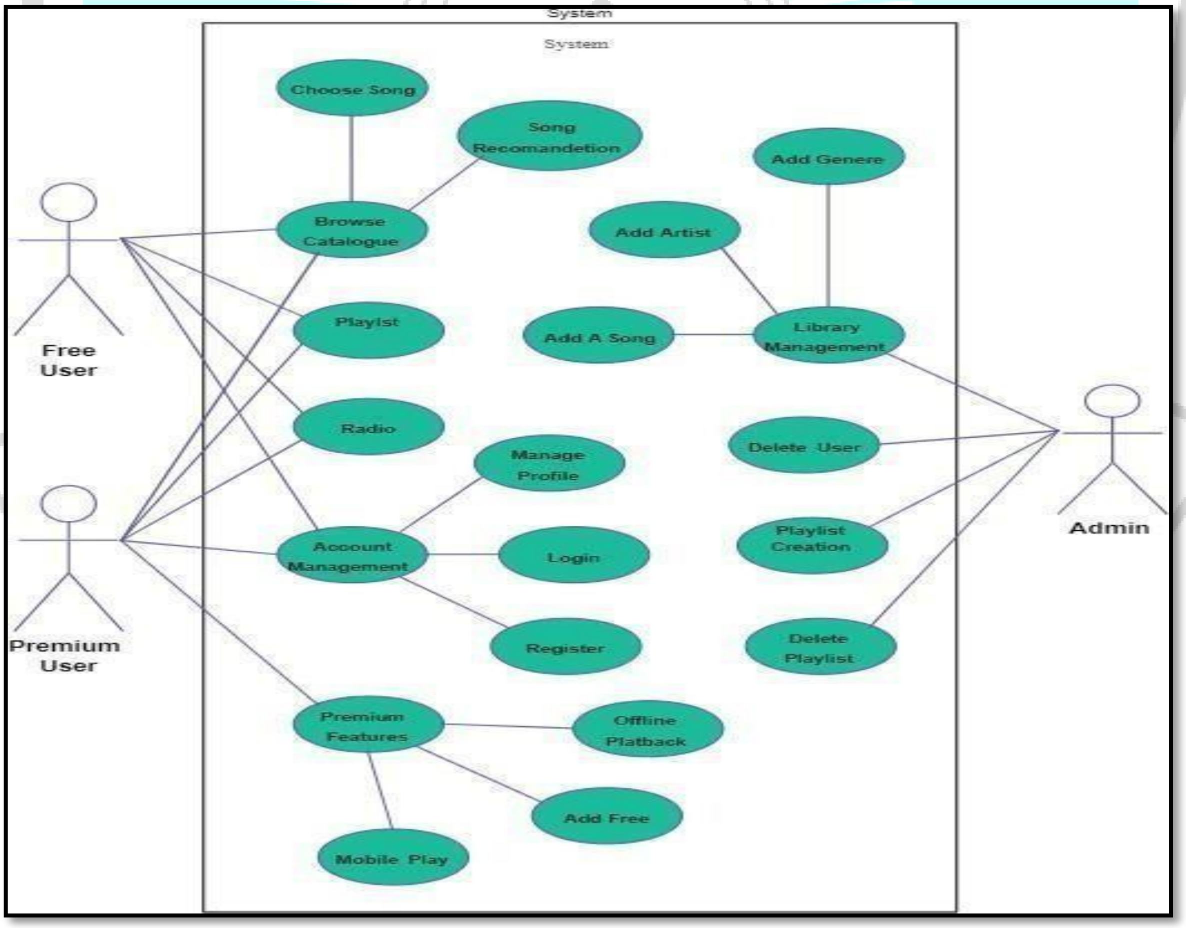
ELEMENTS IN USECASE DIAGRAM

A use case diagram for a Rhythmix is a visual representation of the various interactions and functionalities with in the system. Here's a theoretical explanation of the elements and concepts typically found in a use case diagram for a Rhythmix:

1. **Actors**:
   - **GuestUser**:A person who is not logged in to the Rhythmix but can perform actions like registration and authentication.
   - **Member User(Logged-in)**:A user who has successfully logged into their account and can access additional features.
2. **Use Cases**:

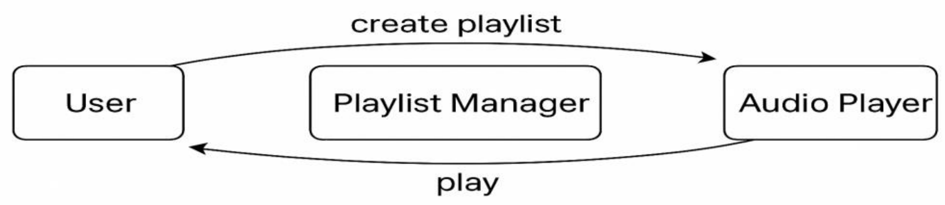
- **User Registration**: Represents the process of creating a new user account with in the Rhythmix.

3. **Relationships**:
    - **Association**: The lines connecting actors to use cases show that actors interact with the system through these use cases. For example, both guest and member users can access the "Search Music" and "Browse & Discover" features.
    - **Generalization**: If there are different types of users with varying permissions and access levels (e.g., regular users and administrators), you can represent these as generalizations or specializations of the "User" actor.
4. **System Boundary**:
    - The box surrounding the use cases and actors represents the system boundary ,indicating that all these elements are part of the Rhythmix system.



(Figure 2:Use Case Diagram for Rhythmix)

4.10 Object Interaction:



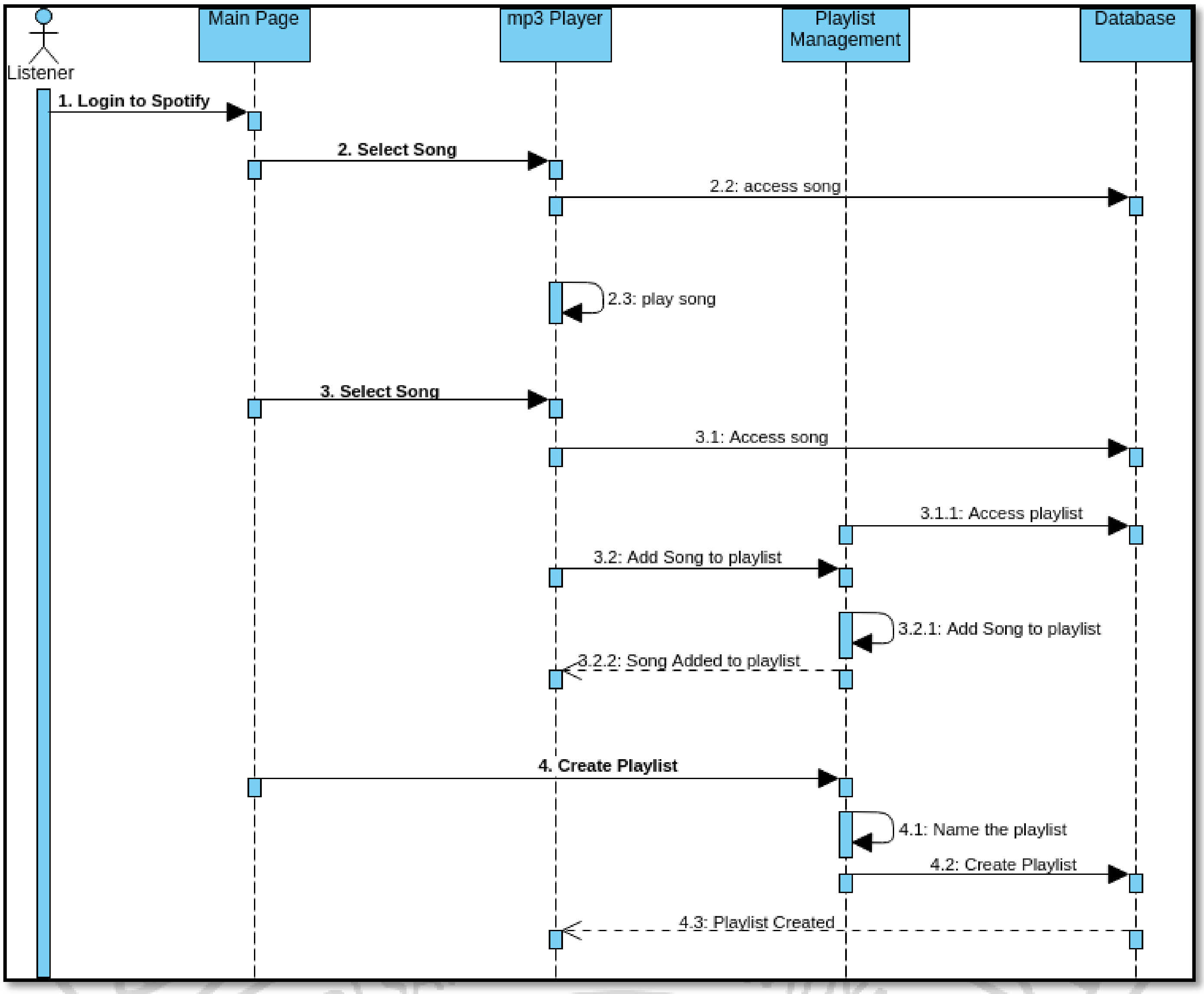
(Figure :3 Object Interaction diagram for Rhythmix)

4.11 Sequence and Collaboration Diagram:

-ELEMENTS IN SEQUENCE DIAGRAM Object

- ➢ Object
- ➢ Life-line bar

➢ Messages



(Figure 4:Sequence Diagram of Rhythmix)

Chapter: 5. System Design

5.1 System Application Design

Rhythmix follows a modular and layered design pattern, breaking the system into clearly defined components — **frontend**, **backend**, and **database** — to support scalability, maintainability, and rapid development. The system is based on the **MVC (Model-View-Controller)** architecture, ensuring a proper separation of concerns and promoting clean code practices.

• Frontend (React.js):

- Built using **React.js**, the frontend is responsible for managing all **user interactions**.
- It uses **functional components**, **React Hooks**, and **state management** libraries like Context API or Redux to handle UI state and actions.
- It dynamically updates the UI without reloading the page (Single Page Application - SPA).
- Responsive design is implemented using **Tailwind CSS** or **CSS3**, ensuring the interface works smoothly across mobile and desktop devices.
- It communicates with backend APIs using **Axios** or **Fetch API** for sending/receiving data securely.

• Backend (Node.js + Express):

- The backend logic is developed using **Node.js**, with **Express.js** serving as the lightweight framework to manage API routing.
- It includes **middleware** for validating requests, parsing JSON, handling errors, and securing routes using **JWT authentication**.
- API endpoints follow RESTful design, offering well-structured routes for songs, users, playlists, and admin functionalities.
- Handles user login, registration, playlist creation, song uploads, and interaction logging.
- Ensures role-based access control (user/admin separation) and input validation using libraries like Joi or Express-Validator.

• Database (MongoDB):

- All data is stored in **MongoDB**, a NoSQL document-based database, using **Mongoose** for schema definition and validation.
- Collections are created for **Users**, **Songs**, **Playlists**, and **Admins**, with relational links via Object IDs where needed.
- Supports flexible schema and horizontal scalability, making it suitable for handling a growing volume of song metadata and user-generated content.
- System logs, user activity, and song access history can also be stored for analytical purposes.

- **5.1.1 Method Pseudo Code**

Below is a simplified pseudo code for core functionality – playing a song:

```
Java script
Copy Edit
IF user clicks on a song:
   FETCH song details from database
   GET the audio URL from cloud storage
   INITIALIZE audio player with URL
   START playback
   ADD this song to the user's 'Recently Played' list
   UPDATE 'recently played' for user
```

Another pseudocode for playlist creation:

```
javascript
CopyEdit
IF user submits new playlist:
   VALIDATE playlist name
   CREATE new playlist document with user ID
   SAVE the playlist object to the 'Playlists' collection in
   MongoDB
   RETURN a success message to the user
   REFRESH playlist view on frontend to show new entry
   SHOW success message
```

5.2 Database Design / Data Structure Design

The **Rhythmix** application uses a **NoSQL, document-based structure** powered by **MongoDB**, which offers flexibility and scalability for managing user-generated content like songs and playlists. The database is designed around collections (similar to tables in relational databases), each storing documents with defined schemas.

5.2.1 Tables and Relationship

- **Users**
  - Fields: User ID, Name, Email, Password (encrypted), Created At
- **Songs**
  - Fields: Song ID, Title, Artist, Genre, Album, Audio URL, Duration, Uploaded By
- **Playlists**
  - Fields: Playlist ID, User ID, Name, List of Song IDs, Created At
- **Admins**
  - Fields: Admin ID, Email, Password

Relationships:

- One **User** can have **multiple Playlists**.
- Each **Playlist** can include **many Songs**.
- Each **Song** can belong to **multiple Playlists** (many-to-many relationship).
- Admins are responsible for uploading and managing songs.

This data structure ensures:

- Fast retrieval of playlists and songs per user.
- Easy expansion (e.g., adding comments, likes, or history logs).
- Secure storage and efficient linkage between users and content.

5.2.2 Logical Description of Data

The logical data design of the **Rhythmix** application is structured to ensure security, scalability, and consistency across all user and media-related operations. MongoDB is used to store documents with clearly defined schemas managed via Mongoose. Below is a breakdown of how each core entity is handled logically:

Users

- Each user is uniquely identified by a UserID, which links them to their personalized data such as playlists and activity history.
- User authentication is handled securely using **JWT (JSON Web Tokens)** to validate sessions.
- Passwords are stored in an **encrypted format** using secure hashing algorithms like **bcrypt**, ensuring they are never exposed in plaintext.
- Users can manage multiple playlists and interact with song content according to their permissions.

Songs

- Every song in the system has a unique SongID.
- Each song document contains metadata such as:
    - Title, Artist, Genre, Album, Duration, and a cloud-based AudioURL.
- Songs are associated with playlists through a **many-to-many relationship**, meaning:
    - A single song can appear in multiple playlists.
    - This relationship is managed through references in the playlist documents.

Playlists

- Playlists are tied to users via the UserID (acting as a foreign key).
- Each playlist includes:
    - A name, creation timestamp, and a list of associated SongIDs.

- Songs are **not embedded directly** inside the playlist document. Instead, the playlist holds an **array of references** to song documents, allowing efficient querying and reduced duplication.

Admins

- Admins are stored in a separate collection to maintain **role-based access control**.
- Admins have privileges to:
  - Upload songs, manage content, and monitor platform activity.
- They **cannot create playlists** like regular users, maintaining clear boundaries between administrative and user functionalities.

Data Communication

- The frontend and backend communicate using **RESTful APIs**, ensuring modular and scalable architecture.
- All API routes involving sensitive actions (like playlist management or uploading songs) are protected using **authentication middleware** that verifies JWT tokens.
- Responses between backend and frontend are exchanged in **JSON format**, promoting easy integration and debugging.

5.3 Input / Output and Interface Design

The user interface (UI) is designed to be intuitive, clean, and responsive using modern front-end technologies such as **CSS3**, **Tailwind CSS**, or **styled-components**. The design ensures that users of all experience levels can interact with the platform smoothly across different devices and screen sizes (desktop, tablet, and mobile).

The interface includes:

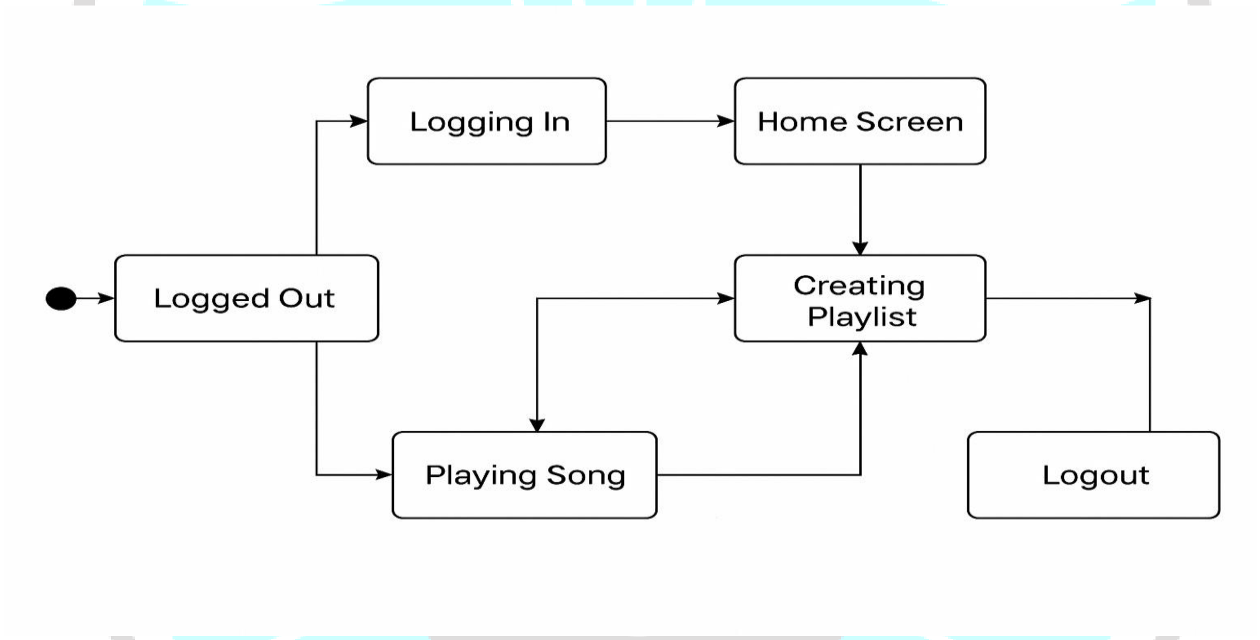
- **Navigation Menu:** Clearly defined options for Home, Browse, Search, Playlists, and Profile, typically placed at the top or side for easy access.
- **Search Bar:** Allows users to search for songs, artists, albums, and playlists in real-time with auto complete suggestions.
- **Music Player:** A fixed bottom player displaying currently playing song title, artist name, playback controls (play/pause, skip, repeat, shuffle), and song progress bar.
- **Library Management:** Sections for users to create, update, and delete playlists, view liked songs, and organize tracks by genre or artist.
- **Responsive Layout:** The design automatically adjusts layout elements to fit the screen size and resolution, ensuring optimal user experience.
- **Input Forms:** Secure and user-friendly forms for login, registration, song uploads (for admins), and playlist creation, with input validations and clear error messages.
- **Output Views:** Well-structured components to display data dynamically:

  -Song Cards: Thumbnail, title, artist, duration

-Playlist Previews: Cover image, song count

- **User Profile View**: Name, email, preferences
- **Admin Dashboard**: Uploaded content, user stats, content management tools

5.3.1 State Transition / UML Diagram



(Figure 5:State Teansition Diagram for Rhythmix)

The transition is event-driven, where each user interaction (e.g., click, submit) triggers a state change.

5.3.2 Samples of Forms, Reports, and Interface

- **Login Form** – Username, password fields with validation.
- **Dashboard** – Displays user playlists, recently played songs, and recommendations.
- **Search Interface** – Input box for song/artist with dynamic results.
- **Playlist Editor** – Add/remove songs to playlists.
- **Audio Player** – Includes play, pause, next, previous, volume control, and current track display.(Include screenshots or wireframes if available in annexure)

Chapter:6.System Testing

System testing is a critical phase in the software development life cycle (SDLC) used to validate that the entire **Rhythmix** application performs as intended across all components — including frontend, backend, database, and APIs.The objective is to ensure **functional correctness**, **user experience consistency**, and **error handling** under various conditions.

Testing Approach:

- **Manual Testing**
  - Performed through **browser-based interactions** to validate UI elements such as:
    - Registration/Login workflows
    - Playlist creation and editing
    - Music playback
    - Responsive layout on different screen sizes
  - Testers manually simulated real user behaviors to ensure visual consistency and flow.

- **API Testing Using Postman**
  - All **RESTful API endpoints** (e.g., login, registration, song upload, playlist update) were tested using **Postman**.
  - Focused on:
    - **Request-response validation** (status codes, payload structure)
    - **Authentication and token verification**
    - **Data persistence** and database updates
  - Edge cases such as missing parameters, invalid tokens, or incorrect request formats were also tested.

- **Functional Testing**
  - Verified that each module performs its specific functionality correctly.
  - Examples:
    - A user can create a playlist and see it persist after refreshing.
    - Music plays smoothly across page transitions.
    - Admin can upload a new song and it appears in the catalog instantly.

- **User Interface Validation**
  - Ensured that:
    - Input validations (e.g., empty fields, invalid emails) work as expected.
    - Feedback messages (success, error) are shown correctly.
    - The layout is responsive and adjusts based on device size.

Test Cases Covered:

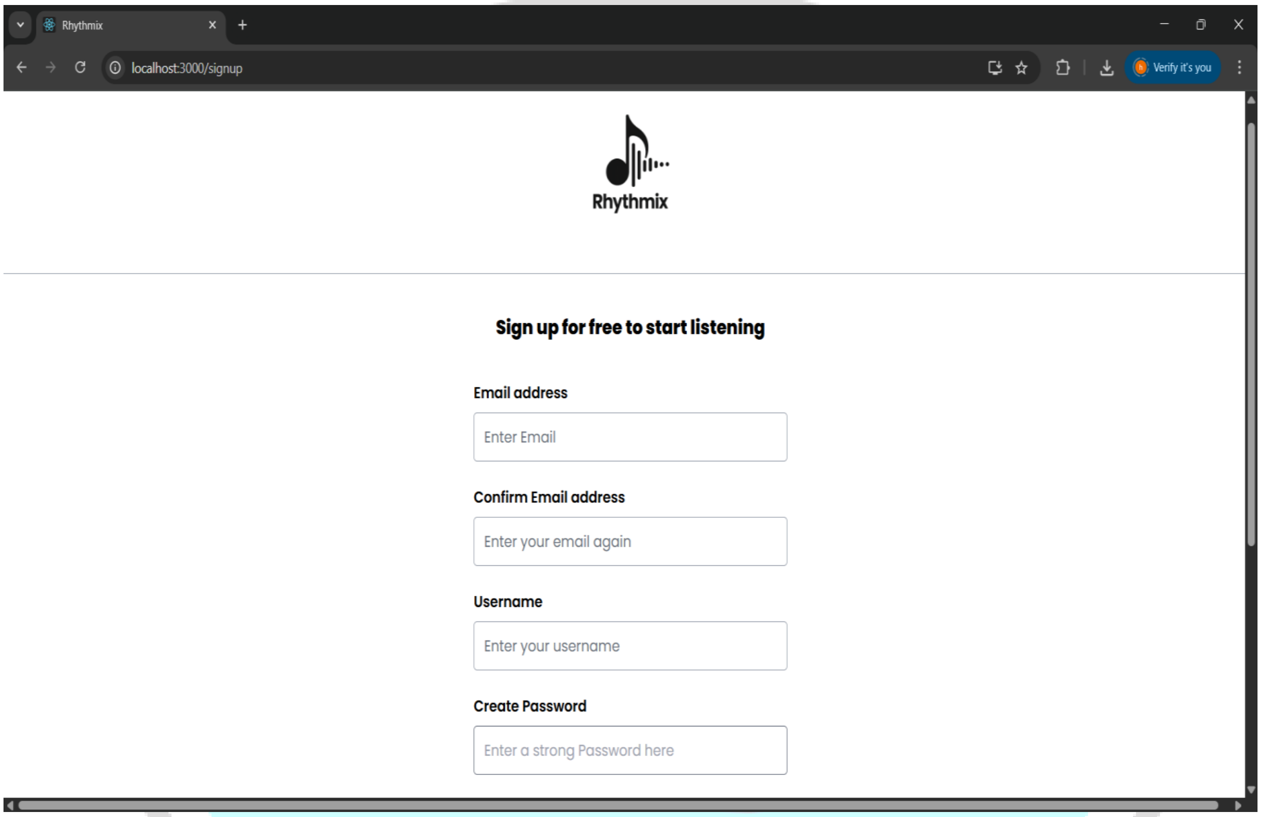
Test Case	Expected Outcome	Status
User registration with valid data	New user account is created and JWT is returned	Pass
Login with wrong password	Error message displayed and no token issued	Pass
Create new playlist	Playlist saved and visible on user dashboard	Pass
Search song by title	Matching results appear in real time	Pass
Audio playback	Song plays without interruption	Pass
Admin uploads a new song	Song is listed under catalog and accessible to users	Pass
Access protected route without token	User is denied access with 401 Unauthorized response	Pass

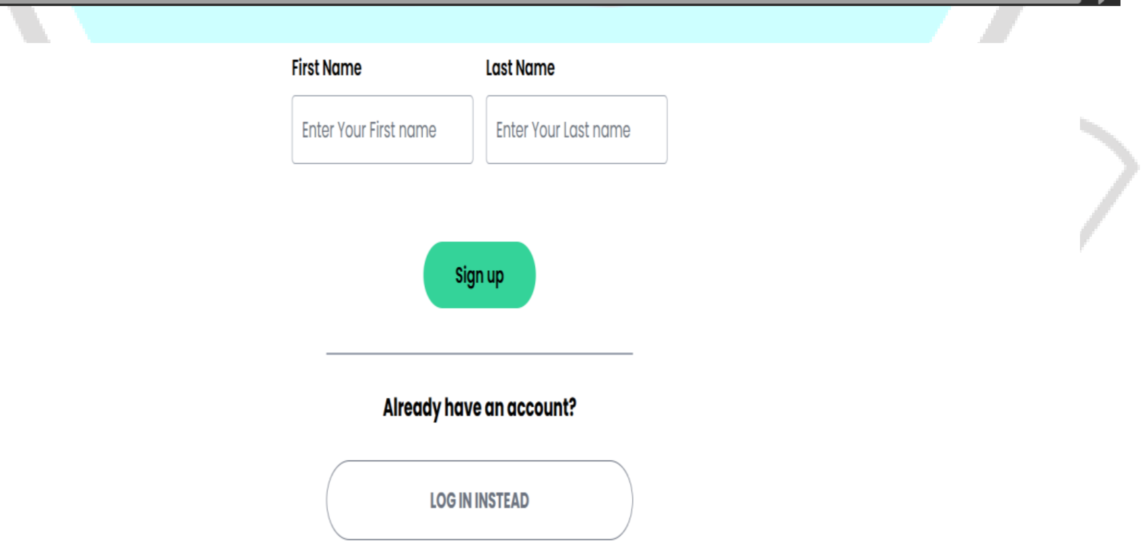
(Table :4 Test cases Covered)

*Screenshort:

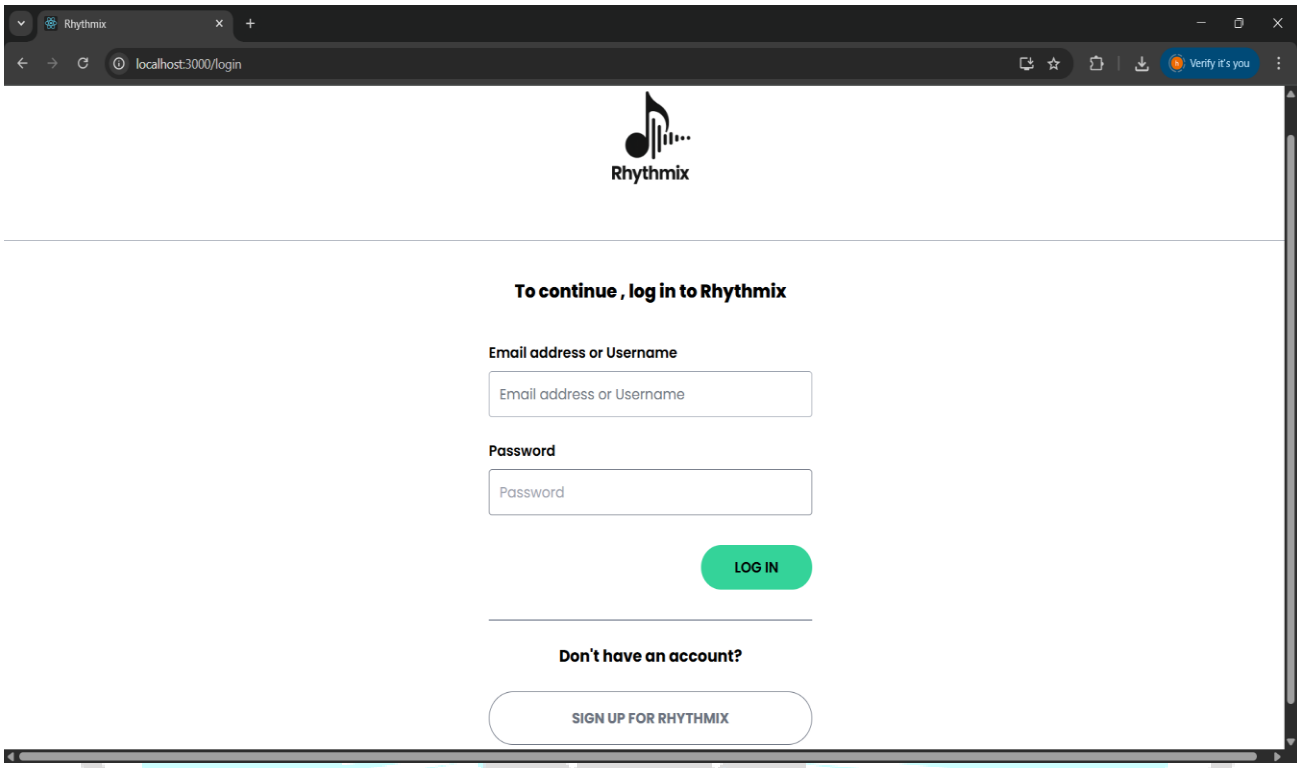
[1] Frontend

1.Sign up page





2.log in page



To continue , log in to Rhythmix

Email address or Username

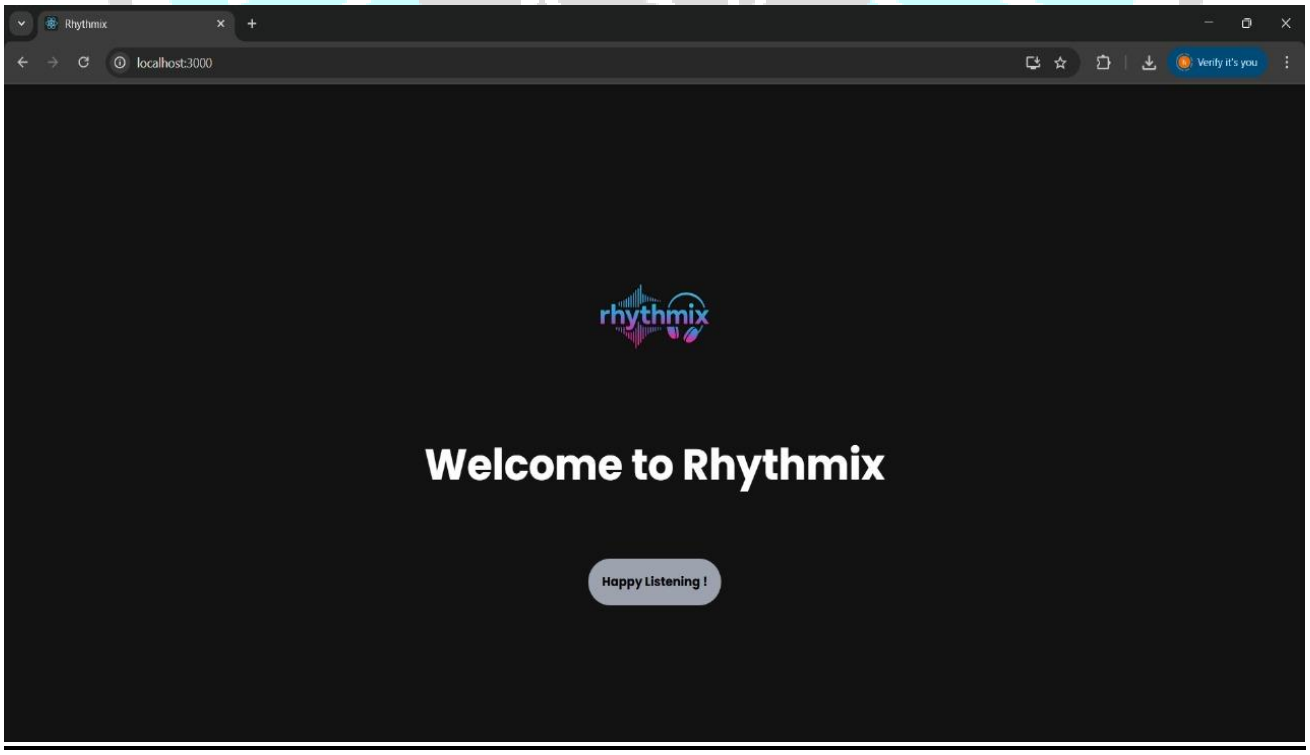
Email address or Username

Password

Password

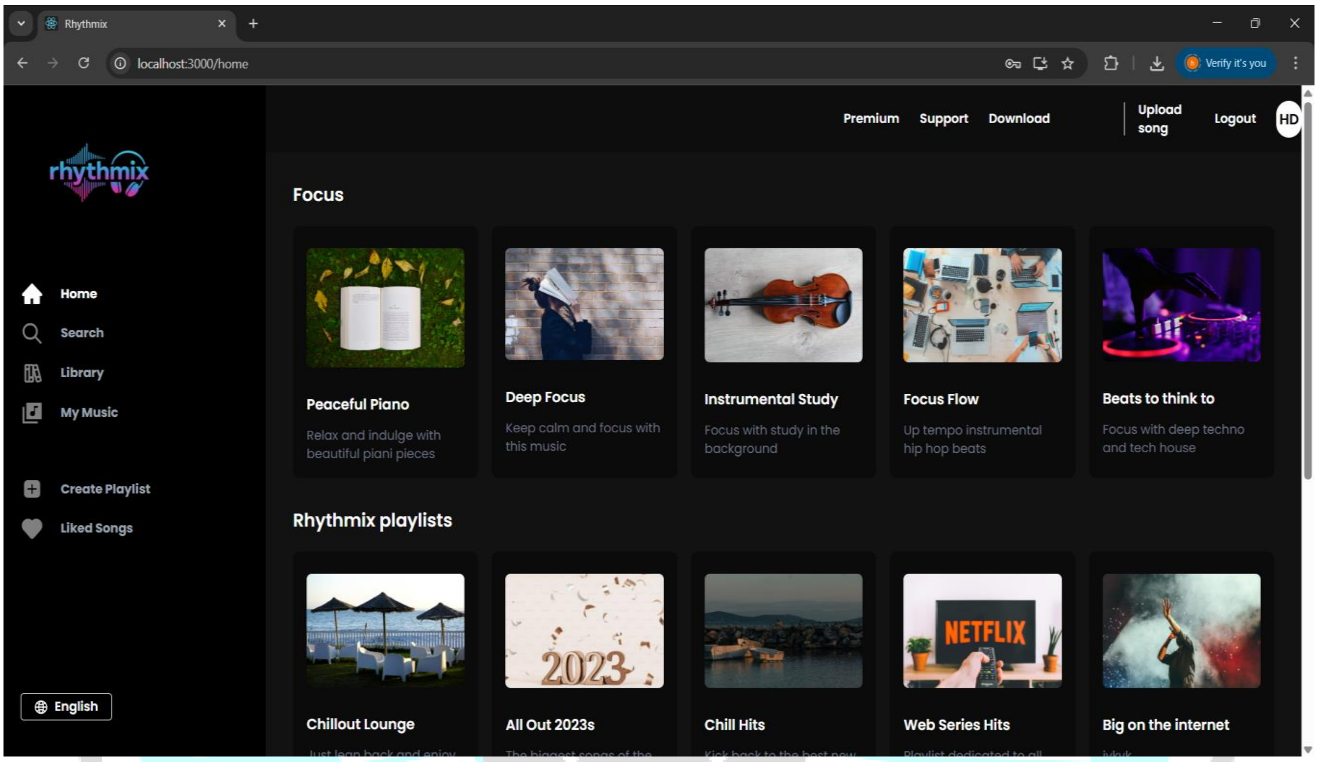
Don't have an account?

3.Welcome page



Welcome to Rhythmix

4.Home page



Focus

Peaceful Piano
Relax and indulge with beautiful piani pieces

Deep Focus
Keep calm and focus with this music

Instrumental Study
Focus with study in the background

Focus Flow
Up tempo instrumental hip hop beats

Beats to think to
Focus with deep techno and tech house

Rhythmix playlists

Chillout Lounge

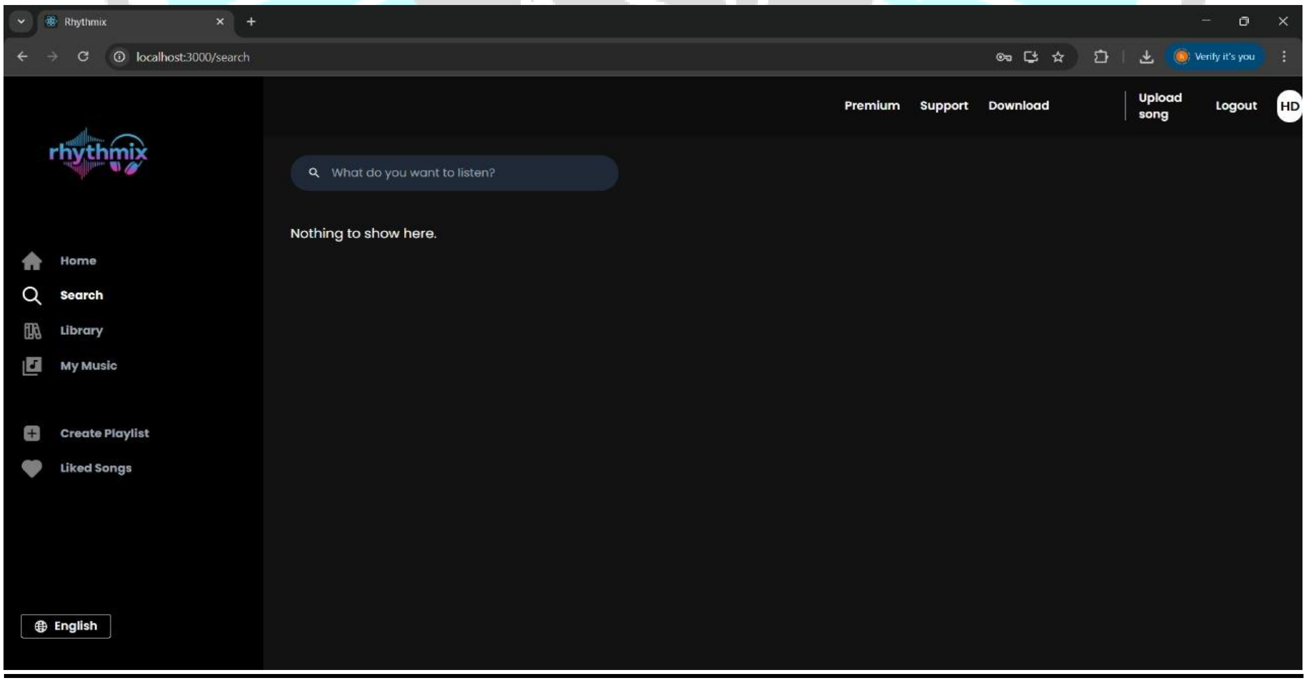
All Out 2023s

Chill Hits

Web Series Hits

Big on the internet

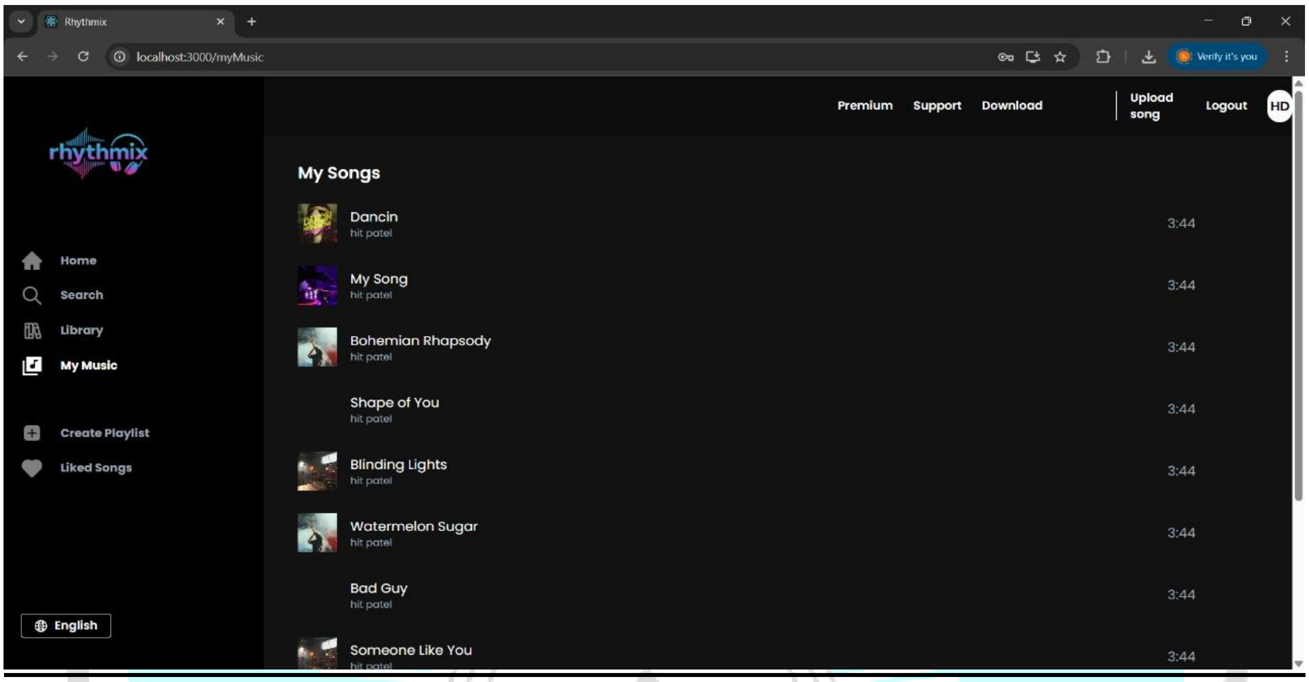
5.Search a song



What do you want to listen?

Nothing to show here.

6. My songs

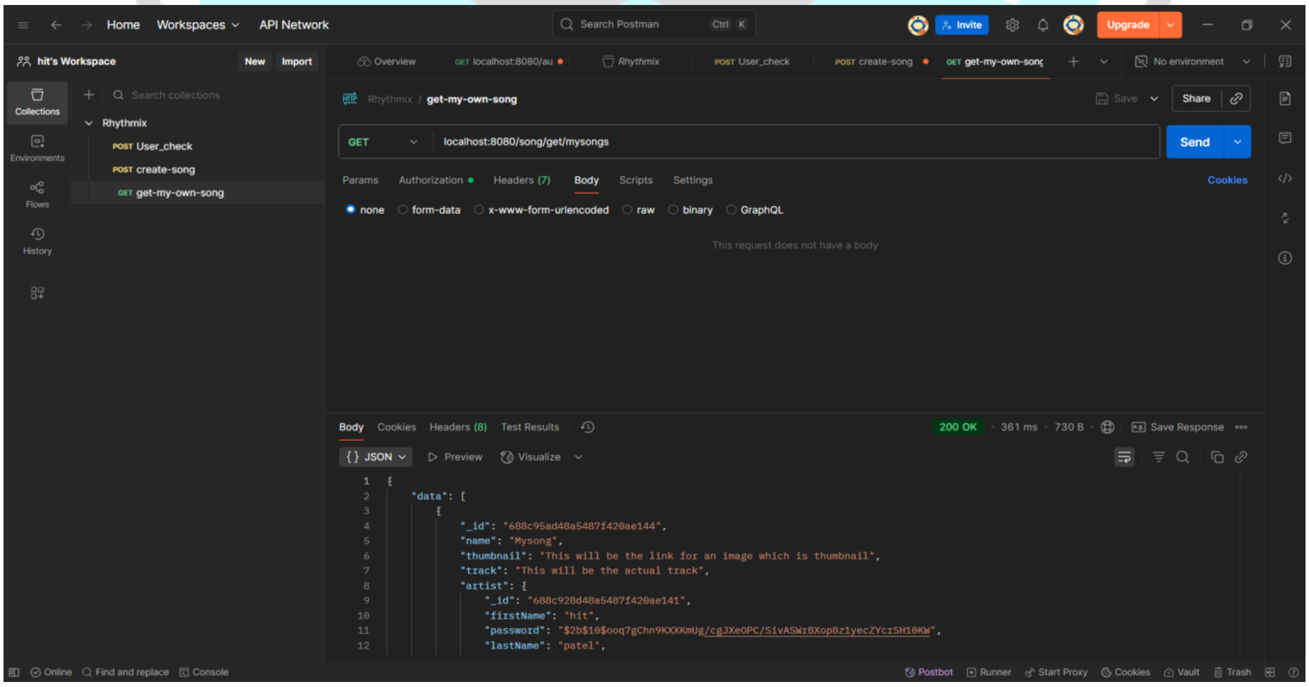


My Songs

Dancin	hit patel	3:44
My Song	hit patel	3:44
Bohemian Rhapsody	hit patel	3:44
Shape of You	hit patel	3:44
Blinding Lights	hit patel	3:44
Watermelon Sugar	hit patel	3:44
Bad Guy	hit patel	3:44
Someone Like You	hit patel	3:44

[2]Backend

1.Backend API testing

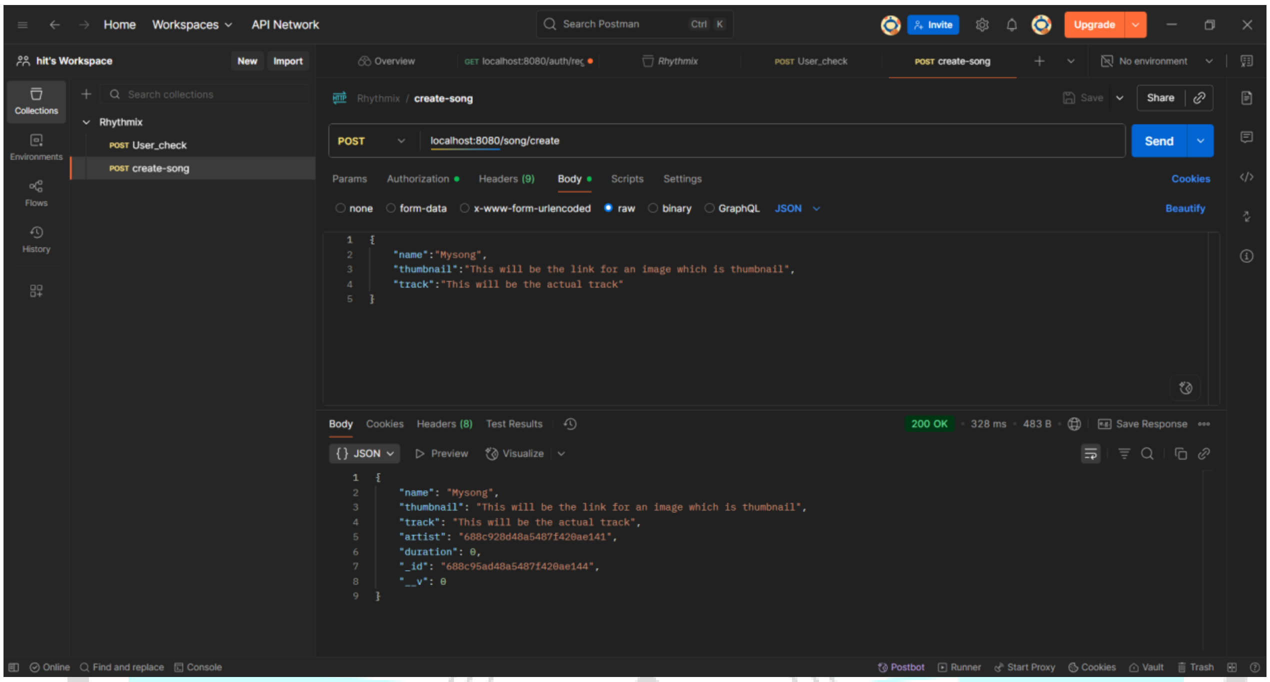


GET localhost:8080/song/get/mysongs

200 OK · 361 ms · 730 B

```
{
    "data": [
        {
            "_id": "688c95ad48a5487f420ae144",
            "name": "Mysong",
            "thumbnail": "This will be the link for an image which is thumbnail",
            "track": "This will be the actual track",
            "artist": {
                "_id": "688c928d48a5487f420ae141",
                "firstName": "hit",
                "password": "$2b$10$ooq7gChn9KXXKmUg/cgJXeOPC/SivASWrBXop8z1yecZYcrSH10KW",
                "lastName": "patel",
```

2.Postman API Request and Response for Creating a Song (POST Request)



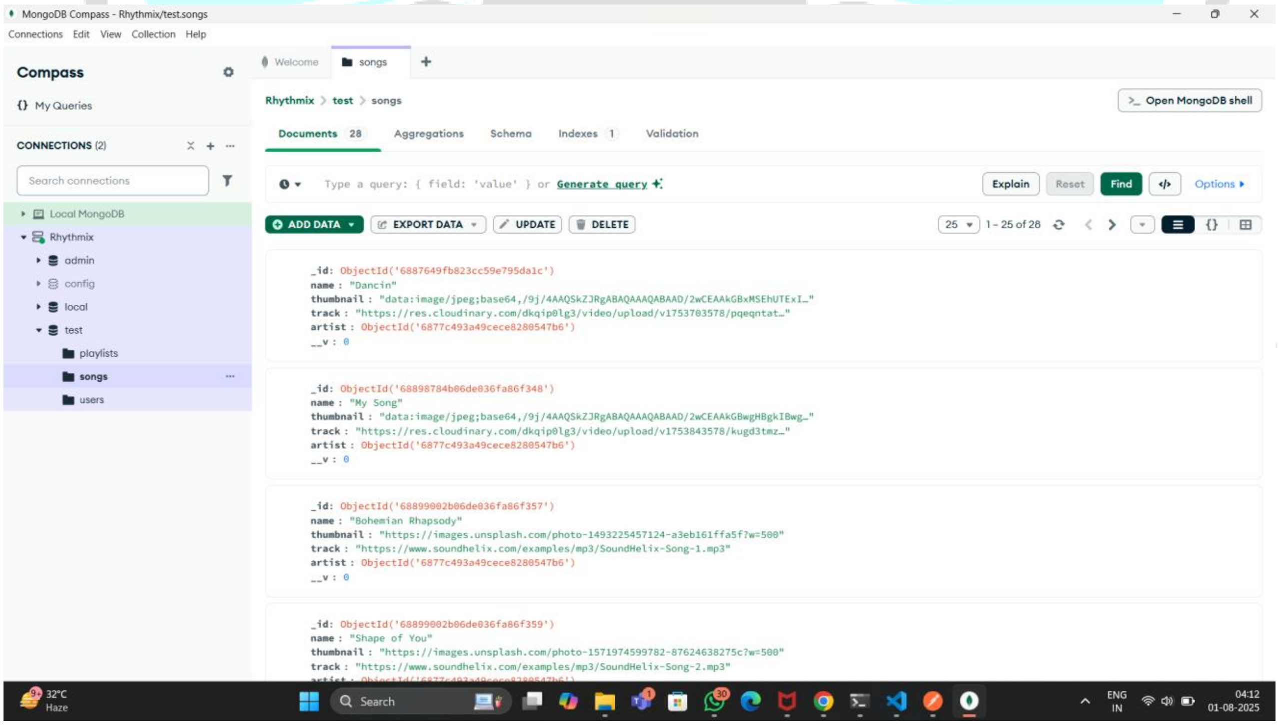
POST localhost:8080/song/create

```
{
    "name":"Mysong",
    "thumbnail":"This will be the link for an image which is thumbnail",
    "track":"This will be the actual track"
}
```

200 OK · 328 ms · 483 B

```
{
    "name": "Mysong",
    "thumbnail": "This will be the link for an image which is thumbnail",
    "track": "This will be the actual track",
    "artist": "688c928d48a5487f420ae141",
    "duration": 0,
    "_id": "688c95ad48a5487f420ae144",
    "__v": 0
}
```

3.Database Collection View Screenshot (MongoDB Compass - Songs Collection)



MongoDB Compass - Rhythmix/test.songs

Rhythmix > test > songs — Documents 28 — 1 – 25 of 28

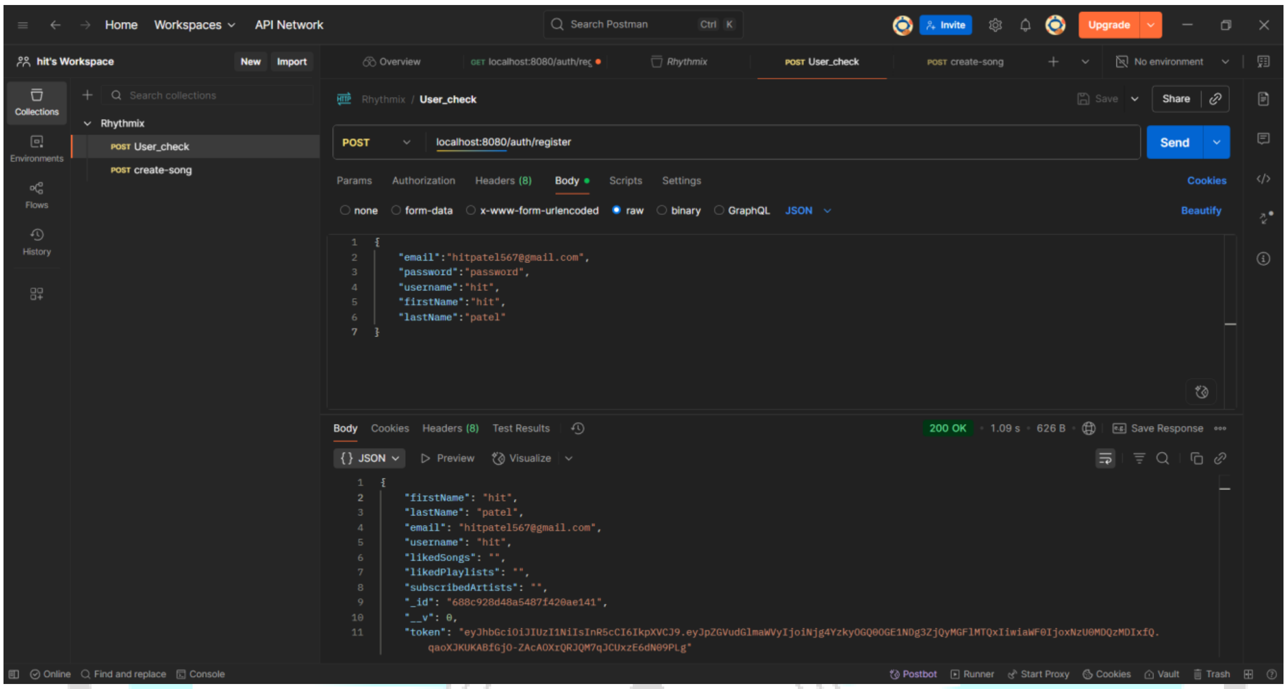
```
_id: ObjectId('6887649fb823cc59e795da1c')
name : "Dancin"
thumbnail : "data:image/jpeg;base64,/9j/4AAQSkZJRgABAQAAAQABAAD/2wCEAAkGBxMSEhUTExI…"
track : "https://res.cloudinary.com/dkqip0lg3/video/upload/v1753703578/pqeqntat…"
artist : ObjectId('6877c493a49cece8280547b6')
__v : 0

_id: ObjectId('68898784b06de036fa86f348')
name : "My Song"
thumbnail : "data:image/jpeg;base64,/9j/4AAQSkZJRgABAQAAAQABAAD/2wCEAAkGBwgHBgkIBwg…"
track : "https://res.cloudinary.com/dkqip0lg3/video/upload/v1753843578/kugd3tmz…"
artist : ObjectId('6877c493a49cece8280547b6')
__v : 0

_id: ObjectId('68899002b06de036fa86f357')
name : "Bohemian Rhapsody"
thumbnail : "https://images.unsplash.com/photo-1493225457124-a3eb161ffa5f?w=500"
track : "https://www.soundhelix.com/examples/mp3/SoundHelix-Song-1.mp3"
artist : ObjectId('6877c493a49cece8280547b6')
__v : 0

_id: ObjectId('68899002b06de036fa86f359')
name : "Shape of You"
thumbnail : "https://images.unsplash.com/photo-1571974599782-87624638275c?w=500"
track : "https://www.soundhelix.com/examples/mp3/SoundHelix-Song-2.mp3"
```

4. **User Authentication API Test (Register User) – Backend API Testing Screenshot**



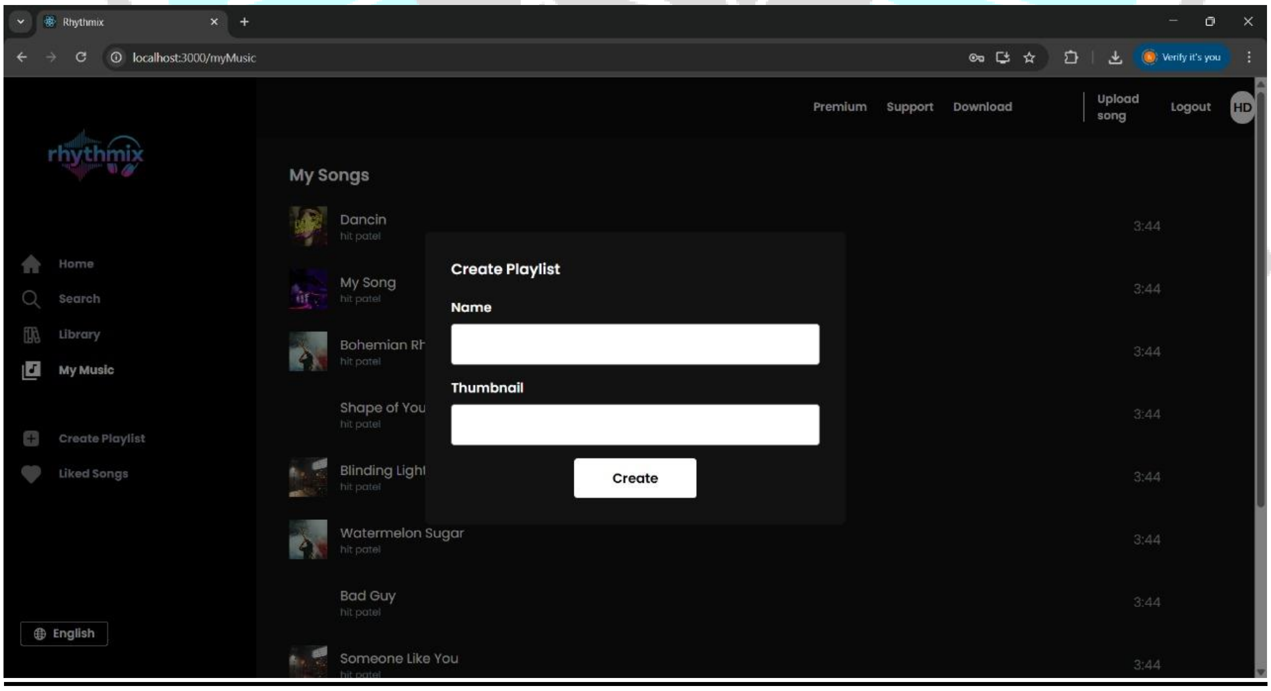
POST localhost:8080/auth/register

```
{
    "email":"hitpatel567@gmail.com",
    "password":"password",
    "username":"hit",
    "firstName":"hit",
    "lastName":"patel"
}
```

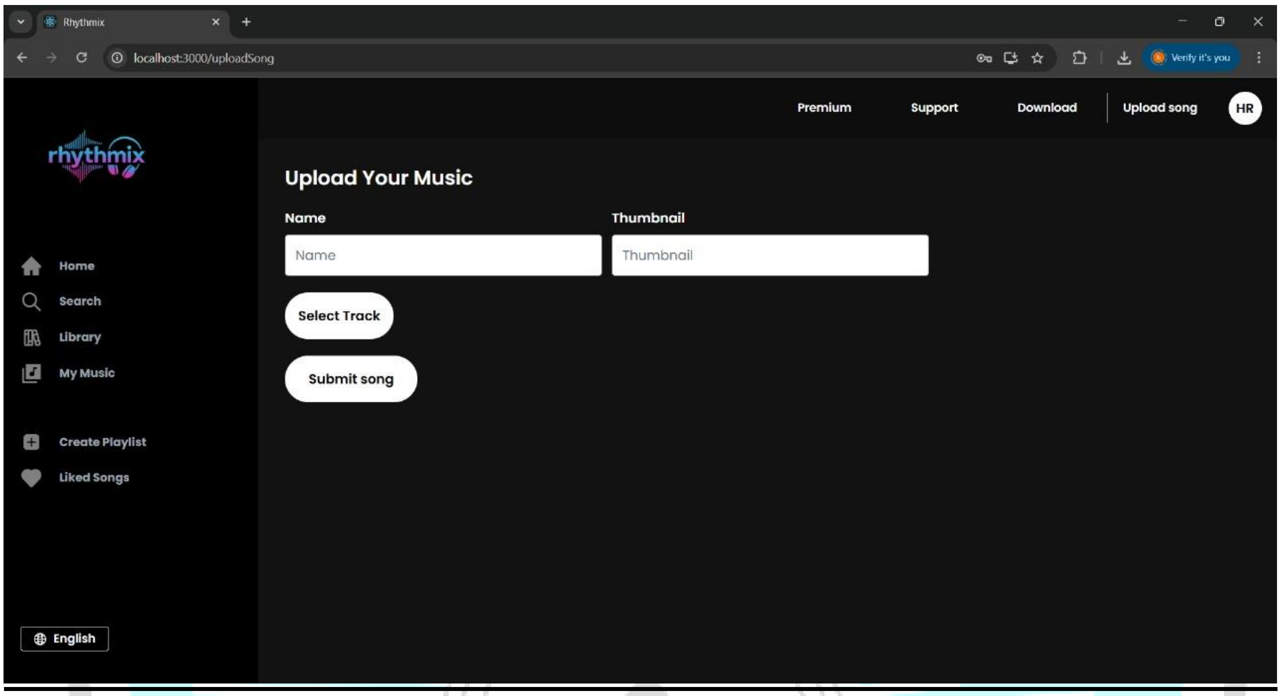
200 OK · 1.09 s · 626 B

```
{
    "firstName": "hit",
    "lastName": "patel",
    "email": "hitpatel567@gmail.com",
    "username": "hit",
    "likedSongs": "",
    "likedPlaylists": "",
    "subscribedArtists": "",
    "_id": "688c928d48a5487f420ae141",
    "__v": 0,
    "token": "eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJpZGVudGlmaWVyIjoiNjg4YzkyOGQ0OGE1NDg3ZjQyMGFlMTQxIiwiaWF0IjoxNzU0MDQzMDIxfQ.
      qaoXJKUKABfGjO-ZAcAOXrQRJQM7qJCUxzE6dN09PLg"
}
```

5.Create playlist



6.Upload song



Chapter:7. Conclusion

Rhythmix is a fully developed, responsive, and user-friendly web-based music streaming application created using the MERN stack — MongoDB, Express.js, React.js, and Node.js. The application offers a wide range of core features including user authentication, personalized music playback, playlist creation, real-time audio streaming, and intuitive navigation. The project ensures that users can explore, stream, and enjoy music effortlessly across different devices and screen sizes.

This project not only demonstrates technical expertise in full-stack web development but also reflects an understanding of how various components — frontend frameworks, backend APIs, databases, and cloud services — can be combined effectively to build scalable and interactive web applications. Key technologies like JWT for authentication, Cloudinary for media storage, and REST APIs for seamless client-server communication have been used to enhance the system's performance and reliability.

Rhythmix was designed with scalability, modularity, and performance in mind. The application architecture supports future updates and feature integration with minimal code disruption. All features have been thoroughly tested and validated against the original project requirements to ensure stability and user satisfaction. Throughout the development cycle, attention was given to coding standards, UI/UX consistency, responsiveness, and error handling.

In summary, Rhythmix stands as a successful implementation of a modern music streaming platform. It showcases how a thoughtful blend of design, development practices, and emerging technologies can come together to create a powerful digital product. The project serves as a strong foundation for future enhancements and demonstrates readiness for real-world deployment in the field of web-based media platforms.

Chapter:8. Bibliography

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5. React Documentation – https://reactjs.org/
6. Cloudinary Developer Docs – https://cloudinary.com/documentation
7. GitHub – Version control platform used for codebase management
8. Postman – API testing tool used during development