

MAKERERE UNIVERSITY COLLEGE OF COMPUTING & INFORMATION SCIENCES
SCHOOL OF COMPUTING AND INFORMATICS TECHNOLOGY

END OF SEMESTER I EXAMINATION 2014/2015

PROGRAMMES: MSc

YEAR OF STUDY: MSc

COURSE NAME: Advanced Programming

COURSE CODE: MCS 7118

DATE: 11th December, 2014

TIME: 4:00 – 7:00 PM

INSTRUCTIONS

- a) THIS PAPER HAS TWO SECTIONS: A AND B
- b) ATTEMPT ALL QUESTIONS IN SECTION A (40 MARKS)
- c) ATTEMPT ANY THREE OUT OF THE FIVE QUESTIONS IN SECTION B (60 MARKS)
- d) DO NOT OPEN THIS EXAM UNTIL YOU ARE TOLD TO DO SO
- e) ALL ROUGH WORK SHOULD BE IN YOUR ANSWER BOOKLET

SECTION A (40 MARKS)

Answer ALL the questions in this section

- a) Define the term 'robustness' in relation to a computer program [2 marks]
- b) What methods could you use to increase robustness? [2 marks]
- c) A security vulnerability allows an unauthorised individual to access data, disrupt its use or destroy data. The heart bleed bug was an example of a vulnerability which allowed an attacker to read data from the vulnerable computer. Briefly outline how the attack worked [5 marks]

d) In **python** a list could be defined as follows:

```
lunch = ['rice', 'chicken', 'sauce', 'carrots', 'soda'];
```

- i) Which value would `lunch[3]` equal? [1 mark]
- ii) Which values would `lunch[-2:]` return? [3 marks]

e) We are cooking a meal and need the following ingredients:

```
ingredients = ['olive oil', 'beef mince', 'tomatoes', 'lasagne sheets',  
'cheese', 'milk']
```

In stock are the following:

```
stock = ['fish', 'olive oil', 'chicken', 'tomatoes', 'beans', 'cheese', 'milk', 'ham']
```

Write (in python) a program to list all the items that we don't have in stock [8 marks]

Regular Expressions

f) Write down a regular expression which matches: [1 mark]

```
fruit, drum, trumpet, rum
```

And doesn't match:

```
friday, kit, trip, contour
```

g) Write down a regular expression which *exactly matches any* 5 letter palindrome, e.g:

```
level, dewed, tenet
```

And *doesn't match* words which contain 5 letter palindromes:

```
unlevel, anonon, makerere
```

[4 marks]

h) Consider the following list of words:

opponent, tripping, hippies, grotto, civic, devalued

For each of the following regular expressions, list those words which will match [2 marks each]

i) `ippi`

ii) `^(.+)\pp\1`

iii) `(.)(.)\2\1$`

iv) `(.)(.){2,}\2\1`

v) `([oi])([pv]).*\2\1`

i) Emma finds out George has bought a faulty gas tank that could explode any second.

Unfortunately she doesn't have his phone number. She has his laptop, and thinks that somewhere on it he might have written down his phone number. Write a grep command she should use to search his computer for text that looks like phone numbers (hint: it will start with 256, and has 12 numerical digits in it, in total, but there might be up to three spaces in the number too) [4 marks]

SECTION B (60 MARKS)

Answer *three* of the following five questions.

QUESTION 1:

A hospital needs a system to monitor all the patients and to alert the doctors about any patient whose vital signs deviate from 'healthy'. Your colleague writes the following program for this task.

```
1 class Patient(object):
2     def __init__(self, name):
3         self.name = name;
4         self.heart_rate = None;
5
6     def toString(self):
7         """Returns a string describing the patient"""
8         return "%s - %d bpm" % (self.name,self.heart_rate);
9
10    def updateHeartRate(self, heart_rate):
11        self.heart_rate = heart_rate;
12
13    def needHelp(self):
14        """Returns true if this patient needs help"""
15        return (self.heart_rate < 50)
16
17 class ChildPatient(Patient):
18     def toString(self):
19         return super (ChildPatient, self).toString()+" (child)";
20
21 class MonitorSystem(object):
22     def __init__(self):
23         self.patientlist = []
24
25     def listHelp(self):
26         """Return a string listing those patients who need help"""
27         for patient in self.patientlist:
28             if (patient.needHelp()):
29                 print patient.toString();
30
31     def addPatient(self,patient):
32         self.patientlist.append(patient);
33
34     def updateHeartRate(self,name,heart_rate):
35         for patient in self.patientlist:
36             if (patient.name == name):
37                 patient.updateHeartRate(heart_rate)
38
39 monitorsystem = MonitorSystem()
40 monitorsystem.addPatient(Patient('Sue'));
41 monitorsystem.addPatient(ChildPatient('Emma'));
42 monitorsystem.updateHeartRate('Sue',72);
43 monitorsystem.updateHeartRate('Emma',24);
44
45 print("Patients who need help:\n")
46 monitorsystem.listHelp()
```

- a) The system works well to start with. The current patients (Sue and Emma) are monitored successfully. More patients are added, called 'Alice', 'Sue' (again) and 'John'. One day a patient isn't helped who needs it. Their name was Sue. What might have caused the system to not alert the doctors? Explain in detail with reference to particular lines of code. [3 marks]
- b) How would you change the system to avoid this? Describe the variables and methods you would add or change. [5 mark]
- c) Children have a higher heart rate than adults, so the threshold at which they need help should be for a heart rate of 60bpm (not 50bpm). What would you add/change to apply this threshold to the child patients? Write the code you would use. [5 marks]
- d) Occasionally a sensor stops working and the heart rate is not updated. What would you add to the program (in general terms) to handle this problem? [3 marks]
- e) Sometimes a glitch happens which means a patient's name is mis-spelt when `updateHeartRate` is called. What happens if the wrong name is used? Is this dangerous? Why/why-not? [3 marks]
- f) What should happen if a patient's name is mis-spelt? [1 mark]

QUESTION 2:

- a) The World Food Programme want a web-based system to target their emergency food drops. A web form is needed into which the *user types the latitude and longitude* for which they want to know how much food is to be dropped. Write some HTML to generate such a form. On submission the form data should go to the `sendfood.py` script (the script will then display the amount of food for that location). [3 marks]
- b) The `sendfood.py` script takes the form data and uses it to select data from the database using the code:
- ```
cur.execute("SELECT * FROM foodsent WHERE latitude = "+lat+" AND longitude = "+long);
```
- Why is this a security vulnerability? [2 marks]

c) What could the user enter for the longitude if they maliciously want to get the locations of all food drops? [5 marks]

d) How would you modify the line of code above to avoid this vulnerability? [3 marks]

e) What is the general term for this type of attack? [1 mark]

f) The foodsent database table looks like this:

| lat   | long  | amount |
|-------|-------|--------|
| 4.321 | 32.31 | 500    |
| 3.149 | 33.03 | 2000   |

Write the SQL command to insert a new row that contains:

|       |       |      |
|-------|-------|------|
| 4.723 | 31.53 | 1000 |
|-------|-------|------|

[3 marks]

g) It is found that this new food drop was only supposed to be 100 kg, write an SQL query to update this in the database, by changing the 1000 into a 100.

[3 marks]

### QUESTION 3:

In 1996 the Ariane 5 rocket exploded due to an error in a computer program that wasn't caught with an exception handler. Specifically, the variable that held the speed wasn't able to hold a large enough value. You've been asked to write the software for the new version of the rocket.

The original version is below:

```
class RocketSystemException(Exception):
 """Base class for exceptions in this module."""
 pass

class ControlSystem(object):
 def updateSpeed(self, speed):
 self.speed = speed;

cs = ControlSystem();
```

a) Define a new exception class called `SpeedTooHighException` which is inherited from the base `RocketSystemException` class. The exception's constructor should take the new speed, and store it in an instance variable in the exception called `speed` [10 marks].

b) This exception should be raised if the speed goes over 10,000 m/s. Write a new version of the `updateSpeed` method to incorporate this [5 marks].

c) Finally, write the code that will call the `cs.updateSpeed()` method, within a try-except block to handle this exception. The handler should print a warning message [5 marks].

#### QUESTION 4

a) Bob is in his work directory (`/home/bob/work`) on his linux server and wants to visit Emma's home directory (`/home/emma`). Give two commands that will achieve this (one using relative paths and one using absolute paths) [4 marks]

b) He wants to find her `.bash_history` but can't see it using the simple `ls` command. Why not? [2 marks]

c) What command should he type in to see the file? [2 marks]

d) The command he eventually runs outputs the following:

```
-rw----- 1 emma emma 15674 Nov 25 11:13 .bash_history
```

Why won't he be able to read the contents of the `.bash_history` file? [3 marks]

e) He wants to copy the `/var/log/syslog` file to his home directory, what command should he use? [3 marks]

f) There's a problem with a component of the server called `dhclient`. He wants to find the last 5 lines of the `syslog` file which mention this string. Write down a linux bash command which will print these lines (hint, you'll need to use pipes: `|`) [6 marks]

```
>> cat /var/log/syslog | grep 'dhclient' | tail -n 4
```

## QUESTION 5

a) Define what a LAMP stack is [3 marks].

b) Not all webservers need to use PHP. For example Python can also be used. John has written a website which prints how many files there are in a particular user's directory on the server. Part of the python cgi script that does this is below. Notice that he uses the python `os.popen` method to run a linux shell command, from inside python.

```
cgi_vars = cgi.FieldStorage() ;
username = cgi_vars.getvalue("username", "");
filecount=os.popen('ls /home/'+username+' -1 | grep -c ""').read()
```

Why is this code insecure? [3 marks]

c) What could you do to make this more secure, in general terms? [1 mark]

d) And specifically how would you make this code more secure? [2 marks]

e) Emma has used this vulnerability and has hacked into John's server. Through privilege escalation, has now got root access. This means she can read raw packet data going through the computer's ethernet card. She can dump all of the data from the network using this command:

```
sudo tcpdump -w -
```

but how could she search this output for lines which contain the word `password`? [5 marks]

e) What is a cross-site scripting vulnerability? [2 marks]

f) What simple step in the processing of the output of a web CGI script can avoid cross-site scripting vulnerabilities? [2 marks]

g) WebAPIs are becoming more common. Give the name of two *formats* widely used for WebAPIs [2 marks]