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SL Assignment 4

1. Create Spring Boot Project and Configure Dependencies

In Spring Tool Suite, create a new Spring Starter project with type Maven and language Java. And choose these dependencies: Spring Web, Thymeleaf, Spring Data JPA, MySQL Driver, Spring Security and Spring Boot DevTools – so the XML code for these dependencies in the `pom.xml` file is as follows:

```
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-web</artifactId>
</dependency>
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-thymeleaf</artifactId>
</dependency>
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-data-jpa</artifactId>
</dependency>
<dependency>
    <groupId>mysql</groupId>
    <artifactId>mysql-connector-java</artifactId>
    <scope>runtime</scope>
</dependency>
```

```
    <dependency>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-starter-security</artifactId>
    </dependency>
    <dependency>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-devtools</artifactId>
        <scope>runtime</scope>
        <optional>true</optional>
    </dependency>
```

Spring Boot DevTools is optional but I recommend it, for using the Spring Boot automatic reload feature to save development time. You can also notice the IDE includes the dependency for JUnit automatically:

```
    <dependency>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-starter-test</artifactId>
        <scope>test</scope>
        <exclusions>
            <exclusion>
                <groupId>org.junit.vintage</groupId>
                <artifactId>junit-vintage-engine</artifactId>
            </exclusion>
        </exclusions>
    </dependency>
```

Spring Boot uses JUnit 5 (JUnit Jupiter) by default, and the exclusion means that no support for older versions of JUnit.

2. Create Database and Configure Data Source

Use MySQL Workbench or MySQL Command Line Client program to create a new database named `codejavadb`(you can choose any name you want):

```
create database codejavadb;
```

Then open the Spring Boot configuration file `application.properties` under `/src/main/resources` directory. Enter the following properties for configuring a data source that will be used by Spring Data JPA:

```
spring.jpa.hibernate.ddl-auto=create

spring.datasource.url=jdbc:mysql://localhost:3306/codejavadb

spring.datasource.username=root

spring.datasource.password=password

spring.jpa.properties.hibernate.format_sql=true
```

Note that we set the `spring.jpa.hibernate.ddl-auto` to `create` in order to let Hibernate create the tables when we run a unit test in the next section. Other properties are self-explanatory.

3. Code Entity Class and Repository Interface

Next, create a new Java class named `User` to map with the corresponding `users` table (not yet created) in the database, with the following code:

```
1
2   package net.codejava;
3
4
5   import javax.persistence.*;
6
7
8   @Entity
9
10  @Table(name = "users")
11  public class User {
12
13
14      @Id
15
16      @GeneratedValue(strategy = GenerationType.IDENTITY)
17
18      private Long id;
19
20
21      @Column(nullable = false, unique = true, length = 45)
22
23      private String email;
24
25
26      @Column(nullable = false, length = 64)
        private String password;


        @Column(name = "first_name", nullable = false, length
    = 20)
        private String firstName;


        @Column(name = "last_name", nullable = false, length =
    20)
        private String lastName;
```

```
        // getters and setters are not shown

    }
```

As you can see, the user information consists of ID, email, password, first name and last name. Here I use common annotations from JPA. The setters and getters are now shown for brevity, so be sure you generate those methods as well.

Next, create a new interface named `UserRepository` to act as a Spring Data JPA repository with the following simple code:

```
1
2  package net.codejava;
3
4
5  import
6  org.springframework.data.jpa.repository.JpaRepository;
7


   public interface UserRepository extends
   JpaRepository<User, Long> {



   }
```

This interface is a subtype of `JpaRepository` which defines common persistence operations (including CRUD) and the implementation will be generated at runtime by Spring Data JPA.

To understand Spring Data JPA from scratch, I recommend you to read this tutorial.

4. Code and Run Unit Test

Next, code a test class named `UserRepositoryTests` under `src/test/java` directory with the following skeleton code:

```
1
2   package net.codejava;
3
4
5   import static org.assertj.core.api.Assertions.assertThat;
6
7
8   import org.junit.jupiter.api.Test;
9
10  import
11  org.springframework.beans.factory.annotation.Autowired;
12  import
13  org.springframework.boot.test.autoconfigure.jdbc.AutoConfi
14  gureTestDatabase;
15
16  import
17  org.springframework.boot.test.autoconfigure.jdbc.AutoConfi
18  gureTestDatabase.Replace;
19  import
20  org.springframework.boot.test.autoconfigure.orm.jpa.DataJp
21  aTest;
22
23  import
24  org.springframework.boot.test.autoconfigure.orm.jpa.TestEn
25  tityManager;
    import org.springframework.test.annotation.Rollback;


    @DataJpaTest
    @AutoConfigureTestDatabase(replace = Replace.NONE)
    @Rollback(false)
    public class UserRepositoryTests {

        @Autowired
        private TestEntityManager entityManager;
```

```
    @Autowired
    private UserRepository repo;

    // test methods go below
}
```

This is a basic test class for testing Spring Data JPA repositories. It is configured to work with the actual database (`@AutoConfigureTestDatabase(replace = Replace.NONE)`) and commit the changes (`@Rollback(false)`). `TestEntityManager` is a wrapper of JPA's `EntityManager` so we can use it in test class like a standard `EntityManager`.

And write the first test method that persists a `User` object into the database as follows:

```
@Test
public void testCreateUser() {
    User user = new User();
    user.setEmail("ravikumar@gmail.com");
    user.setPassword("ravi2020");
    user.setFirstName("Ravi");
    user.setLastName("Kumar");


    User savedUser = repo.save(user);

    User existUser = entityManager.find(User.class,
savedUser.getId());
```

```
    assertThat(user.getEmail()).isEqualTo(existUser.getEmail()
    );



    }
```

Here, you can see I use AssertJ's method `assertThat()` as the assertion statement. It is more readable and more fluent than using traditional JUnit's assertion methods. Run this test method (right click on the method name in the code editor, then select Run As > JUnit Test), you will see it prints the following SQL statements in the console output:

```
1
2   Hibernate:
3
4
5       create table users (
6
7          id bigint not null auto_increment,
8
9           email varchar(45) not null,
10
11          first_name varchar(20) not null,
12
13          last_name varchar(20) not null,
14
15          password varchar(64) not null,
16
17          primary key (id)
18
19      ) engine=InnoDB
20
21
22  Hibernate:
23
    alter table users
       add constraint UK_6dotkott2kjsp8vw4d0m25fb7 unique
(email)
```

```
Hibernate:
    insert
    into
        users
        (email, first_name, last_name, password)
    values
        (?, ?, ?, ?)
```

That means Hibernate actually created the table `users` and insert a new row into it (you don't have to create the table manually, right?).

And Spring Data JPA prints the following statement:

```
Committed transaction for test:
[DefaultTestContext@311bf055 testClass =
UserRepositoryTests…
```

That means the data was stored in the database permanently (as opposed to the default behavior of Spring Data JPA Test is rollback the transaction after each test). You can use MySQL Workbench to verify that the table and data were really created.

And update this property in the `application.properties` file:

```
spring.jpa.hibernate.ddl-auto=none
```

This is to tell Hibernate won't recreate the table in the next run of the application. Also notice that the user's password is stored in plain text (for testing purpose). Later you will learn how to encode it.

5. Code Controller class and Home Page

Next, let's create a Spring MVC controller class named `AppController`, with the first handler method to show the home page, as follows:

```
package net.codejava;


import
org.springframework.beans.factory.annotation.Autowired;
import org.springframework.stereotype.Controller;
import org.springframework.web.bind.annotation.GetMapping;


@Controller
public class AppController {


    @Autowired
    private UserRepository userRepo;


    @GetMapping("")
    public String viewHomePage() {
        return "index";
    }
}
```

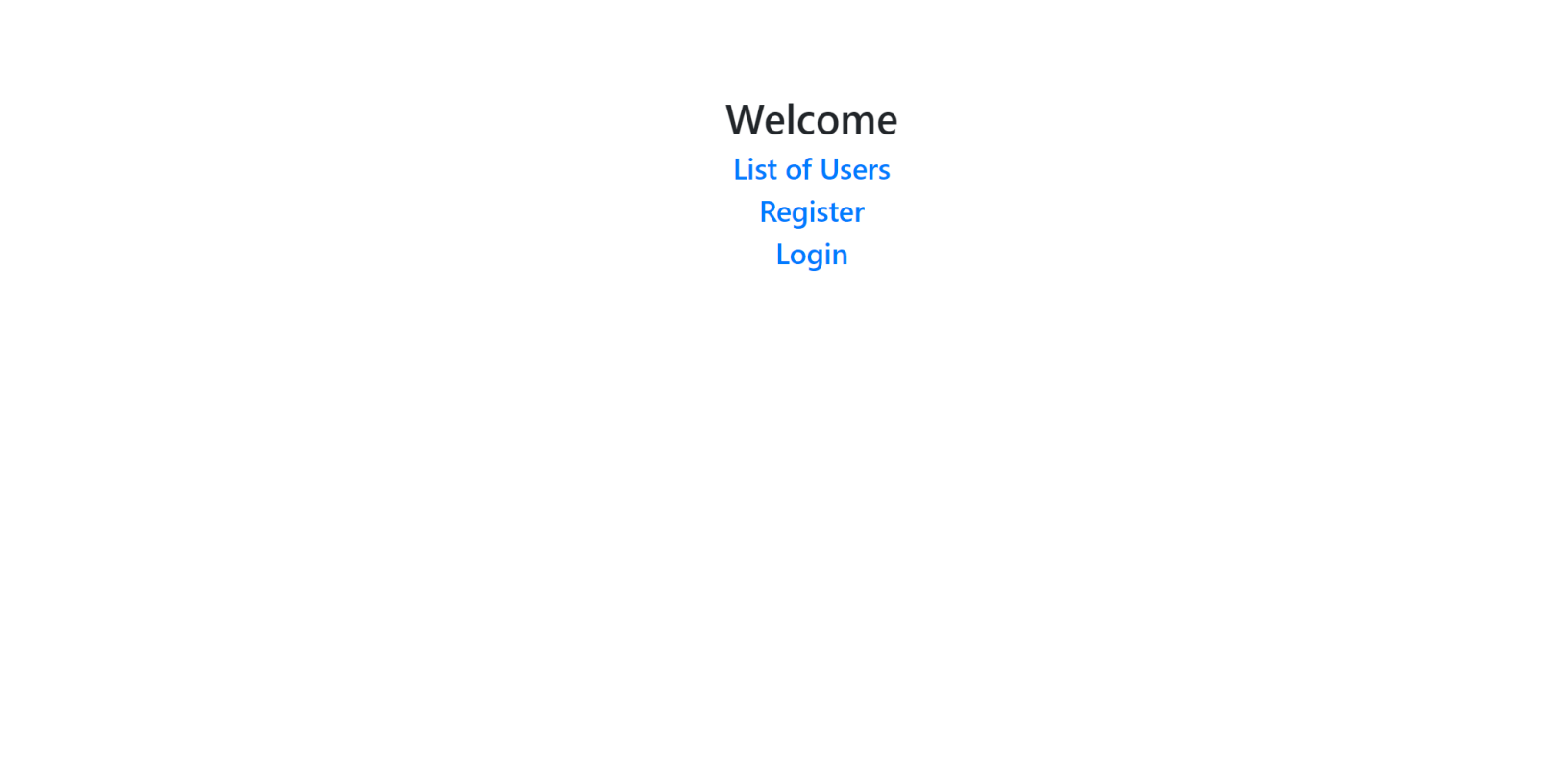
Under `/src/main/resources/templates` directory, create a new HTML file named `index.html` with the following code:

```
<!DOCTYPE html>

<html xmlns:th="http://www.thymeleaf.org">

<head>

    <meta charset="ISO-8859-1">

    <title>Welcome to CodeJava Home</title>

    <link rel="stylesheet" type="text/css"
href="/webjars/bootstrap/css/bootstrap.min.css" />

    <script type="text/javascript"
src="/webjars/jquery/jquery.min.js"></script>

    <script type="text/javascript"
src="/webjars/bootstrap/js/bootstrap.min.js"></script>

</head>

<body>

    <div class="container text-center">

        <h1>Welcome to CodeJava.net</h1>

        <h3><a th:href="/@{/users}">List of Users</a></h3>

        <h3><a th:href="/@{/register}">Register</a></h3>

        <h3><a th:href="/@{/login}">Login</a></h3>

    </div>


</body>

</html>
```

As you can see, in this webpage we use Bootstrap and JQuery from Webjars, so you must add the following dependencies for the project:

```
<dependency>
    <groupId>org.webjars</groupId>
    <artifactId>jquery</artifactId>
    <version>3.4.1</version>
</dependency>
<dependency>
    <groupId>org.webjars</groupId>
    <artifactId>bootstrap</artifactId>
    <version>4.3.1</version>
</dependency>
<dependency>
    <groupId>org.webjars</groupId>
    <artifactId>webjars-locator-core</artifactId>
</dependency>
```

You can also notice Thymeleaf is used to generate the URLs properly.
Now, you can run this Spring Boot Project (using Boot Dashboard of Spring Tool Suite), and access the web application at this URL http://localhost:8080, you should see the homepage appears as shown below:



You see, the home page shows 3 links List of Users, Register and Login. You will learn how to implement each function in the next few minutes.

6. Implement User Registration feature

Add a new handler method in the controller class to show the user registration form (sign up), with the following code:

```
@GetMapping("/register")
public String showRegistrationForm(Model model) {
    model.addAttribute("user", new User());

    return "signup_form";
}
```

This handler method will be executed when a user clicks the Register hyperlink in the homepage.

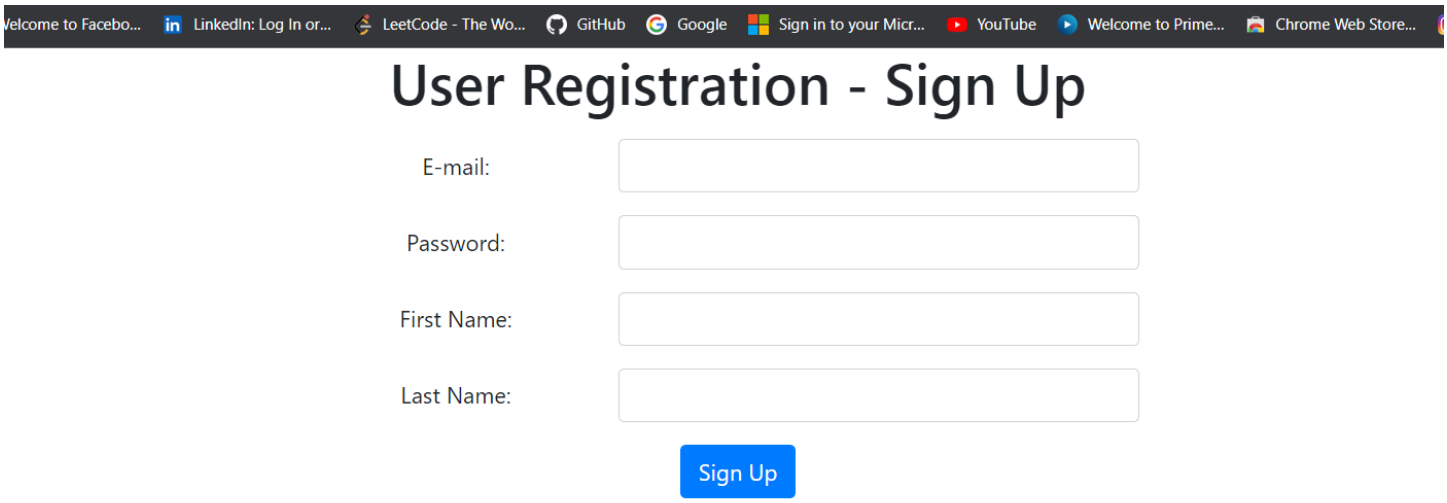
And write code for the user registration page as follows (create `signup_form.html` file):

```
<!DOCTYPE html>

<html xmlns:th="http://www.thymeleaf.org">

<head>

    <meta charset="ISO-8859-1">

    <title>Sign Up - CodeJava</title>

    <link rel="stylesheet" type="text/css"
href="/webjars/bootstrap/css/bootstrap.min.css" />

    <script type="text/javascript"
src="/webjars/jquery/jquery.min.js"></script>

    <script type="text/javascript"
src="/webjars/bootstrap/js/bootstrap.min.js"></script>

</head>

<body>

    <div class="container text-center">

        <div>

            <h1>User Registration - Sign Up</h1>

        </div>

        <form th:action="@{/process_register}"
th:object="${user}"

            method="post" style="max-width: 600px; margin:
0 auto;">

        <div class="m-3">

            <div class="form-group row">

                <label class="col-4
col-form-label">E-mail: </label>

                <div class="col-8">

```

```
                    <input type="email"
th:field="*{email}" class="form-control" required />
                </div>
            </div>


            <div class="form-group row">
                <label class="col-4
col-form-label">Password: </label>
                <div class="col-8">
                    <input type="password"
th:field="*{password}" class="form-control"
                           required minlength="6"
maxlength="10"/>
                </div>
            </div>


            <div class="form-group row">
                <label class="col-4 col-form-label">First
Name: </label>
                <div class="col-8">
                    <input type="text"
th:field="*{firstName}" class="form-control"
                           required minlength="2"
maxlength="20"/>
                </div>
            </div>
```

```
            <div class="form-group row">
                <label class="col-4 col-form-label">Last
Name: </label>
                <div class="col-8">
                    <input type="text"
th:field="*{lastName}" class="form-control"
                           required minlength="2"
maxlength="20" />
                </div>
            </div>


            <div>
                <button type="submit" class="btn
btn-primary">Sign Up</button>
            </div>
        </div>
        </form>
    </div>
</body>
</html>
```

Click Register link in the homepage, you should see the registration page appears like this:



It looks very nice, isn't it? Thanks to Bootstrap and HTML 5. You can also notice with HTML 5, the browser provides validation for input fields so you don't have to use Javascript for that.

Next, code a handler method in the controller class to process registration with the following code:

```
@PostMapping("/process_register")
public String processRegister(User user) {

    BCryptPasswordEncoder passwordEncoder = new
BCryptPasswordEncoder();

    String encodedPassword =
passwordEncoder.encode(user.getPassword());

    user.setPassword(encodedPassword);


    userRepo.save(user);
```

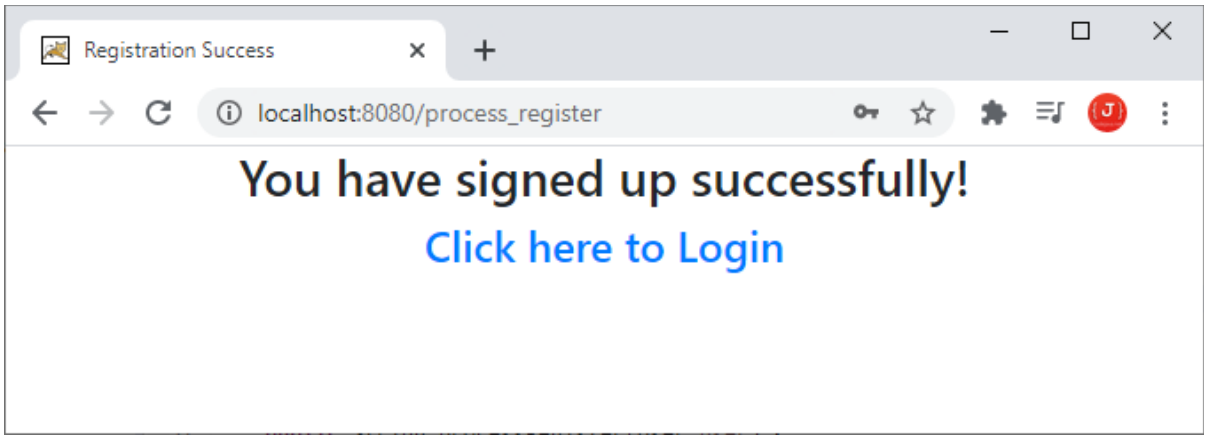
```
        return "register_success";
    }
```

As you can see, here we use `BCryptPasswordEncoder` to encode the user's password so the password itself it not stored in database (for better security) – only the hash value of the password is stored.

After a User object is persisted into the database, it returns a logical view name register_success, so we need to create the corresponding HTML page with the following code:

```
<!DOCTYPE html>
<html xmlns:th="http://www.thymeleaf.org">
<head>
    <meta charset="ISO-8859-1">
    <title>Registration Success</title>
    <link rel="stylesheet" type="text/css"
href="/webjars/bootstrap/css/bootstrap.min.css" />
</head>
<body>
    <div class="container text-center">
        <h3>You have signed up successfully!</h3>
        <h4><a th:href="/@{/login}">Click here to
Login</a></h4>
    </div>


</body>
</html>
```

This page simply displays the successful message after a user has registered, as shown below:



Now you can test the user registration feature and verify result in the database (note that the password should be encoded).

7. Code Custom UserDetails and UserDetailsService Classes

Next, in order to implement authentication (login) feature, we need to create a class of subtype `UserDetails` (defined by Spring Security) to represent an authentication user, with the following code:

```
1
2   package net.codejava;
3
4
5   import java.util.Collection;
6
7
8   import org.springframework.security.core.GrantedAuthority;
9
10  import
11  org.springframework.security.core.userdetails.UserDetails;
12
13
14  public class CustomUserDetails implements UserDetails {
15
16
17      private User user;
18
19
20      public CustomUserDetails(User user) {
21
22          this.user = user;
23
24      }
25
26
27      @Override
28      public Collection<? extends GrantedAuthority>
29  getAuthorities() {
30
31          return null;
32
33      }
34
35
36      @Override
37      public String getPassword() {
38
39          return user.getPassword();
```

```
40
41      }
42
43
44      @Override
45      public String getUsername() {
46
47          return user.getEmail();
48
49      }
50
51
52      @Override
53      public boolean isAccountNonExpired() {
54
55          return true;
        }


        @Override
        public boolean isAccountNonLocked() {
            return true;
        }


        @Override
        public boolean isCredentialsNonExpired() {
            return true;
        }


        @Override
        public boolean isEnabled() {
```

```
            return true;
        }

        public String getFullName() {
            return user.getFirstName() + " " +
    user.getLastName();
        }

    }
```

Spring Security will invoke methods in this class during the authentication process. And next, to tell Spring Security how to look up the user information, we need to code a class that implements the `UserDetailsService` interface, as shown below:

```
1
2   package net.codejava;
3
4
5   import
6   org.springframework.beans.factory.annotation.Autowired;
7   import
8   org.springframework.security.core.userdetails.UserDetails;
9
10  import
11  org.springframework.security.core.userdetails.UserDetailsS
12  ervice;
13
14  import
15  org.springframework.security.core.userdetails.UsernameNotF
16  oundException;
17
18
19  public class CustomUserDetailsService implements
20  UserDetailsService {
21
22
```

```
    @Autowired
    private UserRepository userRepo;

    @Override
    public UserDetails loadUserByUsername(String username)
throws UsernameNotFoundException {
        User user = userRepo.findByEmail(username);
        if (user == null) {
            throw new UsernameNotFoundException("User not
found");
        }
        return new CustomUserDetails(user);
    }

}
```

As you can see, Spring Security will invoke the `loadUserByUsername()` method to authenticate the user, and if successful, a new object of type `CustomUserDetails` object is created to represent the authenticated user.

Also remember to update the `UserRepository` interface for adding this method:

```
1
2  public interface UserRepository extends
3  JpaRepository<User, Long> {
4      @Query("SELECT u FROM User u WHERE u.email = ?1")
5      public User findByEmail(String email);

}
```

Suppose that the email column is unique in the users table, so we define the `findByEmail()` method that returns a single User object based on email (no two users having the same email).

8. Configure Spring Security for Authentication (Login)

Next, create a new Java class for configuring Spring Security with the following code:

```
1
2   package net.codejava;
3
4
5   import javax.sql.DataSource;
6
7
8   import
9   org.springframework.beans.factory.annotation.Autowired;
10
11  import org.springframework.context.annotation.Bean;
12  import
13  org.springframework.context.annotation.Configuration;
14
15  import
16  org.springframework.security.authentication.dao.DaoAuthent
17  icationProvider;
18
19  import
20  org.springframework.security.config.annotation.authenticat
21  ion.builders.AuthenticationManagerBuilder;
22  import
23  org.springframework.security.config.annotation.web.builder
24  s.HttpSecurity;
25
26  import
27  org.springframework.security.config.annotation.web.configu
28  ration.EnableWebSecurity;
29  import
30  org.springframework.security.config.annotation.web.configu
31  ration.WebSecurityConfigurerAdapter;
32
33  import
34  org.springframework.security.core.userdetails.UserDetailsS
35  ervice;
36
```

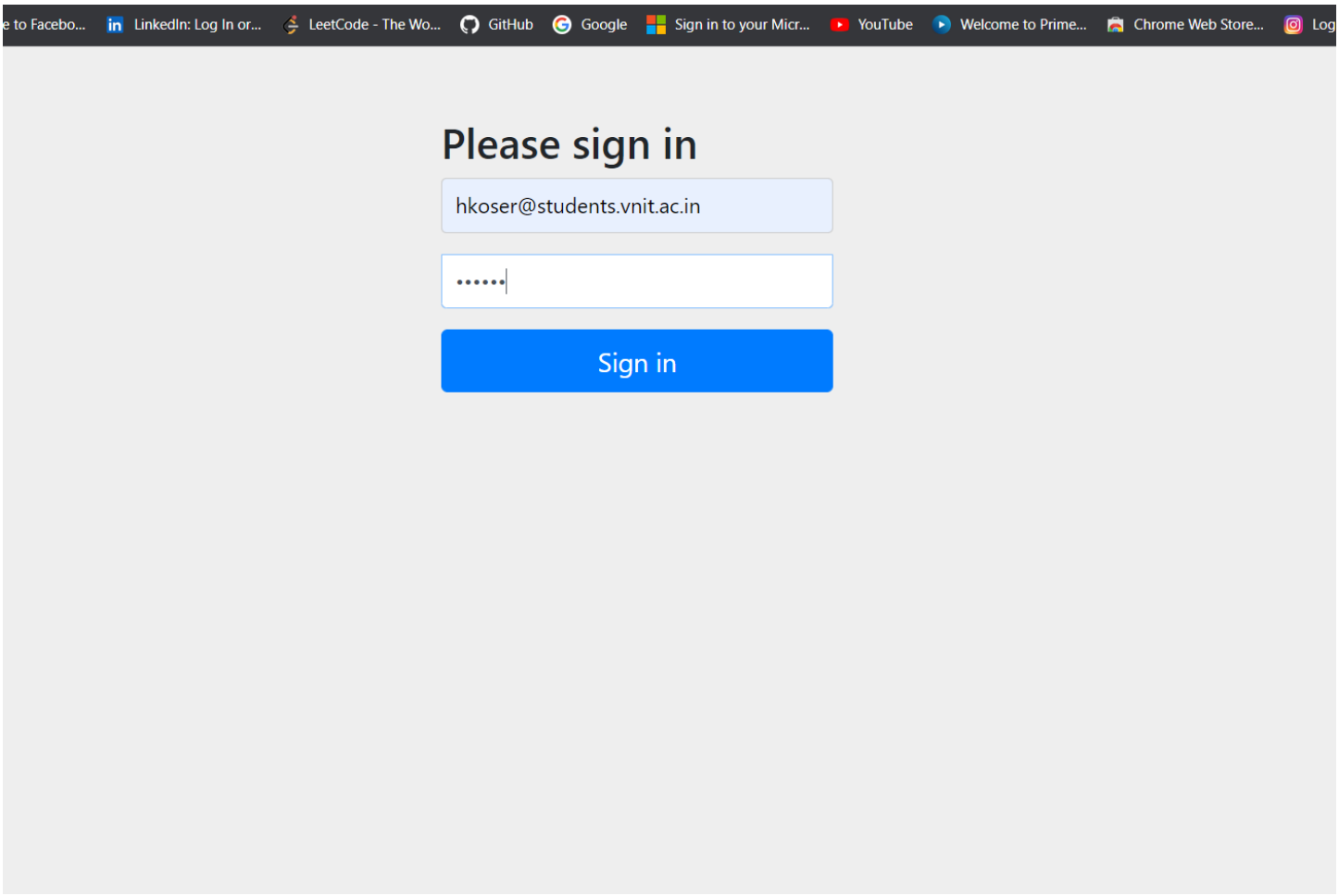
```
37
38 import
39 org.springframework.security.crypto.bcrypt.BCryptPasswordE
40 ncoder;
41
42
43 @Configuration
44 @EnableWebSecurity
45
46 public class WebSecurityConfig extends
47 WebSecurityConfigurerAdapter {
48
49     @Autowired
50     private DataSource dataSource;
51
52
53
54     @Bean
55     public UserDetailsService userDetailsService() {
56
57         return new CustomUserDetailsService();
58     }
59
60
61
    @Bean
    public BCryptPasswordEncoder passwordEncoder() {
        return new BCryptPasswordEncoder();
    }


    @Bean
    public DaoAuthenticationProvider
authenticationProvider() {
        DaoAuthenticationProvider authProvider = new
DaoAuthenticationProvider();
```

```
authProvider.setUserDetailsService(userDetailsService());

authProvider.setPasswordEncoder(passwordEncoder());

        return authProvider;
    }

    @Override
    protected void configure(AuthenticationManagerBuilder
auth) throws Exception {

auth.authenticationProvider(authenticationProvider());
    }

    @Override
    protected void configure(HttpSecurity http) throws
Exception {
        http.authorizeRequests()
            .antMatchers("/users").authenticated()
            .anyRequest().permitAll()
            .and()
            .formLogin()
                .usernameParameter("email")
                .defaultSuccessUrl("/users")
                .permitAll()
```

```
                .and()
                .logout().logoutSuccessUrl("/").permitAll();
        }


    }
```

Here in the `configure()` method, a user must login to see the list users page (URL `/users`) and other pages do not require authentication. We also configure the default login page (generated by Spring Security) with the parameter name of the username field is email and the default success URL is `/users` – that means after successful login, the user will be redirected to the list users page.

Now you can test the login function. Go to the homepage and click Login link, you should see the default login page appears as follows:



Enter the username (email) and password of the user you have registered previously and click Sign in. You should see an error page because the list users page has not been implemented.

9. Code List Users Page and Logout

Next, we're going to implement the list users and logout features. Update the controller class to have the following handler method:

```
@GetMapping("/users")
public String listUsers(Model model) {
    List<User> listUsers = userRepo.findAll();
    model.addAttribute("listUsers", listUsers);

    return "users";
}
```

Here, you can see we call the `findAll()` method on the `UserRepository` but we didn't write that method. It is defined by the Spring Data JPA's `JpaRepository` interface.

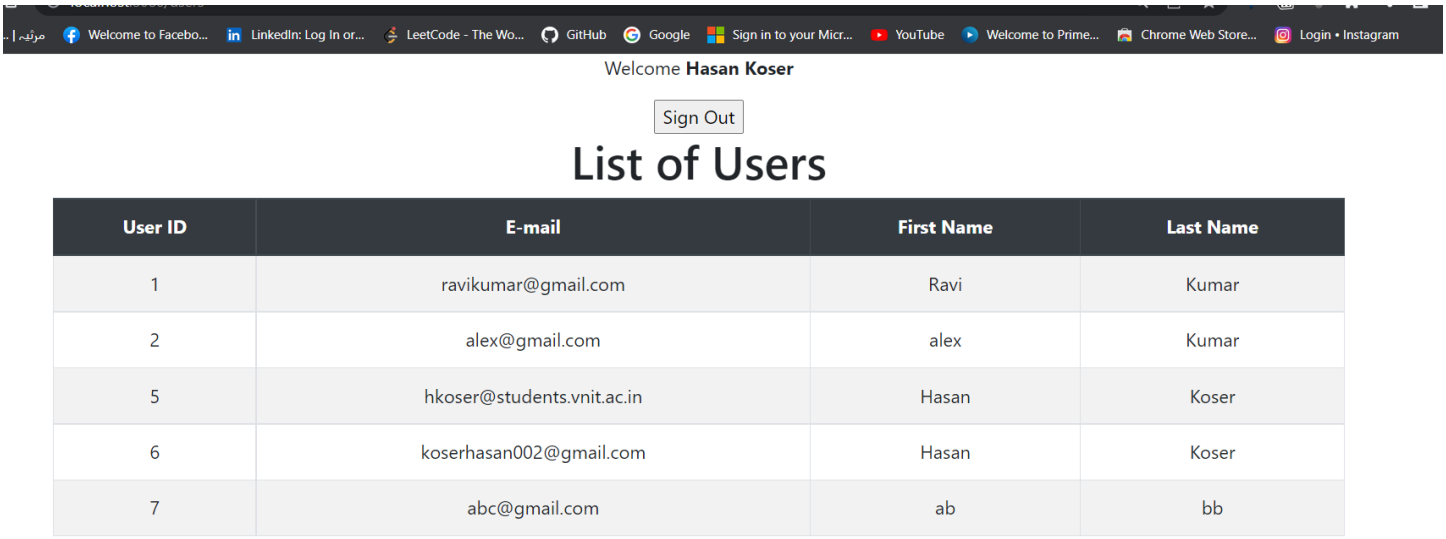
And create the `users.html` file with the following code:

```
<!DOCTYPE html>

<html xmlns:th="http://www.thymeleaf.org">

<head>

    <meta charset="ISO-8859-1">

    <title>List Users</title>

    <link rel="stylesheet" type="text/css"
href="/webjars/bootstrap/css/bootstrap.min.css" />

    <script type="text/javascript"
src="/webjars/jquery/jquery.min.js"></script>

    <script type="text/javascript"
src="/webjars/bootstrap/js/bootstrap.min.js"></script>

</head>

<body>

<div class="container text-center">

    <div>

        <form th:action="@{/logout}" method="post">

            <p>

                Welcome
<b>[[${#request.userPrincipal.principal.fullName}]]</b>

            </p>

            <input type="submit" value="Sign Out" />

        </form>

    </div>

    <div>

        <h1>List of Users</h1>

    </div>
```

```
40
41
42      <div>
43
44          <table class="table table-striped table-bordered">
45
46              <thead class="thead-dark">
                    <tr>
                        <th>User ID</th>
                        <th>E-mail</th>
                        <th>First Name</th>
                        <th>Last Name</th>
                    </tr>
                </thead>
                <tbody>
                    <tr th:each="user: ${listUsers}">
                        <td th:text="${user.id}">User ID</td>
                        <td
    th:text="${user.email}">E-mail</td>
                        <td th:text="${user.firstName}">First
    Name</td>
                        <td th:text="${user.lastName}">Last
    Name</td>
                    </tr>
                </tbody>
            </table>
        </div>
    </div>
```

```
</body>

</html>
```

This page consists of two parts: the first part shows the user's full name with Logout button; and the second one lists all users in the database. It should look something like this:



User ID	E-mail	First Name	Last Name
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