陽明交通大學 計算機系統管理 110學年度上學期 期中考
**NYCU Computer System Administration 110A Midterm Exam**
Date/Time: 2021/11/04 PM 06:40 ~ 08:40 (2 hours)
Open Book, No Electronic Equipment
Assume the operating system is FreeBSD 13.0-Release
English follows Chinese in every question. Both Chinese and English answers are acceptable.

============================= Questions start from here ==================================
**Part A: Multiple Choice (2% each, total 12%, 6 questions)**

1. 下列哪一個環境變數可用來指定指令搜尋路徑？
   Which environment variable can be used to specify the folders to search when executing commands?

   (A) HOME      (B) SEARCH      (C) SHELL      (D) PATH

2. 若想檢查一個 FreeBSD 系統上已安裝的軟體是否有安全性問題，應當使用什麼指令最好？
   To check the security issues of installed software, which command is the best one?

   (A) pkg info      (B) pkg check      (C) pkg audit      (D) pkg version

3. 假設某一目錄有三個檔案，以 /bin/sh 執行了下列兩行指令如下。請問如果再執行了
   echo 'Result: $var' 的執行結果為何？
   Assume we have 3 files in the current directory. The output after executing 2 commands in /bin/sh is
   below. What is the output after executing echo 'Result: $var' ?

   ```
   $ /bin/ls
   1 2 3
   $ var=$(/bin/ls)
   ```

   A) Result: $var      (B) Result: 1 2 3      (C) Result: $1 2 3      (D) Result:

4. 承上題，請問 echo "Result: $var" 的執行結果為何？
   Continued from the above question, what about the output of **echo "Result: $var"** ?

   (A) Result: $var      (B) Result: 1 2 3      (C) Result: $1 2 3      (D) Result:

5. 下列哪一個檔案描述了進入single user mode是否需輸入密碼的設定？
   Which file specifies whether we need to enter the root password when using single user mode?

   (A) /boot/mbr      (B) /boot/loader.conf      (C) /etc/login.conf      (D) /etc/ttys

6. 下列哪些程式應該給予setuid權限？

   Which program should not have "setuid" permission?

   (A) /usr/bin/chsh      (B) /usr/bin/chfn      (C) /usr/bin/passwd      (D) /usr/bin/su

**Part B. Short Answer (total 88%, 18 questions)**

1. (total 4%) Script permission.

   a. (2%) 請問如下輸出所示, 執行名稱為 getPoweredUp.sh 的 shell script 為什麼會發生 Permission denied？

   According to the following shell output, please describe why we got "Permission denied" when trying to execute the shell script "getPoweredUp.sh"?

   ```
   $ ls -l getPoweredUp.sh
   -rwx--x--- 1 wangth  users  0 Nov  5 20:07 getPoweredUp.sh
   $ ./getPoweredUp.sh
   ./getPoweredUp.sh: Permission denied
   $ id
   uid=1001(lctseng) gid=1000(users)
   ```

   b. (2%) 承上題, 如何解決 Permission denied 問題, 讓使用者可正常執行該 script？

   Continued from above question. How to resolve the "Permission denied" issue so that user "lctseng" can execute the "getPoweredUp.sh" script correctly?

2. (2%) 以下的 shell script 欲比較兩個變數 x 與 y 的大小, 試問執行結果是什麼？如欲修改為符合題目需求（即正確的比較兩個變數的數值）, 該如何修改？

   Someone wrote the following script to compare two numeric variables "x" and "y". What is the output of the following script? If we want to obtain the correct result (that is, compare "x" and "y" according to their numeric value), what should we do?

   ```
   #!/bin/sh
   x=5
   y=13
   if [ $x \< $y ]; then
     echo "$x < $y"
   else
     echo "$x >= $y"
   fi
   ```

3. (4%) 刪除 FreeBSD 系統上已安裝的軟體有下列兩種方式：pkg delete 與在該軟體 ports 目錄下 make deinstall。主要的差別是後者是執行 pkg delete -y -f 指令，不做任何 dependency 確認。請問省去 dependency 確認的步驟可能會發生什麼問題，而在什麼(少見的)情況下會需要這樣做？

   To remove installed software from FreeBSD, we can use either "pkg delete" or "make deinstall" in its directory in the ports tree. The major difference between them is that the latter is to directly issue the "pkg delete -y -f" command and skip the dependency checking step. What is the potential issue of skipping the dependency check step, and what is the (rare) case we need to do so?

4. (2%) 撰寫 Bourne Shell(/bin/sh)的 shell script 時，宣告變數除了直接宣告外，有時還會搭配使用 export 與 local 修飾詞。試問直接使用(var=value)與使用 export 和 local 修飾詞(export var=value 與 local var=value)的差別。

   When writing scripts in Bourne Shell (/bin/sh), besides simple variable declaration "var=value", we sometimes use prefixes like "export" and "local". Please describe the difference between "var=value", "export var=value" and "local var=value".

5. (total 6%) The man pages
   a. (2%) man crontab 時會看到 SEE ALSO crontab(5)，請問數字 5 所代表的意義為何？
      From the output of "man crontab", we can find "SEE ALSO crontab(5)". What does number "5" mean?

   b. (2%) 承上題，如何查詢 crontab(5) 的資料？
      Continued from above question. How to open the man page of "crontab(5)"?

   c. (2%) 下列為 ls 指令的 manual 部份內容，請問"[ ]"與"…"所代表的意義為何？
      Part of the manual of command "ls" is below. What are the meanings of "[ ]" and "…"

      ```
      ls [--libxo] [-ABCFGHILPRSTUWZabcdfghiklmnopqrstuwxy1,] [-D format] [file ...]
      ```

6. (total 6%) 在 FreeBSD 上安裝軟體可以使用 Ports System 或 Pkg。試回答下列問題。
   In FreeBSD, we can install applications using "Ports System" or "Pkg". Please answer the following questions.

   a. (3%) 請問兩者主要的差別是什麼？
      What are the major differences between the two tools?

   b. (3%) 請舉例什麼情況適合使用 Ports System，而什麼情況適合使用 Pkg 呢？
      Please list some scenarios that the Ports System is preferred? What about Pkg?

7. (10%) crontab

a. (4%) 請說明下列兩行cron job會在何時執行指定指令
   Please indicate when these two commands will be executed.

   ```
   0 8 1-15 * *  /home/wangth/remind.sh
   0 5 * * 0,6  /usr/bin/tar czvf /backup/haha.`/bin/date +\%Y\%m\%d`.tar.gz /etc
   ```

b. (4%) 承上題, 透過 crontab -e 或 crontab <filename> 來設定 cron table 的作法何者較佳？為什麼？
   You can create cron entries by using "crontab -e" or "crontab <filename>". Which one is the better way to configure cron entries? Why?

c. (2%) 承上題, 請說明如何更改設定編輯所採用的編輯器
   Please explain how to change the default crontab editor.

8. (6%) 當你發現有一個 process 佔用 90% 以上的 CPU 資源, 通常會有下列三種處理方式：
   When there is a process that occupies more than 90% CPU in the system, we usually take one of the following 3 actions to resolve this issue:

   **1)** 使用nice或renice指令調整該process的niceness數值
   Use the "kill" command to send a SIGTERM signal to that process.

   **2)** 使用kill指令送SIGTERM signal給該process
   Use the "kill" command to send a SIGKILL signal to that process.

   **3)** 使用kill指令送SIGKILL signal給該process
   Use the "kill" command to send a SIGKILL signal to that process.

   a. (4%) 你會依照哪種順序來採用上述三種方法？請以編號作答, 並解釋為什麼？
      What is the reasonable order when taking the above three actions? Why?

   b. (2%) 請說明 SIGKILL 與 SIGTERM 兩種 signal 的差異為何？
      Please describe the difference between SIGKILL and SIGTERM.

9. (4%, 2% each) 許多系統服務都會在開機時自動執行。請簡述在 FreeBSD 的 init 與 Linux 的 Systemd 機制中, 分別會在哪些地方定義啟動服務所需的相依性與指令。
   Many background services are launched during the system booting up. Please describe where these services define their dependencies and launch commands. You need to answer both "init style" in FreeBSD and "Systemd style" in Linux.

10. (2%) 請分別解釋以下兩個 link 指令在原始檔案 fileA 被修改、刪除之後，對目標檔案 fileB 所造成的影響（請從inode與data block的角度來分別解釋修改與刪除）。

We have two link creation commands below. What happens to the target file "fileB" after the source file "fileA" is modified or deleted? Please describe the outcome for these commands for modification and deletion respectively. You should answer this question from the aspect of inode and data blocks.

```
$ ln fileA fileB
$ ln -s fileA fileB
```

11. (total 4%) Script permission.

 a. (2%) 請問如下輸出所示，執行名稱為 getPoweredUp.sh 的 shell script 為什麼會發生 Permission denied？

According to the following shell output, please describe why we got "Permission denied" when trying to execute the shell script "getPoweredUp.sh"?

```
$ ls -l getPoweredUp.sh
-rwx--x---  1 wangth  users  0 Nov  5 20:07 getPoweredUp.sh
$ ./getPoweredUp.sh
./getPoweredUp.sh: Permission denied
$ id
uid=1001(lctseng) gid=1000(users)
```

 a. (2%) 承上題，如何解決Permission denied問題，讓使用者可正常執行該script？

Continued from above question. How to resolve the "Permission denied" issue so that user "lctseng" can execute the "getPoweredUp.sh" script correctly?

12. (total 8%) 假設系統中有下列四個程式，且目錄都是可讀可執行。

Assume we have the following four programs/scripts in the system. All directories are readable and executable.

```
lrwxr-xr-x  1 root     wheel 6      Oct 23  2020    /usr/bin/chfn -> chpass
-r-sr-xr-x  1 root     wheel 23928  Oct 23  2020    /usr/bin/chpass
-rwxr-xr--  1 lctseng  user  1037   Nov 10  08:53   /home/lctseng/game.exe
-rwxr-sr-x  1 wangth   staff 1037   Nov 9   06:33   /home/wangth/run.sh
```

使用者資訊如下：

User accounts are below:

```
$ id root
uid=0(root) gid=0(wheel) groups=0(wheel),5(operator)
$ id wangth
uid=1002(wangth) gid=1199(alumni) groups=1199(alumni),0(wheel)
$ id lctseng
uid=1001(lctseng) gid=1000(user) groups=1000(user)
```

a. (2%) 請問當使用者 wangth 是否可執行 /usr/bin/chfn？如果可以，該 process 的 UID、GID、EUID、EGID分別為何？

Is it possible for the user "wangth" to execute "/usr/bin/chsh"? If it is possible, what are the UID, GID, EUID and EGID of that process?

b. (2%) 請問當使用者 wangth 是否可執行 /home/lctseng/game.exe？如果可以，該 process 的 UID、GID、EUID、EGID 各為何？

Is it possible for the user "wangth" to execute "/home/lctseng/game.exe"? If it is possible, what are the UID, GID, EUID and EGID of that process?

c. (2%) 請問當使用者 lctseng 是否可執行 /home/wangth/run.sh？如果可以，該 process 的 UID、GID、EUID、EGID 各為何？

Is it possible for the user "lctseng" to execute "/home/wangth/run.sh"? If it is possible, what are the UID, GID, EUID and EGID of that process?

d. (2%) 請問上述 file access mode 的 r-s 中的 s 意義為何？有什麼潛在的危險？

What is the meaning of "s" in the file access mode "r-s"? What are the potential security issues?

13. (total 6%, 3% each) 當系統當機或斷電導致檔案系統不一致 (dirty) 的時候，可以怎麼修復？為什麼日誌型檔案系統可以節省修復的時間？

After a system crashes or power failure and the file system is dirty, how can we fix it? Why is the journal file system able to reduce the repairing time?

14. (3%) CoW (copy on write) 檔案系統的優缺點為何？請說明適合的應用場景。

Please explain the pros and cons of CoW (copy on write) filesystems, and describe a scenario.

15. (total 4%) File and directory permissions.

a. (2%) 若希望建立的目錄其屬性為 d --- r-- r-x，請問 umask 數值需設定為何？

If we want to change the default directory permission to "d --- r-- r-x". What is the "umask" value?

b. (2%) 若希望建立的檔案其屬性為 - r-- --- rw-，且目錄具有 x 權限，請問 umask 數值需設定為何？

If we want to change the default file permission to "- r-- --- rw-" and make the default directory permission include "x". What is the "umask" value?

16. (4%) 請問對於 swap 放置的地方使用 RAID 以及加密的功能，是否能增加系統安全還有穩定的程度，或只是增加不必要的開銷，請說明原因。

Does it make any difference in the system security and robustness to use RAID and enable disk encryption for the swap space, or just adding necessary overhead? Please explain the reason.

17. (4%) 某台機器 root 使用者的 crontab 有以下內容：
This is a cron job of the root user of a machine:

```
0 4 * * 1 (cd /raid; /usr/local/bin/rsync -aH --delete cs /backup/user/)
```

請問這樣有什麼潛在的安全性問題，以及該如何修正？
Please explain the potential security issues of this and how to fix them.

18. (total 9%) RAID
   a. (3%) 在硬碟規格都一樣的情況下，請比較兩個硬碟組成的 RAID1 和單獨一個硬碟，分別在寫入和讀取時理論上的效率，並說明原因。
      Given that the specs of the hard drives are the same, please compare the theoretical read and write performance of a 2-disk RAID1 with a single disk, and explain why.

   b. (3%) 在硬碟規格都一樣的情況下，請比較兩個硬碟組成的 RAID0 和單獨一個硬碟，分別在寫入和讀取時理論上的效率，並說明原因。
      Given that the specs of the hard drives are the same, please compare the theoretical read and write performance of a 2-disk RAID0 with a single disk, and explain why.

   c. (3%) RAID5 的容量為成員硬碟總容量減去一個硬碟的容量。理論上成員硬碟越多，減少空間耗損的比例就越低，但是在實務上卻不建議用太多硬碟組成一個超大的 RAID5，請解釋原因。
      The size of a RAID5 is the total size of all member disks subtracting the size of one disk. In theory, having more member disks, the less space overhead is. However, in practice, it is not recommended to create a RAID5 with too many disks. Please explain the reason.