|  |  |
| --- | --- |
| Pie chart and stacks    Oracle XE Bookstore Database: User Roles, Data Population, and Security Monitoring | Members   * Erin David Cullen 600530 * Juan Oosthuizen 600161 * Tian Petrus Strydom 600318 * Zoë Janse Van Rensburg 601277 * Justin Scheepers 600245   **DBA381: Database Administration** |

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# Installation & Configuration of Oracle Database

### 1.1 Operating System Used

* **Operating System:** Windows 11 Pro (64-bit)
* **Oracle Version:** Oracle Database 21c Express Edition
* **Host Environment:** Local physical machine
* **System Specifications:**
  + **Processor:** Intel I7-14700K
  + **RAM:** 64 GB
  + **Disk Space:** 3 Disk, 4 TB, RAID 5

### 1.2 Step-by-Step Installation Process

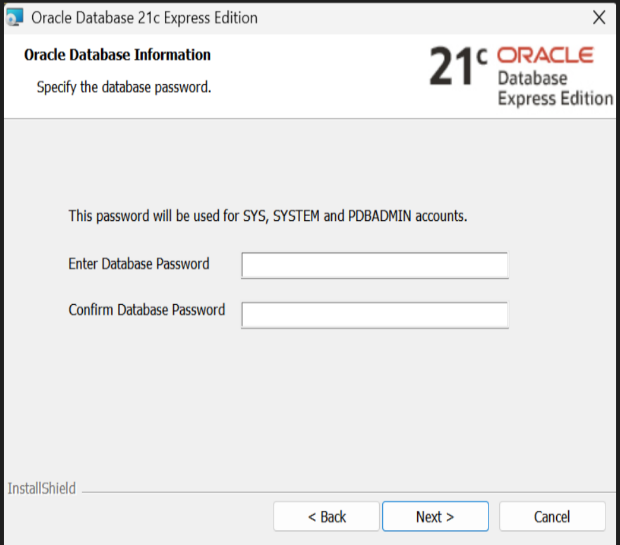
**Step 1: Download Oracle Software**

* **Link:** <https://www.oracle.com/za/database/technologies/xe-downloads.html>

A screenshot of a computer

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Step 2: Extract the “OracleXE213\_Win64.zip” using 7zip or WinZip

Step 3: Run the setup.exe and select the installation options according to your database and Windows user requirements.

Step 4: Keep the Login simple as this is a development database.

Password = “password”

### 1.3 Configuration Adjustments

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Take Note of the paths that the installer provides.

A close-up of a computer code

AI-generated content may be incorrect.Destination, Oracle Home and Base are used by the OS PATH Environment Variables to tell Oracle where the database scripts are located.

Secondly it provides the connection information, the IP address is currently locally hosted through port 1521.

Step 2:

To publish to the local network, the user needs to update listener.ora (C:\app\%user%\product\21c\homes\OraDB21Home1\network\admin\listener.ora)

A computer code with white text

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The user can add the highlighted row, using the IP address of the machine on the local network. To simplify things, the user can also add the following (HOST = \*\*\*\*)

* (0.0.0.0)
* (127.0.0.1)
* (localhost)

which are all internal IP addresses which make database development easier.

Step 3: Test the listeners  
open `command prompt` and enter “lsnrctl status”  
-> and it should return a list of services. Services we are interested in:

* Service "XE" has 1 instance -> can connect to, but has limited SQL Plus capabilities
* Service "XEXDB" has 1 instance
* Service "xepdb1" has 1 instance -> this is what we will connect to

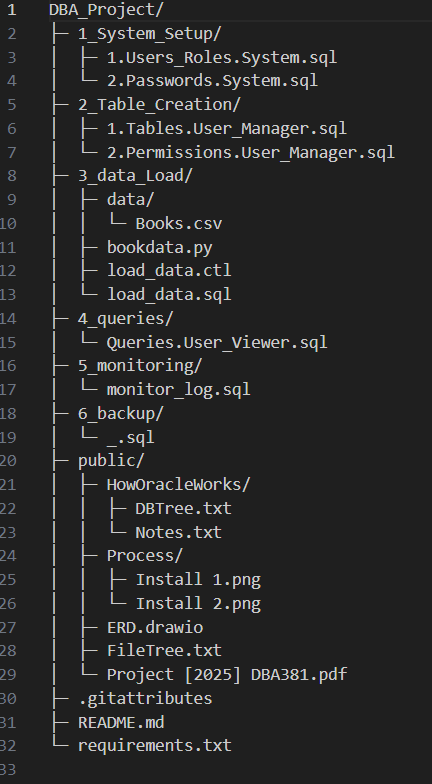
1. Start the SQL Plus application. From the command-line, enter the command SQLPLUS to start SQL Plus.

**Note: If You See "sqlplus is not recognized..."**

* It means the Oracle bin path is not in your environment variables.
* You can add it permanently:
  1. Right-click **This PC > Properties**
  2. Click **Advanced system settings > Environment Variables**
  3. Under **System Variables**, find Path > click **Edit**

*C:\app\oracle\product\19.0.0\dbhome\_1\bin*

* 1. Click OK and restart Command Prompt.



Oracle organizes data in one centralized database, while users, roles, and schemas are used to govern how people can access and use that data. XE from Oracle allows developers to set up a Container Database and a Pluggable Database named XEPDB1, which is an isolated workspace. The framework includes users who are allowed to sign in and own schemas, which contain all tables, views, procedures, and triggers. Creating roles groups together needed privileges and makes it easier to grant and reuse the same permissions for users.

Before anything else, you connect as the SYSTEM user Oracle’s default DBA account to establish a secure set up. SYSTEM instead handles users, roles, and privileges, but doesn’t make application data tables. Roles were generated from the SYSTEM schema to determine how much access each person or object would have: For people with just access, room for information is bookstore\_read\_only, for people who can add or alter articles, it’s bookstore\_data\_entry, and users on bookstore\_manager can also use DDL to design tables and other objects.

Next, SYSTEM made severalusers and assigned them their Roles. User\_viewer got the bookstore\_read\_only role as part of the setup. user\_clerk now has the bookstore\_data\_entry role, and user\_manager now has the bookstore\_manager role. Every user was assigned the default USERS tablespace and given unlimited space to use for their objects in their schemas. User\_manager was given additional privileges, such as unlimited tablespace, so they could handle and control the objects of the application.

With the users and roles arranged, the user\_manager account was then used to set up the actual tables needed by the application. For instance, tblBook contains columns for a book’s ID, the title, and the price. Once the table was created, access was set up so that the bookstore\_read\_only could SELECT data, bookstore\_data\_entry could INSERT, UPDATE, and SELECT, while bookstore\_manager could do everything, including DELETE.

By organizing things in this way, each user is restricted to their appropriate functions, guaranteeing the safety, accuracy, and administration of the whole system. It is built according to standards for schemas, permissions, and access in Oracle.

To configure Oracle database on Windows:

1. Log in to SQL\*Plus application with sys as sysdba and the password you opt during the installation process in the Schema Password step.
2. Create the user and grant access to the database. The database name is the one that you set in [Installing Oracle Database on Windows](https://docs.oracle.com/en/java/java-components/advanced-management-console/2.25/install-guide/oracle-database-installation-and-configuration-advanced-management-console.html#GUID-B7AA0781-E0F9-41D3-8772-350F58501C3F).

A screenshot of a computer program

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Configure your Oracle database. If you encounter an issue with the SQL Create User statement, then log out of SQL\*Plus application and repeat step 1 and step 2.

1. After you successfully create the user, exit the SQL\*Plus application and log back into SQL\*Plus as user. You are prompted to set up the password.
2. The Oracle Database user credentials provided in this topic are examples. The AMC doesn’t need to know your database user credentials. Oracle database user credentials are only required to configure the Data Source connection in the application server.

### Configuration Settings

During the Oracle Database setup using Database Configuration Assistant (DBCA), configuration settings were applied to ensure the database was optimized for the project's development needs:

A screen shot of a computer program

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# Organisational Requirements and Database Design

### 2.1 Organisational Requirements

An online bookstore which requires a database system to manage and streamline its core business operations.

* Management of Books: Store detailed information about each book, including title, author(s), publisher, publication date, price, and stock quantity.
* Author Information: Maintain a record of authors who can write multiple books.
* Customer Records: Track customer details such as name, address, and email for order processing and communication.
* Order Processing: Record customer orders, including order date and the customer placing the order.
* Order Details: Track each item in an order, including the book, quantity ordered, and price at the time of purchase.
* Relationships: Support many-to-many relationships between books and authors, and one-to-many relationships between customers and orders.
* Security: Control access to the database with user roles and privileges.
* Performance: Implement indexing to speed up queries on frequently accessed columns.

A screen shot of a computer code

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### 2.2 Schema

Resetting

A screenshot of a computer screen

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| **Entity** | **Description** |
| --- | --- |
| Book | Contains details such as title, publisher, publication date, price, and stock quantity. |
| Author | Stores author details including unique ID and name. |
| Customer | Contains customer information like name, address, and email. |
| Order | Records each customer order with order date and customer reference. |
| Order Detail | Captures individual items in an order: book ID, quantity, and price at order time. |
| BookAuthor (junction table) | Implements the many-to-many relationship between books and authors. |

A computer screen shot of text

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2.3 Entity Relationship Diagram (ERD)

1. tblAuthor
   * Holds details of book authors.
   * Primary Key (PK): AuthorID
2. tblBook
   * Contains information about books.
   * Primary Key: BookID
3. tblBookAuthor
   * A junction (link) table to handle the many-to-many relationship between books and authors.
   * Composite Primary Key (CPK): BookAuthorID
   * Foreign Keys (FK): BookID, AuthorID
4. tblCustomer
   * Stores customer information.
   * Primary Key: CustomerID
5. tblOrder
   * Represents customer orders.
   * Primary Key: OrderID
   * Foreign Key: CustomerID
6. tblOrderDetail
   * Represents the specific books included in an order.
   * Primary Key: OrderDetailID
   * Foreign Keys: OrderID, BookID

**A diagram of a computer

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Relationships Explained

1. Author Book (Many-to-Many)
   * Implemented through: tblBookAuthor
   * One book can have many authors, and one author can write many books.
   * tblBookAuthor links tblBook and tblAuthor using their IDs.
2. Customer Order (One-to-Many)
   * One customer can place many orders.
   * tblOrder has a CustomerID foreign key pointing to tblCustomer.
3. Order OrderDetail (One-to-Many)
   * One order can include multiple books.
   * tblOrderDetail uses OrderID as a foreign key pointing to tblOrder.
4. Book OrderDetail (One-to-Many)
   * One book can appear in many order details.
   * tblOrderDetail also has a BookID foreign key pointing to tblBook.

**A screen shot of a computer program

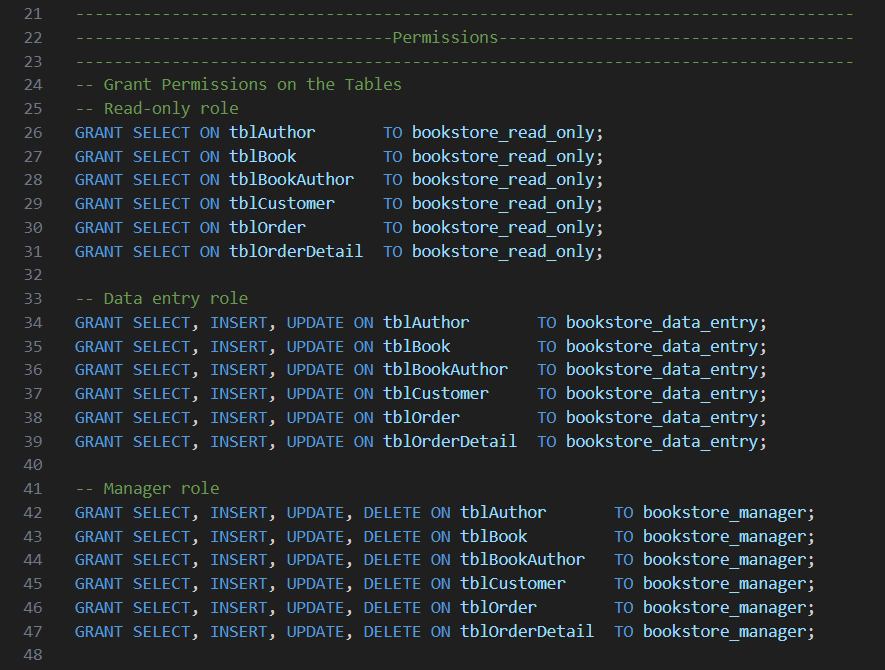
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### 2.4 Table Descriptions

| **Table Name** | **Description** |
| --- | --- |
| tblBook | Stores book-specific data including title, publisher, publication date, price, and quantity in stock. |
| tblAuthor | Contains author ID and author name. |
| tblCustomer | Holds customer details such as name, address, and email. |
| tblOrder | Contains order ID, order date, and foreign key to customer. |
| tblOrderDetail | Contains details of books ordered (quantity, price) linked to orders. |
| tblBookAuthor | Junction table linking books to authors by their IDs. |

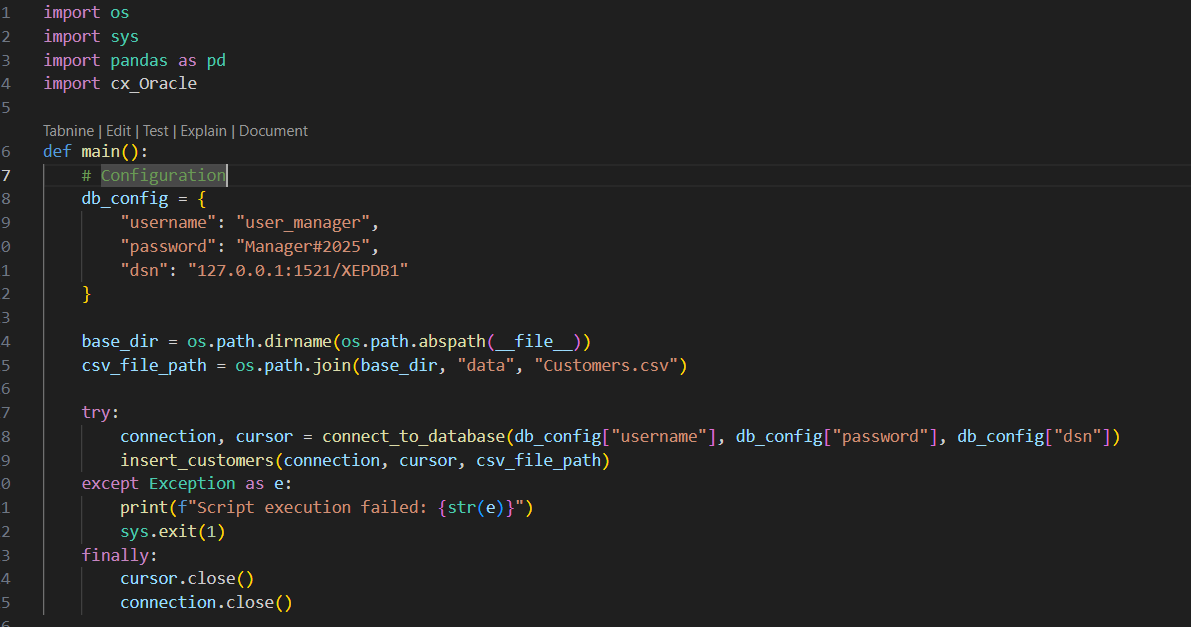


### 2.5 Views Created

| **View Name** | **Purpose** |
| --- | --- |
| vw\_BooksByAuthor | Lists books along with their associated authors. |
| vw\_CustomerOrders | Lists customers alongside their orders and order details. |

### 2.6 Indexes Created

| **Table** | **Column(s)** | **Purpose** |
| --- | --- | --- |
| tblBook | BookTitle | Speeds up searches and lookups by book title. |
| tblOrderDetail | (OrderID, BookID) | Enhances joins and lookups involving orders and books. |



# Data Population and Query Execution

### Data Population Process

To populate the database with sample data, CSV files containing data for books, authors, and customers were used. Python scripts leveraging the **Pandas** library for data handling and **cx\_Oracle** for Oracle database connectivity automated the data import process.

**Steps:**

1. **Data Cleaning:**  
   Before loading, the data was cleaned to remove duplicates, empty values, and special characters from book titles and author names. Publication dates were converted to Oracle-compatible date formats.

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Data Loading

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1. **Author Data Insertion:**  
   Unique authors were identified and inserted into the tblAuthor table. Existing authors were checked to avoid duplication with a roll back function.

A computer screen with text and images

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1. **Book Data Insertion:**  
   Books were inserted into the tblBook table with fields such as title, publisher, publication date, price, and quantity.

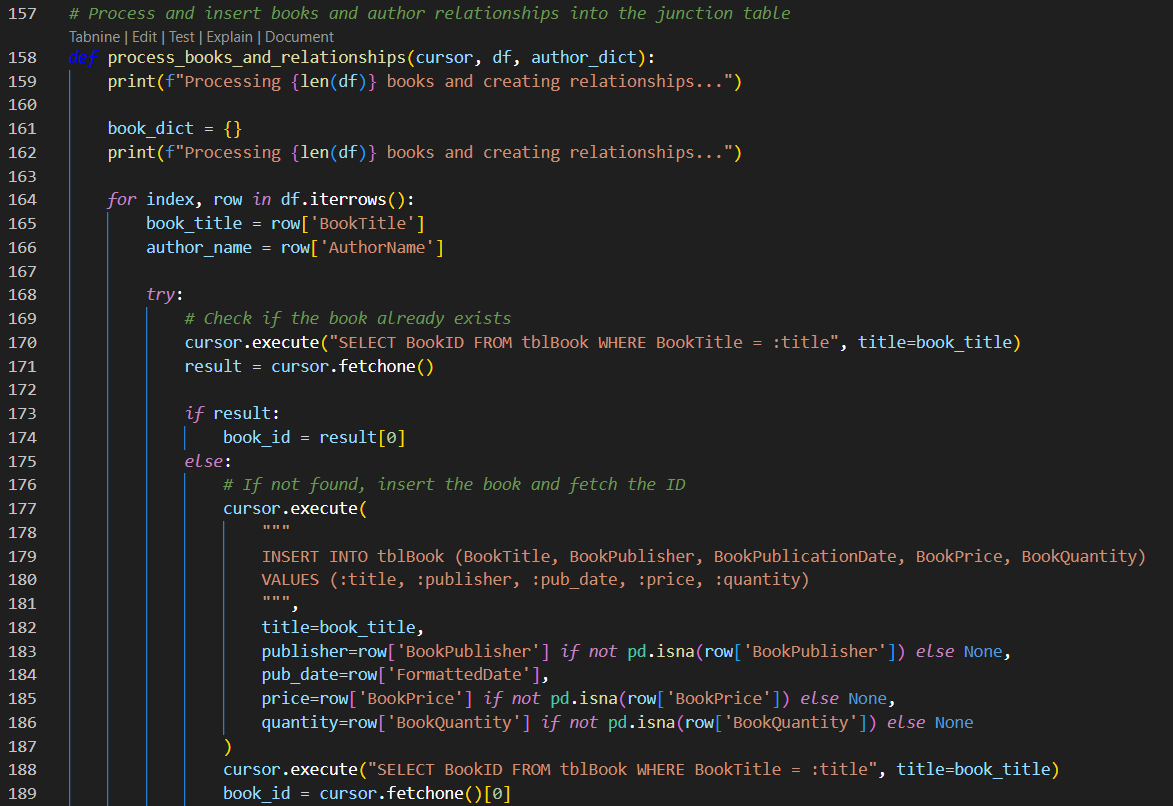
A screen shot of a computer program

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A computer screen shot of a program

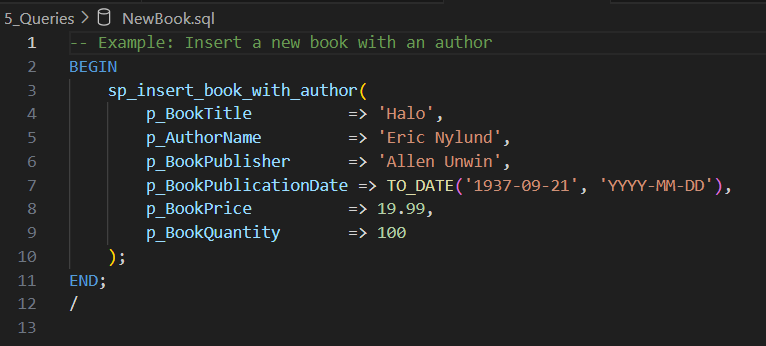
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1. **Author–Book Relationships:**  
   The many-to-many relationship between books and authors was maintained by inserting records into the junction table tblBookAuthor.



1. **Customer Data Insertion:**  
   Customer information was imported from the CSV file and inserted into the tblCustomer table. A screen shot of a computer

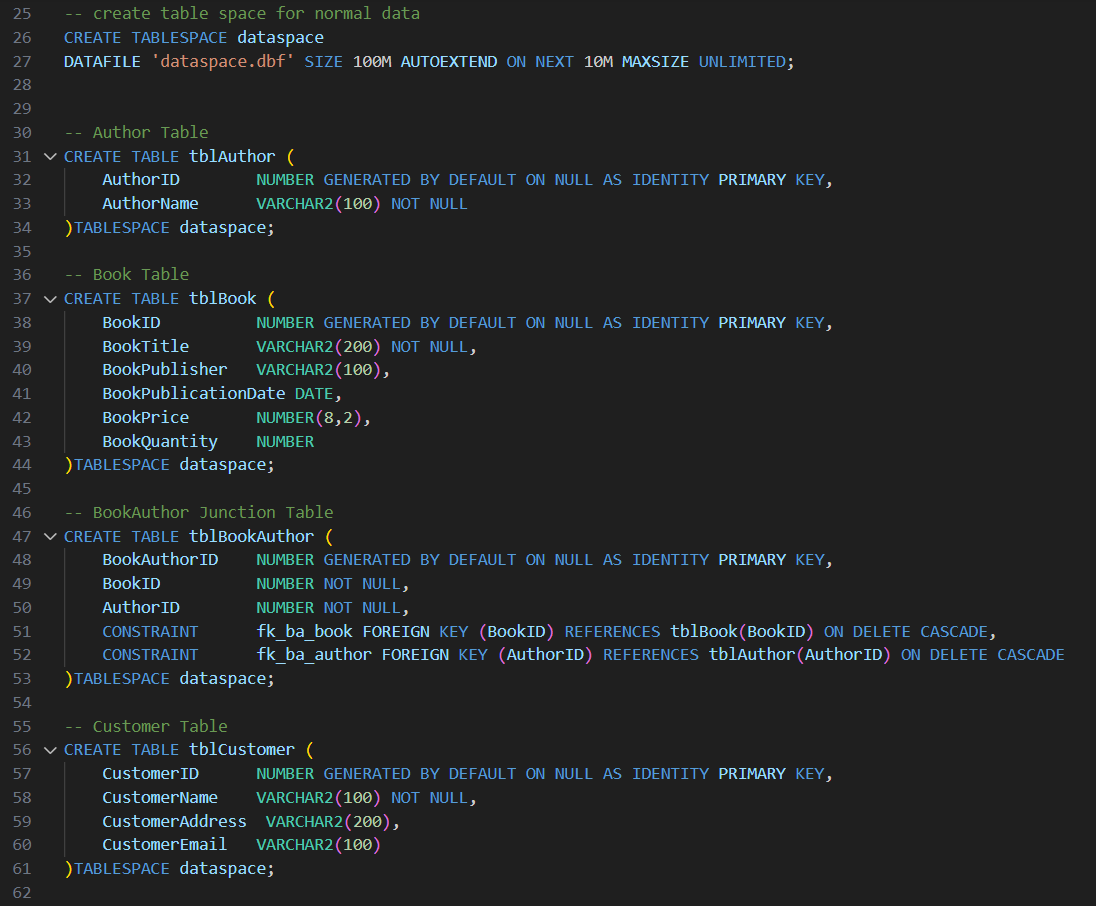
   AI-generated content may be incorrect.
2. **Transaction Management:**  
   All inserts were handled in transactions to maintain data integrity; any errors triggered a rollback.



### Queries user\_viewer.sql

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A computer screen shot of a program

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### Explanation of the Procedure sp\_insert\_book\_with\_author

This stored procedure is made to reduce complexity and automatically add a book and its author to the database while keeping the data links between the three tables in place.

Checks for Existing Author:

* Tries to discover the AuthorID for the name of the author.
* When the author does not exist, it adds the new author and stores their ID as the AuthorID.

Inserts the Book:

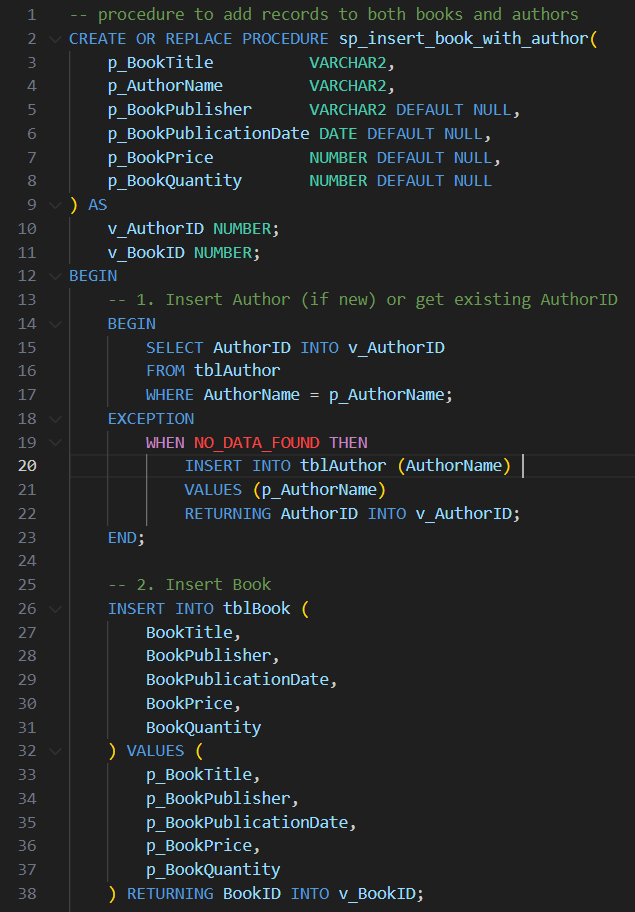
* Inputs all the required details into the book record.
* Captures the newly generated BookID.
* Links the Book and Author:
* Inserts a row into the tblBookAuthor table to match a book and an author.

Transaction Handling:

* After all the steps are successful, the smart contract completes the transaction.
* Should an error arise, the transaction will be cancelled, and the error is printed out using DBMS\_OUTPUT.

Key Benefits:

* Stays in sync with the consistency and order of data in the database
* Prevents duplicate authors
* Stores frequently used multi-stage inserts in a common place.

A computer screen with text on it

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# Security Implementation

**To secure the database and control who can access what, roles, users, privileges, and password policies were created as layers for security. It’s designed according to Oracle’s approach where management tasks (SYSTEM) are apart from the tasks that involve application data (users/schemas).**

### Table.User\_manger.sql

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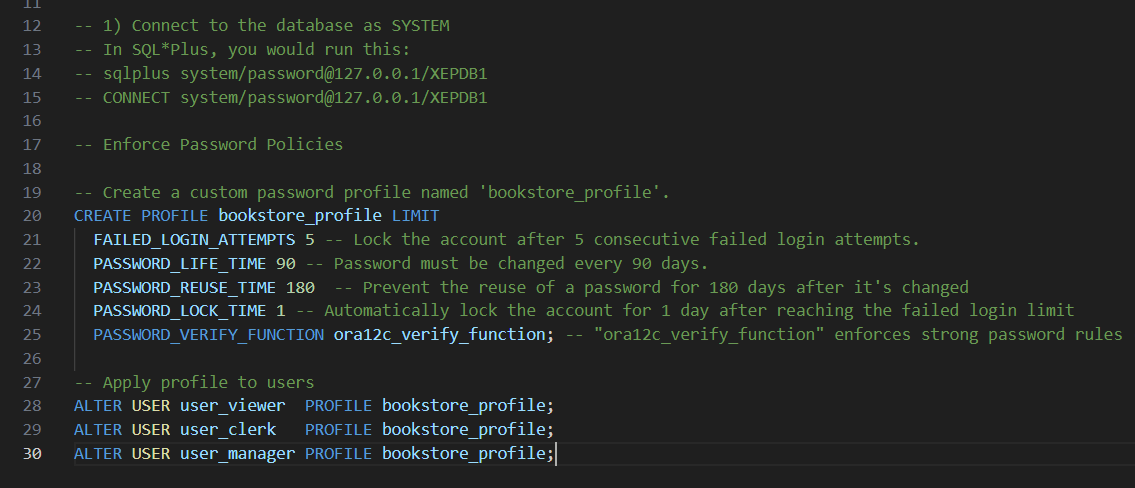
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### Permissions.user\_manager.sql

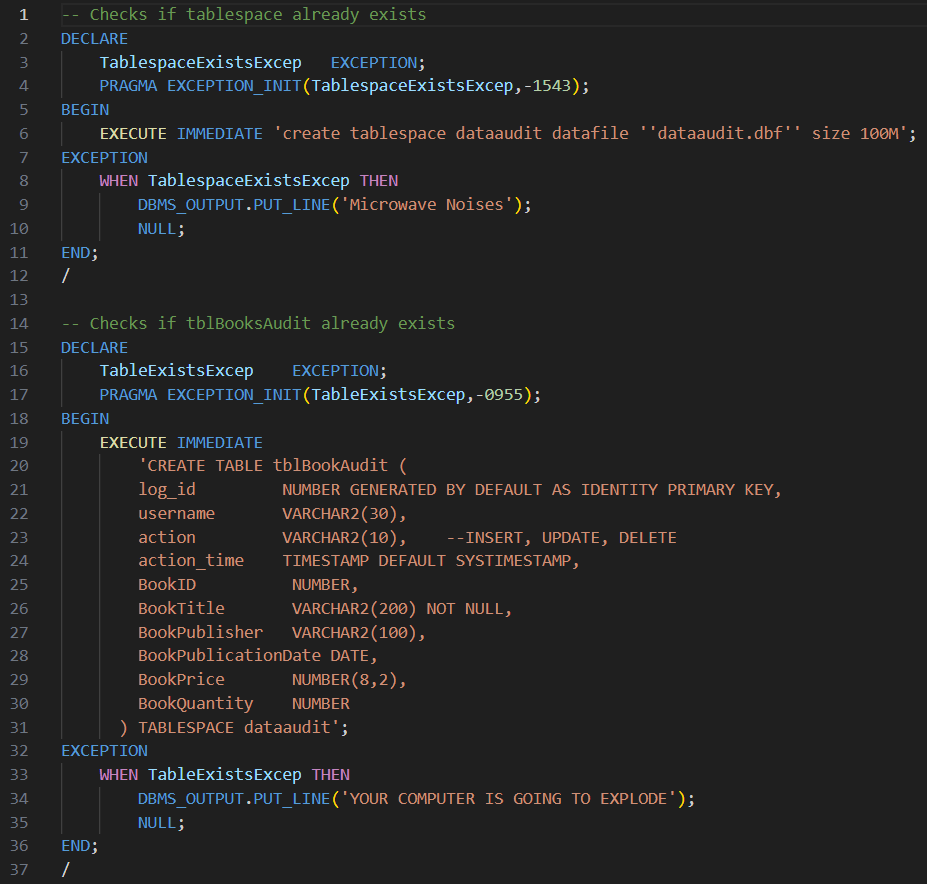
**A screen shot of a computer program

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Security measures put in the database were making user accounts, setting up their roles and what they can do, and making sure everyone had good and safe passwords. Two users were created: book\_admin can make changes in the books, while readonly\_user can only read them. Corresponding roles were also created AdminRole gets all the permissions and ReadOnlyRole can only view data in the database. These roles were then given to the right people depending on what they needed to do in the organization. To further keep the system safe, rules were put in place so that passwords had to include a mixture of uppercase and lowercase letters, a number, and a special character. Additionally, passwords would have to be changed every 90 days, and if someone typed in the wrong password three times in a row, their account would get locked. These measures all worked together to make sure only the right people could get to the data and change it, while following the best rules for keeping things secure.



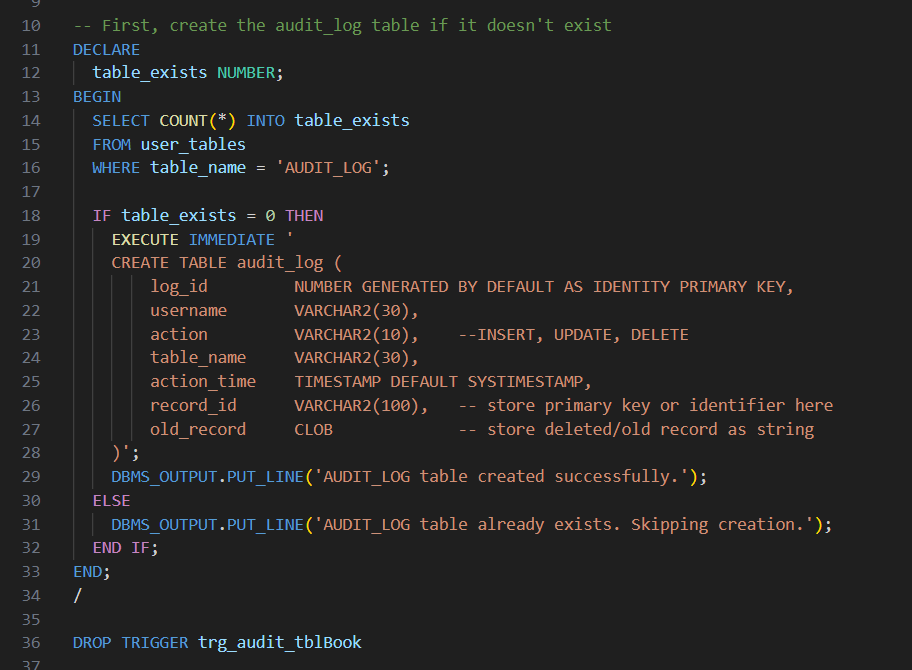
Note "ora12c\_verify\_function" enforces strong password rules (at least one uppercase, one digit, special char etc.)



# Monitoring and Troubleshooting

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AI-generated content may be incorrect.To make sure the database was stable, available, and safe, several checks were done during the project. Regular checks with Oracle SQL Developer and by running queries on dynamic views like v$session helped me keep an eye on who was signed in and notice if anyone was trying to get in who shouldn't. Custom functions and rules were also set up to keep track of every change that happened to main tables like tblBook, and all the changes were saved in the tblBookAudit table in the dataaudit tablespace. This separation made it easier to handle the increasing amount of log data and helped the system work faster. During testing, we ran into a few little problems. One issue was that the queries on the tblBook table ran slowly, which got fixed by adding a new index on the BookTitle column. Another issue happened when the Oracle listener wouldn’t start, which was resolved by checking the listener.ora file and then simply restarting the service. Additionally, some users tried logging in more than once, but failed, which showed how important it is to have good, strong passwords. In response, a new set of rules was placed on all users, making sure that passwords were more complicated, changing them every 90 days, and locking accounts after a few wrong login attempts. These checks and quick fixes helped keep the database safe, fast, and well-working while it was being used.

A computer screen shot of text

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The provided PL/SQL script implements an auditing mechanism to automatically log all changes made to the tblBook table. It begins by checking whether the audit\_log table already exists, and if not, it creates the table with fields to store audit metadata—such as the user who performed the action, the type of action (INSERT, UPDATE, DELETE), the name of the affected table, the timestamp of the action, the record identifier (BookID), and a detailed snapshot of the previous record state stored in a CLOB field (old\_record). Following this, a trigger named trg\_audit\_tblBook is created to fire **after** any insert, update, or delete operation on tblBook. When a change occurs, the trigger captures the current user and action type. For updates and deletions, it constructs a string containing the old values of the record, which is then stored in the audit table. This automated logging helps track data changes, supports accountability, and enables administrators to trace historical modifications for auditing and debugging purposes. The use of DBMS\_OUTPUT allows feedback during table creation for easier development visibility.



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