

## CNT 4714 – Project Three – Summer 2022

**Title:** “Project Three: Developing A Three-Tier Distributed Web-Based Application”

**Points:** 100 points (bonus problem potentially adds 15 points – see page 14.)

**Due Date:** Thursday August 4, 2022 by 11:59 pm (WebCourses time)

**Objectives:** To incorporate many of the techniques you’ve learned so far this semester into a distributed three-tier web-based application which uses servlets and JSP technology running on a Tomcat container/server to access and maintain a persistent MySQL database using JDBC.

**Description:** In this assignment you will utilize a suppliers/parts/jobs/shipments database (creation/population script available on Webcourses under Project 3) as the back-end database. Front-end access to this database by end users will occur through a single page displayed in the client’s web browser. The schema of the backend database consists of four tables with the following schemas for each table:

```
suppliers (snum, sname, status, city) //information about suppliers  
parts (pnum, pname, color, weight, city) //information about parts  
jobs (jnum, jname, numworkers, city) //information about jobs  
shipments (snum, pnum, jnum, quantity) //suppliers ship parts to jobs in specific quantities
```

The database will enforce referential integrity via foreign key constraints. The primary key for the shipments table is a composite key consisting of three foreign keys (the primary keys in the suppliers, parts, and jobs tables). Referential integrity means that a shipment record cannot exist unless it links back (via referential integrity) to existing entities on all foreign keys. Thus, a shipment record cannot exist unless the referenced snum, pnum, and jnum already exist in their respective tables.

The first-tier (user-level front-end) of your web-application will be three different JSP pages, one of which handles root-level user clients, another which handles non-root-level clients, to enter arbitrary SQL commands into a window (i.e. a form) and submit them to a server application for processing. The third JSP page will be a dedicated data entry form for entering new shipment records into the shipments table.

The front-ends of all three applications (**and only the front-end**) will utilize JSP technology. The front-ends for the root-level and client-level users, will provide the user a simple form in which they will enter a SQL command (any DML, DDL, or DCL command could theoretically be entered by the user, however we will restrict to queries, insert, update, replace, and delete commands). These two front-ends will provide only three buttons for the user, an “Execute Command” button that will cause the execution of the SQL command currently in the input window, a “Reset Form” button that simply clears any content currently in the form input area, and a “Clear Results” button that will erase the currently displayed data (user optional). The third front-end will be utilized only by naïve data-entry users by filling in a form. The data-entry users will not enter SQL commands to accomplish their tasks. Rather, their web-application will use the preparedStatement interface and extract the parameters from their form and issue the SQL command in the background.

The front-ends will run on any web-based browser that you would like to use. The applications will connect to the backend database via properties files dependent on which front-end page is utilized. This connection must be handled using properties read from a properties file. You will have three different properties files, one for the root-level users, one for the client-level users (all the same as project 2 except for the different database), and one for the data entry-level users.

The second-tier servlets, are in charge of handling the SQL command interface for the users. The root-level user app (and the data entry level app – see below), will also implement the server-side business/application logic. This logic will increment by 5, the status of a supplier anytime that supplier is involved in the insertion/update of a shipment record in which the quantity is greater than or equal to 100. Note that any update of quantity  $\geq 100$  will affect any supplier involved in a shipment with a quantity  $\geq 100$ . The example screen shots illustrate this case. An insert of a shipment tuple (S5, P6, J7, 400) will cause the status of every supplier who has a shipment with a quantity of 100 or greater to be increased by 5. In other words, even if a supplier's shipment is not directly affected by the update, their status will be affected if they have any shipment with quantity  $\geq 100$ . (**See page 14 for a bonus problem that implements a modified version of this business rule.**) The business logic of the second tier will reside in the servlet on the Tomcat web-application server (server-side application). This means that the business logic is not to be implemented in the DBMS via a trigger.

The client-level servlet will handle the SQL command interface, just as the root-level servlet does, however, due to the restrictions on the client-level privileges, no business-logic will be implemented in this application.

The data entry-level servlet will provide the user a template (form) for the shipments table data to be entered and will execute the necessary updating command by extracting the parameters from the form and issuing a prepared statement update to the database. You may want to refer to the JDBC notes from Module 3 to refresh your memory of how the `PreparedStatement()` interface differs from the normal `Statement()` interface.

The third-tier (back-end) is the persistent MySQL database described above and is under control of the MySQL DBMS server. You will create and maintain this database via the creation/population script. See the important note below concerning when/how to re-run this script for your final submission.

## References:

Notes: Lecture Notes for MySQL installation and use. Documentation for MySQL available at: <http://www.mysql.com>. More information on JDBC can be found at: <http://www.oracle.com/technetwork/java/javase/jdbc/index.html>. More information on Tomcat can be found at <http://tomcat.apache.org>. Lecture Notes for Servlets. Lecture Notes for JSPs.

## Restrictions:

Your source file shall begin with comments containing the following information:

`/* Name:`

**Course: CNT 4714 – Summer 2022 – Project Three**

**Assignment title: A Three-Tier Distributed Web-Based Application**

**Date: August 4, 2022**

`*/`

**Special Note: Due to end of semester time constraints this will be a hard deadline.**

**Input Specification:** The suppliers/part/jobs/shipments database (named project3) that is created/populated by the script `project3dbscript.sql`, is the back-end to this application. All other input comes from the front-end user submitted to the application server based servlet entered as either queries or updates to this database. There are three sets of commands that you are to execute against this database included in the `project3rootcommands.sql`, `project3clientcommands.sql`, and `project3dataentrycommands.sql` available on WebCourses under Project 3. As with Project 2, your client-level user will have only select privileges on the `project3` database. The data entry-level user will have only select, insert and update privileges on the `project3` database. Also, as with Project 2, your front-end cannot execute the entire script at one time. You'll need to execute the commands in this script one at a time in your application (copy and paste!). You can run the scripts in the MySQL Workbench if you'd like to compare/see the result sets for each user command.

**Output Specification:** All output is generated by the servlets and should appear in the user's browser as a text/html page presented to the user. All MySQL-side errors should be caught and reported to the user via the interface. **IMPORTANT:** Be sure to re-run the `project3dbscript.sql` database creation/population script before you begin creating your screen shots for submission. By doing so you will ensure that the database is in its initial state so that all update operations will produce the values we are expecting to see in your result outputs. Then, as with Project 2, run all commands in sequence from the `project3rootcommands.sql` script file (total of 20 different commands), followed immediately by all commands in sequence from the `project3clientcommands.sql` script file (total of 4 different commands), followed immediately by all commands in sequence from the `project3dataentrycommands.sql` script file.

### **Deliverables:**

- (1) You should submit your entire Project3 webapp folder from Tomcat for this program. If you submit the entire folder, then all of the files necessary to execute your web application will be included with the directory structure intact. Submit this via WebCourses no later than **11:59pm Sunday August xx, 2022**.
- (2) The following 20 screen shots from the `project3rootcommands.sql` script file must be submitted as part of the deliverables for this project. (You can include the screenshots in the top-level of your webapps folder if you'd like, just be sure to include a note that you've done so.)
  - a. Command 1
  - b. Command 2A
  - c. Command 2B
  - d. Command 2C
  - e. Command 3A
  - f. Command 3B
  - g. Command 3C
  - h. Command 3D
  - i. Command 3E
  - j. Command 4
  - k. Command 5A
  - l. Command 5B
  - m. Command 5C
  - n. Command 5D
  - o. Command 5E

- p. Command 6
  - q. Command 7
  - r. Command 8
  - s. Command 9
  - t. Command 10
- (3) The following 4 screenshots from the `project3clientcommands.sql` script file must be submitted as part of the deliverables for this project. (You can include the screenshots in the top-level of your webapps folder if you'd like, just be sure to include a note that you've done so.)
- a. Command 1
  - b. Command 2
  - c. Command 3
  - d. Command 4
- (4) The following 4 screenshots from the `project3dataentrycommands.sql` script file must be submitted as part of the deliverables for this project. (You can include the screenshots in the top-level of your webapps folder if you'd like, just be sure to include a note that you've done so.)
- a. Command 1
  - b. Command 2
  - c. Command 3
  - d. Command 4
- (5) One final screenshot, taken from the MySQL Workbench using a root-user connection, executing the command `select * from suppliers;` This will show the final status of all suppliers after the execution of all commands in the three user-level scripts.

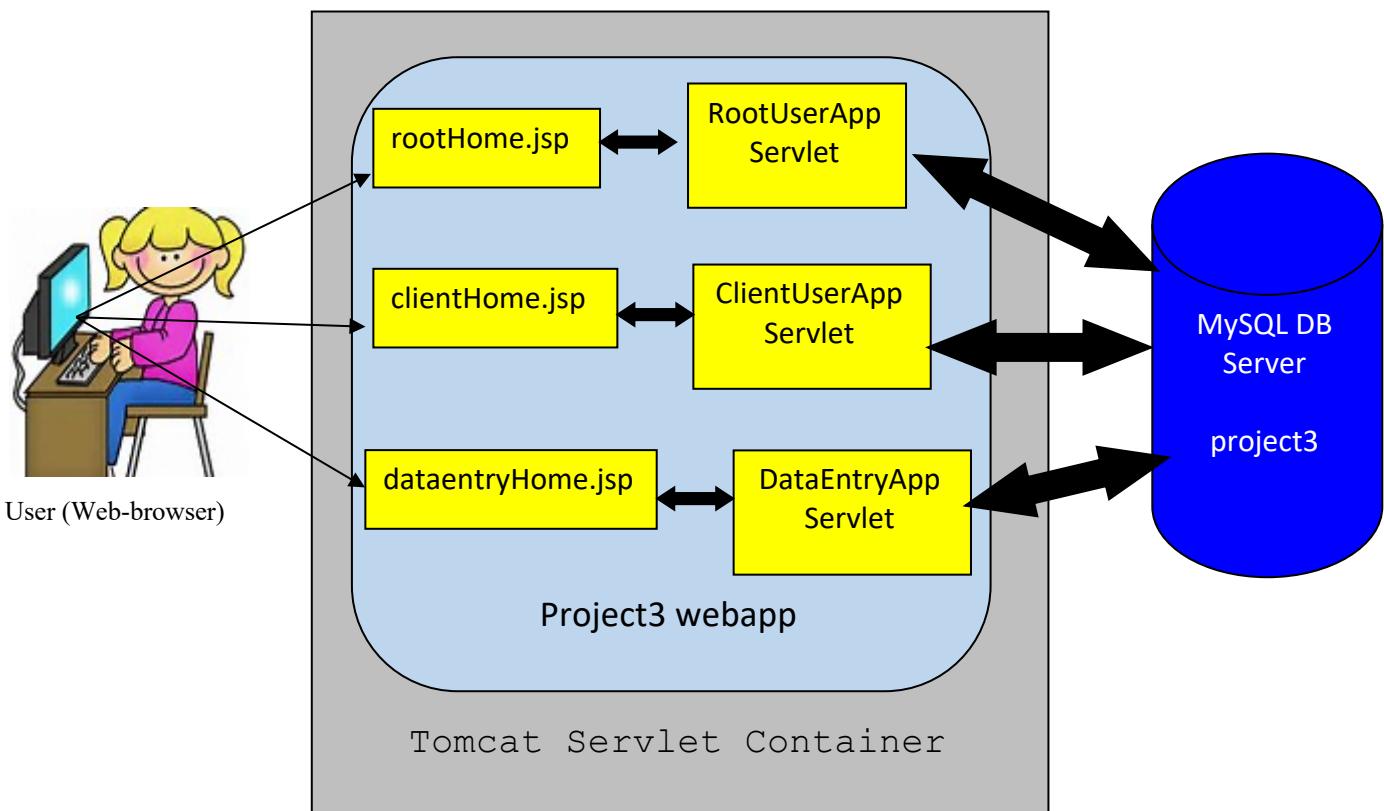
#### **Additional Information:**

Be very careful when setting up the directory structures required for the web applications running under your server (Tomcat 10.0.22 or later). See the course notes on servlets for the exact directory structure that must be developed. Be sure that your development IDE and the JVM running under Tomcat are of the same vintage.

Attend/watch Q&A sessions for more information and project details. Additional videos for select parts of this project will also be made available.

**Important:** Please name your webapp: **Project3**. Let the TAs know if you are doing the bonus problem by attaching a note to your WebCourses submission.

## Schematic Overview of Project Components:



### Suggested project development approach

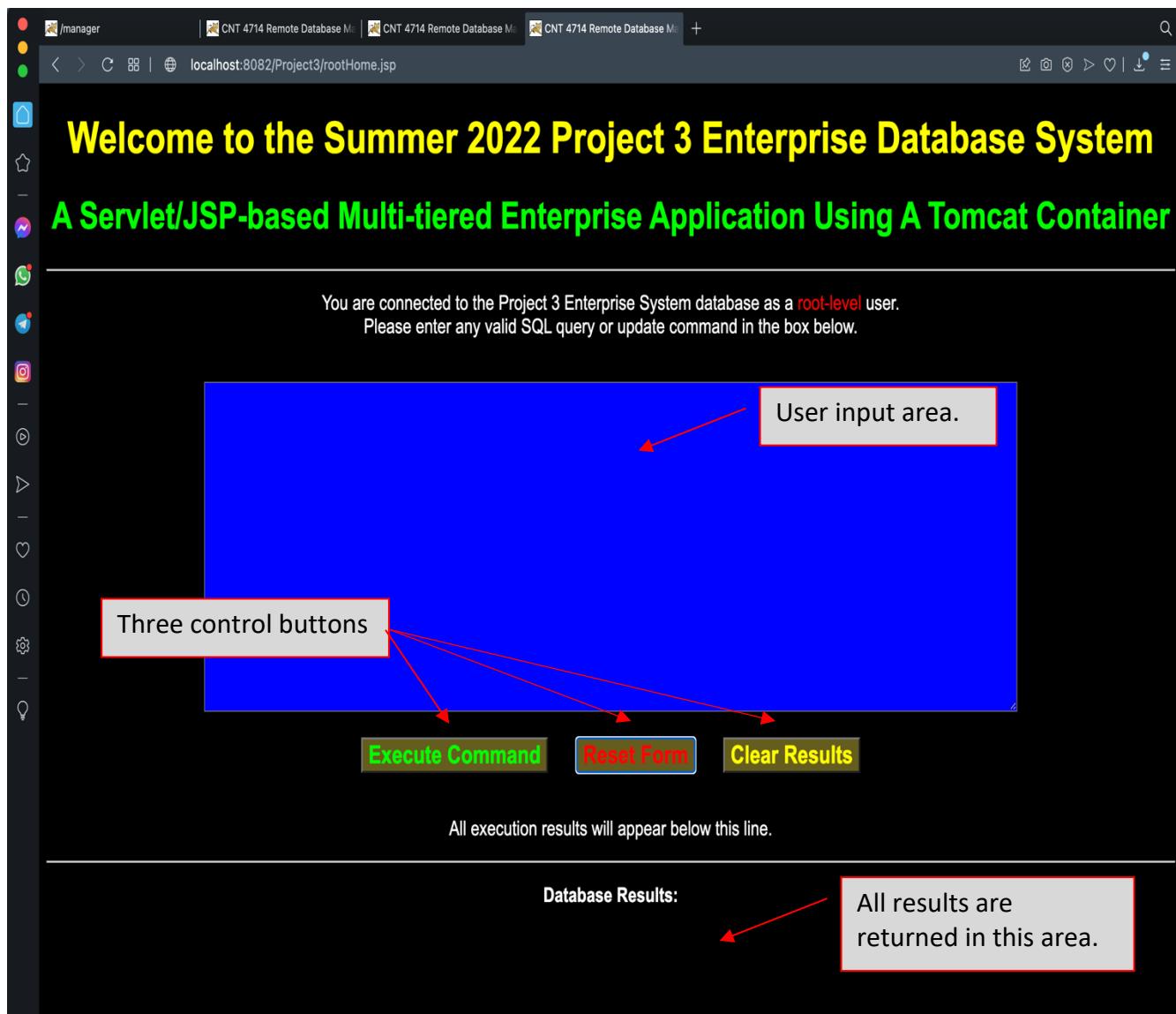
1. Install Tomcat and run some of the examples from the notes to ensure that Tomcat is installed and configured properly before beginning any steps on the project itself.
2. Develop front-end .html files `rootHome.html`, `clientHome.html` and `dataentryHome.html`. These will be later converted to .jsp files (see 7 below). This can be done in any editing environment of your choice. Do not specify a specific action for your form submission at this point (use a null string for the action).
3. Construct basic Project3 webapp framework inside Tomcat webapp folder. Deploy files from step 1 above and test/refine in browser of your choice.
4. Construct initial `web.xml` file in `Project3/WEB-INF`. Additional refinement may be needed later.
5. Create properties files for the root-level users, client-level users, and data entry-level users. These will be placed in the `lib` folder of the Project3 web app (i.e. `Project3/WEB-INF/lib`)..
6. Begin development of the servlets. Basic operation of the root-level servlet and the client-level servlet are the same, with only a small difference (more later). So develop the client-level servlet first and copy and paste with modifications for the root-level servlet later. As we will discuss in the Q&A sessions, the initial servlet (for testing) should do nothing more than simply return "Hi".
7. Load servlet test files into Tomcat Project3 webapp in correct location and perform initial integration testing of complete package.
8. Further develop all servlet code to complete the basic functionality of the servlets. This includes modification of the front-end interfaces to become .jsp files so that all results are

returned to a single page via a targeted location and not require either a complete browser page refresh or the user to employ the browser “back” button. These techniques will be explained later in the JSP notes and also Q&A sessions.

9. Add business logic to the root-level servlet – develop non-bonus version first.
10. Optional: implement the bonus-version of the business logic.
11. Add business logic to the data entry-level servlet.
12. Recreate the project3 database.
13. Run through the three user-level command scripts and generate screenshots from your application running these commands.

### Some screen shots illustrating the application.

Main root-level user initial JSP page (initial configuration):



Main client-level user initial JSP page (initial configuration):

The screenshot shows a web browser window with the URL `localhost:8082/Project3/clientHome.jsp`. The page title is "Welcome to the Summer 2022 Project 3 Enterprise Database System". Below the title, a sub-header reads "A Servlet/JSP-based Multi-tiered Enterprise Application Using A Tomcat Container". A message states: "You are connected to the Project 3 Enterprise System database as a **client-level** user. Please enter any valid SQL query or update command in the box below." A text input field contains the SQL query `select * from suppliers`. At the bottom, there are three buttons: "Execute Command" (green), "Reset Form" (yellow), and "Clear Results" (blue). A note below the buttons says "All execution results will appear below this line." The browser interface includes a sidebar with various icons and tabs at the top.

The data entry-level user interface.

The screenshot shows a web browser window with four tabs, all titled "CNT 4714 Remote Database Ma". The active tab displays a JSP-based enterprise application. The page title is "Welcome to the Summer 2022 Project 3 Enterprise Database System" in red, followed by "A Servlet/JSP-based Multi-tiered Enterprise Application Using A Tomcat Container" in blue. A message in white text on a black background states: "You are connected to the Project 3 Enterprise System database as a **data-entry-level** user. Please enter the data values in the form below to add a new record to the shipments table." Below this, there is a form with four input fields labeled "snum", "pnum", "jnum", and "quantity", each with a yellow border. At the bottom of the form are two buttons: "Enter Record into Database" in green and "Clear Results" in red. To the left of the form is a vertical sidebar with various icons: a house, star, minus, mail, phone, location, camera, and gear.

Welcome to the Summer 2022 Project 3 Enterprise Database System

A Servlet/JSP-based Multi-tiered Enterprise Application Using A Tomcat Container

You are connected to the Project 3 Enterprise System database as a **data-entry-level** user.  
Please enter the data values in the form below to add a new record to the shipments table.

snum	pnum	jnum	quantity

Enter Record into Database      Clear Results

Database Results:

## Root-level User Examples

The following several screenshots illustrate operations from the root-level user interface.

User simply clicks the “Execute Command” button and the SQL command in the form is executed:

The screenshot shows a web browser window with four tabs open, all titled "CNT 4714 Remote Database Ma". The active tab is "localhost:8082/Project3/RootUserApp". The page content is as follows:

**Welcome to the Summer 2022 Project 3 Enterprise Database System**  
**A Servlet/JSP-based Multi-tiered Enterprise Application Using A Tomcat Container**

You are connected to the Project 3 Enterprise System database as a **root-level** user.  
Please enter any valid SQL query or update command in the box below.

```
select * from jobs
```

**Execute Command**   **Reset Form**   **Clear Results**

All execution results will appear below this line.

**Database Results:**

jnum	jname	numworkers	city
J1	Operation DB	45	Berlin
J13	Night Strike	350	Paris
J2	Really Big Job	500	Melbourne
J22	Project On-Time	200	London
J3	Small Job	100	Chicago
J4	New Job	50	Berlin
J5	My Job	1	Orlando
J6	A New Job	14	Milan

User makes a mistake entering an SQL command:

The screenshot shows a web browser window with four tabs, all titled "CNT 4714 Remote Database Ma". The active tab displays the URL "localhost:8082/Project3/RootUserApp". The page content is as follows:

**Welcome to the Summer 2022 Project 3 Enterprise Database System**

**A Servlet/JSP-based Multi-tiered Enterprise Application Using A Tomcat Container**

You are connected to the Project 3 Enterprise System.

Please enter any valid SQL query or update command in the box below.

select something from suppliers

**Execute Command**   **Reset Form**   **Clear Results**

All execution results will appear below this line.

**Database Results:**

Error executing the SQL statement:  
Unknown column 'something' in 'field list'

Annotations and callouts:

- A red box highlights the error message "There is no column named something in the shipments table." with a red arrow pointing to it from the left.
- A large blue box highlights the input area containing the SQL command "select something from suppliers". A red arrow points from the left towards this box.
- A red box highlights the "Error from Database" message with a red arrow pointing to it from the right.
- A red box highlights the "Database Results:" header with a red arrow pointing to it from the bottom.

Inserts and updates may cause changes to the supplier status field (business logic is triggered) as shown below:

Current state of the suppliers table (i.e., select \* from suppliers) (only partial screen shown to allow viewing entire results table):

Note the current status of supplier number S5. (Also note status of S1, S12, S17, S21, S22, S3, S44, and S6.)

Database Results:			
snum	sname	status	city
S1	Michael Schumacher	1	Berlin
S10	David Coulthard	2	London
S11	Bernard Hinault	7	Paris
S12	Eddy Merckx	1	Brussels
S13	Candice Swanepoel	3	Cape Town
S14	Adriana Lima	4	Sao Paulo
S15	Jennifer Lawrence	6	Owensboro
S16	Fernando Alonso	4	Madrid
S17	Rubens Barrichello	3	Sao Paulo
S18	Tom Boonen	2	Brussels
S19	Johan Messeuw	1	Eekloo
S2	Juan Pablo Montoya	4	Interlagos
S20	Danilo Rossi	2	Milan
S21	Lizzie Armistead	1	Hempstead
S22	Jan Ullrich	5	Bonn
S3	Dietrich Thurau	1	Berlin
S32	Bernd Schnieder	2	Berlin
S33	Rolf Aldag	3	Berlin
S4	Mark Webber	5	Melbourne
S44	Beryl Burton	4	London
S5	Jenson Button	4	London
S56	Marianne Vos	8	Zandvoort
S6	Nicola Gianniberti	2	Milan
S7	Christian Albers	3	Orlando
S8	Giancarlo Fisichella	3	Milan
S9	Kimi Rikkonen	2	Helsinki

Results from running the query “select \* from suppliers” – to be used to illustrate an update operation explained on pages 12-14. Notice that the supplier S5’s status is currently 4.

User issues the following insert command:

The screenshot shows a web browser window with four tabs open, all titled "CNT 4714 Remote Database Manager". The active tab displays a welcome message for a project application. The message reads: "Welcome to the Summer 2022 Project 3 Enterprise Database System" and "A Servlet/JSP-based Multi-tiered Enterprise Application Using A Tomcat Container". Below this, a note states: "You are connected to the Project 3 Enterprise System database as a **root-level** user. Please enter any valid SQL query or update command in the box below." A text input field contains the SQL command: "insert into shipments values ('S5','P6','J4',400)". At the bottom of the page, there are three buttons: "Execute Command", "Reset Form", and "Clear Results". A note below the buttons says: "All execution results will appear below this line." Under the heading "Database Results:", a message box contains the text: "The statement executed successfully. 1 row(s) affected." followed by "Business Logic Detected! - Updating Supplier Status" and "Business Logic updated 9 supplier status marks.".

Alert message when an update to the quantity field in the shipments table has caused an update of a supplier's status in the supplier table. Note that the application will use this alert message any time the business logic is tested even if it did not trigger any updates. This means that this message would appear with different values even if no rows are updated (more examples below).

After executing update command (the previous insert), the user re-runs select \* from suppliers. Note that S5's status has been increased by 5, but so too has S1, S12, S17, S21, S22, S3, S44, and S6. Allowing the previous insert command to affect only supplier S5's status is handled by the bonus version of this project (see below).

Database Results:			
snum	sname	status	city
S1	Michael Schumacher	6	Berlin
S10	David Coulthard	2	London
S11	Bernard Hinault	7	Paris
S12	Eddy Merckx	6	Brussels
S13	Candice Swanepoel	3	Cape Town
S14	Adriana Lima	4	Sao Paulo
S15	Jennifer Lawrence	6	Owensboro
S16	Fernando Alonso	4	Madrid
S17	Rubens Barrichello	8	Sao Paulo
S18	Tom Boonen	2	Brussels
S19	Johan Messeuw	1	Eekloo
S2	Juan Pablo Montoya	4	Interlagos
S20	Danilo Rossi	2	Milan
S21	Lizzie Armistead	6	Hempstead
S22	Jan Ullrich	10	Bonn
S3	Dietrich Thurau	6	Berlin
S32	Bernd Schnieder	2	Berlin
S33	Rolf Aldag	3	Berlin
S4	Mark Webber	5	Melbourne
S44	Beryl Burton	9	London
S5	Jenson Button	9	London
S56	Marianne Vos	8	Zandvoort
S6	Nicola Gianniberti	7	Milan
S7	Christian Albers	3	Orlando
S8	Giancarlo Fisichella	3	Milan
S9	Kimi Rikkonen	2	Helsinki

Notice on page 11 (in the original suppliers table) that supplier S5 had a status of 4. After this update, the business logic has increased supplier S5's status by 5, so it is now 9.

Notice too, that suppliers S1, S12, S17, S21, S22, S3, S44, and S6 also had their status increased by 5, since they already recorded with a shipment in which the quantity was  $\geq 100$  when the insert command was issued, even though the issued command did not affect them directly.. See bonus problem below for a "fix".

Example of an update command that does not trigger the business logic.

The screenshot shows a web browser window with four tabs open, all titled "CNT 4714 Remote Database Ma". The active tab displays the URL "localhost:8082/Project3/RootUserApp". The page content is as follows:

**Welcome to the Summer 2022 Project 3 Enterprise Database System**  
**A Servlet/JSP-based Multi-tiered Enterprise Application Using A Tomcat Container**

You are connected to the Project 3 Enterprise System database as a **root-level** user.  
Please enter any valid SQL query or update command in the box below.

```
update jobs set jname = "Tough Job" where jnum = "J1"
```

**Execute Command**   **Reset Form**   **Clear Results**

All execution results will appear below this line.

**Database Results:**

```
The statement executed successfully. A total of 1 row(s) were updated.  
Business Logic Not Triggered!
```

Example of an update command that triggers the business logic but results in no changes to any supplier's status.

The screenshot shows a web browser window with the URL `localhost:8082/Project3/RootUserApp`. The page title is "Welcome to the Summer 2022 Project 3 Enterprise Database System" and the subtitle is "A Servlet/JSP-based Multi-tiered Enterprise Application Using A Tomcat Container". A message indicates the user is connected as a `root-level` user and to enter any valid SQL query or update command. A red box highlights the command input field containing `update shipments set quantity=10`. Below the input field are three buttons: `Execute Command`, `Reset Form`, and `Clear Results`. A red line points from this area down to the `Database Results` section. The results show: "The statement executed successfully. 57 row(s) affected.", "Business Logic Detected! - Updating Supplier Status", and "Business Logic updated 0 supplier status marks.". A callout box with a red border contains the note: "Note that this update is an ‘unsafe’ update since there is no limiting clause and every row in the table will be updated. In this case all 57 rows in the table will now have a quantity of 10."

You are connected to the Project 3 Enterprise System database as a `root-level` user.  
Please enter any valid SQL query or update command in the box below.

update shipments set quantity=10

`Execute Command`   `Reset Form`   `Clear Results`

All execution results will appear below this line.

**Database Results:**

The statement executed successfully.  
57 row(s) affected.

Business Logic Detected! - Updating Supplier Status

Business Logic updated 0 supplier status marks.

Note that this update is an “unsafe” update since there is no limiting clause and every row in the table will be updated. In this case all 57 rows in the table will now have a quantity of 10.

## Client-level User Examples

A client-level user issues a command for which they have privileges (note that this is the same result as the one shown for a root-level user on page 9).

The screenshot shows a web browser window with the URL `localhost:8082/Project3/ClientUserApp`. The title bar displays "Welcome to the Summer 2022 Project 3 Enterprise Database System". The main content area has a dark background with red and cyan text. It displays a welcome message and a SQL command in a text input field. Below the input field are three buttons: "Execute Command", "Reset Form", and "Clear Results". A note indicates that execution results will appear below the "Database Results" section. The "Database Results" section contains a table with 8 rows of data.

Welcome to the Summer 2022 Project 3 Enterprise Database System

A Servlet/JSP-based Multi-tiered Enterprise Application Using A Tomcat Container

You are connected to the Project 3 Enterprise System database as a **client-level** user.  
Please enter any valid SQL query or update command in the box below.

```
select * from jobs
```

**Execute Command**   **Reset Form**   **Clear Results**

All execution results will appear below this line.

**Database Results:**

jnum	jname	numworkers	city
J1	Operation DB	45	Berlin
J13	Night Strike	350	Paris
J2	Really Big Job	500	Melbourne
J22	Project On-Time	200	London
J3	Small Job	100	Chicago
J4	New Job	50	Berlin
J5	My Job	1	Orlando
J6	A New Job	14	Milan

A client-level user issues a command for which they do not have privilege to execute.

The screenshot shows a web application interface for a database system. The title bar indicates the URL is `localhost:8082/Project3/ClientUserApp`. The main content area has a dark background with red and white text. It displays a welcome message: "Welcome to the Summer 2022 Project 3 Enterprise Database System" and "A Servlet/JSP-based Multi-tiered Enterprise Application Using A Tomcat Container". Below this, a message states: "You are connected to the Project 3 Enterprise System database as a **client-level** user. Please enter any valid SQL query or update command in the box below." A text input field contains the SQL statement: `insert into shipments values ("S5","P6","J4",400)`. Below the input field are three buttons: "Execute Command" (green), "Reset Form" (red), and "Clear Results" (yellow). A note below the buttons says: "All execution results will appear below this line." Under the heading "Database Results:", there is a red box containing the error message: "Error executing the SQL statement: INSERT command denied to user 'client'@'localhost' for table 'shipments'".

## Data Entry-level User Examples

The data entry-level user interface provides only a template (form) for the user to enter data values for new shipment records. Note: the database does not specify any default values for any attributes in the shipments table. Therefore, the user must supply all four values to be used by the PreparedStatement interface.

In this example, the quantity value will trigger the business logic and update supplier S5's status by 5.

The screenshot shows a web browser window with a dark theme. The title bar displays multiple tabs, one of which is "localhost:8082/Project3/DataEntryUserApp". The main content area features a large red header: "Welcome to the Summer 2022 Project 3 Enterprise Database System" and a cyan sub-header: "A Servlet/JSP-based Multi-tiered Enterprise Application Using A Tomcat Container". On the left side, there is a vertical sidebar with various icons. The central part of the page contains a form for entering shipment data. The form has four input fields: "snum" (S5), "pnum" (P6), "jnum" (J4), and "quantity" (400). Below the form are two buttons: "Enter Record Into Database" (in green) and "Clear Results" (in red). At the bottom, a section titled "Database Results:" contains a green box with the message: "New shipment record successfully entered in database. Business logic triggered."

snum	pnum	jnum	quantity
S5	P6	J4	400

Database Results:

New shipment record successfully entered in database. Business logic triggered.

In this example, the business logic is not triggered as the quantity value is less than 100.

The screenshot shows a web browser window with the URL `localhost:8082/Project3/DataEntryUserApp`. The page title is "Welcome to the Summer 2022 Project 3 Enterprise Database System". Below the title, there is a heading "A Servlet/JSP-based Multi-tiered Enterprise Application Using A Tomcat Container". A message indicates the user is connected to the database as a `data-entry-level` user and is prompted to enter data values to add a new record to the shipments table. A form is displayed with four input fields: `snum` (S5), `pnum` (P6), `jnum` (J4), and `quantity` (33). Below the form are two buttons: "Enter Record Into Database" and "Clear Results". At the bottom, a "Database Results:" section displays a green message: "New shipment record successfully entered in database. Business logic not triggered."

Welcome to the Summer 2022 Project 3 Enterprise Database System

A Servlet/JSP-based Multi-tiered Enterprise Application Using A Tomcat Container

You are connected to the Project 3 Enterprise System database as a `data-entry-level` user.  
Please enter the data values in the form below to add a new record to the shipments table.

<code>snum</code>	<code>pnum</code>	<code>jnum</code>	<code>quantity</code>
S5	P6	J4	33

**Enter Record Into Database**   **Clear Results**

Database Results:

New shipment record successfully entered in database. Business logic not triggered.

In this example, the attempt to insert the record violates referential integrity and is not allowed.

Welcome to the Summer 2022 Project 3 Enterprise Database System

A Servlet/JSP-based Multi-tiered Enterprise Application Using A Tomcat Container

You are connected to the Project 3 Enterprise System database as a **data-entry-level** user.  
Please enter the data values in the form below to add a new record to the shipments table.

snum	pnum	jnum	quantity
S5	P6	J7	133

Enter Record Into Database      Clear Results

Database Results:

Error executing the SQL statement:  
Cannot add or update a child row: a foreign key constraint fails

## BONUS PROBLEM: 15 points

Instead of allowing any update/insert of a quantity  $\geq 100$  to affect any supplier with a shipment involving a quantity  $\geq 100$ , adjust the business logic portion of your application so that an insert/update of a quantity greater than 100, causes a change to the status of only those suppliers directly affected by the update. For example, using the case shown above, when inserting the row (S5, P6, J4, 400) into the shipments table, only the status of supplier S5 should be increased by 5 (see screen shot below). However, an update such as: UPDATE shipments SET quantity = quantity + 50 WHERE pnum = "P3", would increase by 5 the status of every supplier who ships part P3 in a quantity  $\geq 100$  after the update has been issued.

NOTE: If you elect to do the bonus problem, submit only this version of your application. Do not also submit the non-bonus problem version. Let the TAs know if you've elected to do the bonus problem or not.

I will provide many hints for the bonus problem during the Q&A sessions for this project.

With the correct business logic (the bonus version) in place, issue the original insert command as above (on page 12), we now get the correct effect for our update command.

The screenshot shows a web browser window with four tabs, all titled "CNT 4714 Remote Database M". The URL in the address bar is "localhost:8082/Project3/RootUserApp". The main content area displays the following text:

Welcome to the Summer 2022 Project 3 Enterprise Database System  
A Servlet/JSP-based Multi-tiered Enterprise Application Using A Tomcat Container

You are connected to the Project 3 Enterprise System database as a **root-level** user.  
Please enter any valid SQL query or update command in the box below.

insert into shipments values ("S5","P6","J4",400)

Below this input field are three buttons: "Execute Command", "Reset Form", and "Clear Results".

All execution results will appear below this line.

Database Results:

The statement executed successfully.  
1 row(s) affected.

Business Logic Detected! - Updating Supplier Status  
Business Logic updated 1 supplier status marks.

## Database Results:

snum	sname	status	city
S1	Michael Schumacher	1	Berlin
S10	David Coulthard	2	London
S11	Bernard Hinault	7	Paris
S12	Eddy Merckx	1	Brussels
S13	Candice Swanepoel	3	Cape Town
S14	Adriana Lima	4	Sao Paulo
S15	Jennifer Lawrence	6	Owensboro
S16	Fernando Alonso	4	Madrid
S17	Rubens Barrichello	3	Sao Paulo
S18	Tom Boonen	2	Brussels
S19	Johan Messeuw	1	Eekloo
S2	Juan Pablo Montoya	4	Interlagos
S20	Danilo Rossi	2	Milan
S21	Lizzie Armistead	1	Hempstead
S22	Jan Ullrich	5	Bonn
S3	Dietrich Thurau	1	Berlin
S32	Bernd Schnieder	2	Berlin
S33	Rolf Aldag	3	Berlin
S4	Mark Webber	5	Melbourne
S44	Beryl Burton	4	London
S5	Jenson Button	9	London
S56	Marianne Vos	8	Zandvoort
S6	Nicola Gianniberti	2	Milan
S7	Christian Albers	3	Orlando
S8	Giancarlo Fisichella	3	Milan
S9	Kimi Rikonnen	2	Helsinki

Notice that this time, with the improved business logic that only the supplier directly affected by the insert has had their status updated, all other supplier status values remain unchanged. Compare with table on page 11.

No changes to S1, S12, S17, S21, S22, S3, S44, or S6 this time.

Only supplier S5 had a change of status due to the insertion of the row (S5, P6, J7, 400) as they were the only supplier affected by this update.