

# Administration of Operating Systems

## DO2003

11th of January 2011

9<sup>00</sup>–13<sup>00</sup>

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75% of Part 1  $\Rightarrow$  3  
Grade: 75% of Part 2  $\Rightarrow$  4  
75% of Part 3  $\Rightarrow$  5

To get grade 4 you must have passed grade 3,  
to get grade 5 you must have passed grade 3 and 4.

### **Tools allowed:**

Pencil and eraser.

Dictionary, as long as it is a paper one and there are no notes in it.

Other tools according to central regulations.

**Important! Read the instructions on next page before you start!**

Make sure you fill the answer sheet form carefully – it will be read by a machine so avoid changing your mind. I suggest you think about your answers first, note them down on the question form, and only transfer them to the answer sheet afterwards: when you are sure of them. If you make a mistake, you need to *erase* the wrong answer.

Mark your selection with an “**X**” in the chosen box, corner to corner.

Make sure you put your personal ID number in the “ID” part of the answer sheet (encode “T” and “N” in personal ID number as 1).

You need to hand in all the answer sheets. The one you have received is for *Part 1* and *Part 2*. Answers to *Part 3* are to be given on a separate paper – but make sure you sign this paper as well!

You are free to keep or throw away the questions form.

In *Part 1*, exactly one of the four alternatives is always correct. You get 1 point if you mark it, and 0 points otherwise. There are no negative points for wrong answers.

In *Part 2*, you need to match numbers 1-4 against A-F letters. In most cases there exists a letter that corresponds to each number, but it is **not** guaranteed! You get 1 point for each correct match, and **-1** point for each incorrect match. Therefore, if you are not sure of your answer, it might be a good idea to leave some answers empty (this is always 0 points).

In *Part 3*, you are supposed to show both a deep understanding of the topic and some critical thinking. Therefore, we are interested in your thoughts on the subject, including an explanation of *why* do you think so.

## Good Luck!

# Part 1

1. Which network utility can be used to configure network interfaces and to display their current configuration?
  - (a) `dig`
  - (b) `ping`
  - (c) `ifconfig`
  - (d) `traceroute`
2. Which of the following statements is incorrect?
  - (a) The `dpkg` utility works with packages in the form of `.deb` files
  - (b) `apt` downloads package headers and packages from servers called repositories.
  - (c) `dpkg` can be used to download, install, remove, and manage dependencies of software packages.
  - (d) Higher-level package management tools, such as `aptitude`, rely on `apt` which, itself, relies on `dpkg` to manage the packages in the system.
3. The user's home directory contains only two files, named `grades.txt` and `exam.txt`, respectively. After executing `cd ~` and `cp exam.txt ./exam.bkp`, what files will the home directory contain:
  - (a) `grades.txt` and `exam.txt`
  - (b) `grades.txt`, `exam.txt` and `exam.bkp`
  - (c) `grades.txt`
  - (d) `grades.txt` and `exam.bkp`
4. Which command is used to remove a software package and its configuration files?
  - (a) `aptitude uninstall <package name> --keep-config`
  - (b) `aptitude reinstall <package name>`
  - (c) `aptitude purge <package name>`
  - (d) `aptitude remove <package name>`

5. `$ ls`

`report1 report2 report3 script1.sh script2.sh script.sh`

What do you expect to see on the screen after executing `ls *[0-9].sh > files` command?

- (a) `script1.sh script2.sh script.sh`
- (b) Nothing, the output is redirected to a file.
- (c) `script1.sh script2.sh`
- (d) `script.sh`

6. Which technique allows several computers to share a single Internet connection and IP address?

- (a) BIND
- (b) NIS
- (c) NFS
- (d) NAT

7. In a typical GNU/Linux configuration, a regular (non-root) user is allowed to:

- (a) none of the others.
- (b) change contents of (most) files in `/etc`
- (c) copy (most) files from `/etc`
- (d) create files and directories in `/etc`

8. Considering the following commands and their corresponding outputs

```
~$ ls -l
total 4
drwxrwxr-x 2 ide ide 4096 2011-12-12 09:28 MyDocs
-rw----- 1 ide ide  556 2011-12-12 09:29 exam_grades
-rw-rw-r-- 1 ide ide 4523 2011-12-12 09:30 prac_exam
-rw-rw-r-- 1 ide ide 1234 2011-12-12 09:29 theo_exam
~$ mv *exam ~/MyDocs/ 2> /dev/null
```

What is the expected output of the `ls` command?

- (a) exam\_grades MyDocs prac\_exam theo\_exam
- (b) MyDocs prac\_exam theo\_exam
- (c) exam\_grades MyDocs
- (d) MyDocs

9. What does the `mount` command do, when issued without any arguments?

- (a) It mounts the default filesystem(s) with default settings.
- (b) It displays the usage message indicating which arguments it accepts.
- (c) It lists filesystems that are ready to be mounted.
- (d) It lists the currently mounted filesystems.

10. Which of the following is an advantage of fiber optics over copper cables?

- (a) Cheaper, at least in large-scale installations.
- (b) Better security.
- (c) Faster data transmission.
- (d) All of those.

11. Select an incorrect statement about DNS:

- (a) DNS maps domain names to IP addresses, but not IP addresses to domain names.
- (b) In `https://mail.student.hh.se/zimbra/`, the “mail” part is a host-name.
- (c) `bind` is one of the most commonly used implementations of the DNS protocol.
- (d) *DNS spoofing* occurs when a DNS server receives non-authentic data, and later supplies it to its clients.

12. Select the incorrect command description for the vi editor
- (a) `dd` — delete current line.
  - (b) `:q!` — save and quit.
  - (c) `i` — switch to insert mode.
  - (d) `/txt` — move to the occurrence of `txt`.
13. What is stored in `/etc/passwd` file on a modern GNU/Linux system?
- (a) List of users and their passwords in clear text.
  - (b) List of users and their passwords, hashed using MD5.
  - (c) List of all users who have permission to use the system.
  - (d) List of users, but not their passwords.
14. Which server should you install in order to share filesystems and printers between Windows and GNU/Linux systems?
- (a) `bind`
  - (b) `nfs`
  - (c) DNS
  - (d) `samba`
15. Which of the following is not a valid conditional expression?
- (a) `[ $# -eq 0 ]`
  - (b) `test $# -eq 0`
  - (c) `(( $# < 1 ))`
  - (d) `& $# == 0 &`

16. You have executed the following commands, in order to understand the configuration of the environment:

```
$ cd ~
$ pwd
/home/ide
$ ls -l
-rwxr--r-- 1 ide ide 123 Jan 11 11:11 script.sh
$ echo $PATH
/usr/local/bin:/usr/bin:/bin:/usr/local/games:/usr/games
```

You know that there are (at least) four ways to run a shell script from the command line:

```
$ script.sh
$ bash script.sh
$ ./script.sh
$ /home/ide/script.sh
```

Which of those four ways will result in an error message?

- (a) neither of those four.
  - (b) only `script.sh`
  - (c) all four of them.
  - (d) only `bash script.sh`
17. Which of the following numeric permission specifications do not fit the provided descriptions?
- (a) 777: Owner, group, and others can read, write, and execute file.
  - (b) 755: Owner can read, write, and execute file; group and others can read and execute file.
  - (c) 710: Owner can read, write, and execute file; group and others can execute file.
  - (d) 644: Owner can read and write file; group and others can read file.

18. Which password is required when using the `sudo` command?
- (a) The `sudo` password
  - (b) The password of current user
  - (c) The root password
  - (d) Using `sudo` never requires a password
19. Which of the following describes the firewall capabilities of modern GNU/Linux system?
- (a) `iptables` is a framework within Linux kernel for controlling network packet filtering.
  - (b) Thanks to the technique called *connection tracking*, Linux firewall can understand application-layer protocols and therefore mark two distinct connections as “related”.
  - (c) `netfilter` sets up, maintains, and displays the rules stored in `iptables`.
  - (d) You need to configure `firestarter` before you can take advantage of hardware firewall.
20. Which of the following is not a protocol related to sending/receiving emails?
- (a) IMAP
  - (b) SMTP
  - (c) MUA
  - (d) POP3
21. `$ sort list > temp`  
`$ lpr temp`  
`$ rm temp`
- The commands above are equivalent to
- (a) `sort list > lpr`
  - (b) `cat list | sort | lpr`
  - (c) `sort list | rm list | lpr`
  - (d) `list > sort > lpr`

22. Which command will *add* a directory `/prog` to the `$PATH` variable?

- (a) `$PATH=/prog:$PATH`
- (b) `$PATH=/prog`
- (c) `PATH=/prog:$PATH`
- (d) `PATH=/prog:PATH`

23. What can you say about the following utilities and their corresponding descriptions?

`ls`: Lists files

`cat`: Displays the content of a file

`rm`: Deletes files and directories

`cp`: Copies files and directories

`mv`: Renames a file or a directory

`grep`: Searches for a string

`file`: Determines file type

- (a) The description about `rm` is incorrect.
- (b) All descriptions are correct.
- (c) `rm` and `cp` do not work with directories.
- (d) There is no utility named `file`.

24. Which application layer protocol does not use TCP?

- (a) HTTP
- (b) DHCP
- (c) SMTP
- (d) FTP

25. The user `ide`, logged in on host `ubuntu`, issues the following command:

```
$ ssh -p 2020 sat@ubuntuserver cat list.txt | grep Monday
```

Which of the following statements is true?

- (a) The connection will use a standard port for SSH service.
  - (b) The `grep` command will be performed on the `ubuntuserver` system.
  - (c) The `grep` command will be performed on the `ubuntu` system.
  - (d) The user is going to use the same username on both local and remote system.
26. Free software, as defined by Richard Stallman's Free Software Foundation, does not mean that
- (a) author must distribute the software free of charge.
  - (b) author needs to make the source code available.
  - (c) users are free to use and redistribute the software and its source code.
  - (d) users are free to study, change, and improve the software source code.
27. Which of the following statements about NFS is incorrect?
- (a) The use of NFS usually results in an increased storage needs.
  - (b) The `/etc/exports` file lists the directory hierarchies that the system exports.
  - (c) The `/etc/fstab` file controls which filesystems are mounted at boot time.
  - (d) NFS allows a server to share selected local directory hierarchies with client systems on a heterogeneous network.
28. Which method would you use to notify system users that you are going to reboot the system in 10 minutes?
- (a) Put a message in the `/etc/motd` file.
  - (b) Send a message using email.
  - (c) Use `apache` server.
  - (d) Send a message using the `wall` utility.

29. There is a missing statement in the pseudo-code below.

```
while test-command
  if test-command
  then
    commands
  elif test-command
  then
    commands
  else
    commands
  fi
done
```

Which statement is missing?

- (a) `else`
  - (b) `do`
  - (c) `elif`
  - (d) `fi`
30. Why would you set up a network information service (NIS) on your local network?
- (a) To share local directory hierarchies across the network.
  - (b) To centralise user and system configuration data, making administration easier.
  - (c) To offer centralised and managed backup service for authorised network clients.
  - (d) To offer easy interaction between users in the form of real-time text messaging and conferencing.
31. You have taken over administration of an `apache` web server from a colleague who has left the company. You notice that `apache` is not obeying directives from `.htaccess` files. What can you do to fix this?
- (a) Change the owner of `.htaccess` files to user `www`.
  - (b) Change configuration option `AllowOverride` from `None` to `All`.
  - (c) Make `.htaccess` files executable (for example, using `chmod` utility).
  - (d) Make `.htaccess` files executable (for example, using `file` utility).

32. Which feature allows `apache` server to respond to requests directed to different hostnames that share the same IP address as though it were multiple servers?
- (a) Multiviews
  - (b) Type maps
  - (c) Virtual hosts
  - (d) Common Gateway Interface
33. The user `ide` issues `cd ~/docs/report/../../course/../../pictures/` in the command line. What is the new working directory?
- (a) `/docs`
  - (b) `/home/ide/pictures`
  - (c) It is not possible to determine the new working directory from the provided information.
  - (d) `/home/ide`
34. You want to delete a directory `/home/ide/MyDocs/`. The directory contains files and subdirectories. Which command you will use to delete the this directory and its content?
- (a) `rm -R /home/ide/MyDocs/*.*`
  - (b) `rm -r /home/ide/MyDocs`
  - (c) `rm /home/ide/MyDocs/`
  - (d) `rmdir /home/ide/MyDocs/`
35. You have created an alias as follows: `alias ls='ls -a'`. Which of the following can be an output of the `ls -F` command?
- (a) `./ ../ dir/ script.sh`
  - (b) This command will result in an error message, since an option has already been provided in the alias definition.
  - (c) `dir/ script.sh`
  - (d) `. dir script.sh`

36. Select the incorrect statement about FTP protocol
- (a) The control connection is established after the client logs into the FTP server.
  - (b) A data connection is established, among others, after the client asks a FTP server to transfer a file.
  - (c) A passive connection is initiated by the client.
  - (d) An active connection is initiated by the server.
37. Select the incorrect statement about the Linux kernel:
- (a) The kernel includes shells (command interpreters).
  - (b) The kernel includes the low-level hardware interfaces (drivers) and manages processes.
  - (c) Programs interact with the kernel through system calls.
  - (d) The kernel allocates machine resources.
38. Suppose that you have created a backup of a given file. After doing some changes to the original file, you want to compare the new contents with this backup. What is the most convenient utility to use?
- (a) `diff`
  - (b) `sort`
  - (c) `head`
  - (d) `grep`
39. Which statement about filenames in `ext3` filesystem is incorrect?
- (a) `prac_exam`, `Prac_exam`, and `PRAC_EXAM` represent three distinct files.
  - (b) Filename extensions often help describe the contents of the file, but the filesystem does not enforce this.
  - (c) A filename that ends with a period is called a hidden filename.
  - (d) Filenames can be up to 255 characters long.

40. Which of the following is the correct statement about job control?

- (a) Bash assigns a job number to each command you run, including those you run in the background.
- (b) Bash assigns a job number to commands you run, but only those you run in the background.
- (c) `fg` moves a foreground job to the background.
- (d) Bash assigns a job number to commands you run, except for those you run in the background.

## Part 2

1. You have four tasks that need to be done:

- (1) You have a file containing an alphabetically-sorted list of student names and the number of bonus points they have received for submitting multiple choice questions in the Administration of Operating Systems course. You need names of 5 students who have received the highest number of points.
- (2) You are planning to make a major re-configuration of the system, and you want to make sure that if something goes wrong, you will have a way to restore the working settings.
- (3) Calculate md5 sum of all files within a given directory tree (i.e. directory and its subdirectories) that have been modified today.
- (4) You notice that there is some server listening on port 25378, but you don't remember what program that is. You need to locate its configuration file(s).

For each task, choose a utility from the list below that can be used to solve this task (among others, i.e. this utility does not necessarily need to solve the task by itself, but it can be part of the solution):

- (a) `cp`
- (b) `lspci`
- (c) `find`
- (d) `grep`
- (e) `chmod`
- (f) `head`

2. Match the Shell special characters with their corresponding description

1. `>`
2. `<`
3. `'`
4. `$( )`

- (a) Performs command substitution.
- (b) Redirects standard output.
- (c) Quotes a string, preventing all substitution.
- (d) Redirects standard input.
- (e) Evaluates an arithmetic expression.
- (f) Quotes a string, allowing only variable and command substitution.

3. Match the following network utilities with their corresponding descriptions.

(1) `ftp`

(2) `ssh`

(3) `scp`

(4) `wget`

(a) Securely executes commands on a remote system.

(b) Securely copies one or more files to or from a remote system.

(c) Creates, manages, and converts RSA or DSA authentication keys.

(d) Interactive utility for transferring files over a network.

(e) Retrieve files from the Internet using HTTP, HTTPS or FTP protocols.

(f) A secure alternative to `ftp`, with very similar set of user commands.

4. You have installed the apache server. The important parts of the configuration are the following:

```
Listen 80
<Directory />
    Options -Indexes +FollowSymLinks
    AllowOverride None
</Directory>
<VirtualHost *:80>
    DocumentRoot /www/example1
    ServerName www.example1.com
</VirtualHost>
<VirtualHost *:80>
    DocumentRoot /www/example2
    ServerName www.example2.com
</VirtualHost>
```

Moreover, directory `/www/example1` contains the following files: `index.html` `a.html` `b.html`, while directory `/www/example2` contains the following files: `x.sh` `y.sh`. Given that, match those four requests:

- (1) `http://www.example1.com/`
- (2) `http://www.example2.com/`
- (3) `http://www.example1.com/a.html`
- (4) `http://www.example2.com/x.sh`

with the responses:

- (a) Contents of `/www/example2/x.sh` file
- (b) Contents of `/www/example2/index.html` file
- (c) Result of executing `/www/example2/x.sh` file as bash script
- (d) Contents of `/www/example1/index.html` file
- (e) 404 “No such file” error.
- (f) Contents of `/www/example1/a.html` file

5. You need to print a list of subdirectories, together with the amount of disk space that each subdirectory occupies, properly sorted. Order the elements below correctly. *Hint:* the full command consists of four parts.

- (a) `grep -v "/.*/"`
- (b) `du -k`
- (c) `sort -n |`
- (d) `>`
- (e) `|`
- (f) `| sort -n`

6. Order the following programs involved in sending an email message from Alice to Bob, starting with the first one to handle the message first and ending with the one to handle that message last

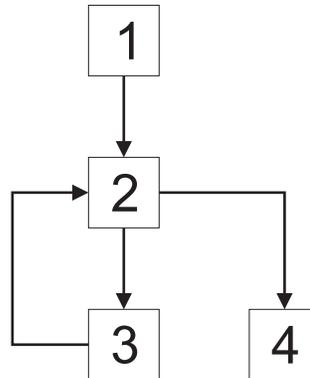
- (a) Alice's Mail Delivery Agent
- (b) MTA
- (c) Alice's Mail User Agent
- (d) Bob's Mail User Agent
- (e) Alice's Mail Submission Agent
- (f) Bob's Mail Submission Agent

7. The `ls -l` command displays various information about a file in a single line. Match the numbers above the line with the letter indicating what kind of information this part of the line contains.

```
----1----      -2-      --3-                          -4-  
-rwxrwxr-x+ 3 ide ide 2048 2010-08-12.13:15 ide
```

- (a) The name of the file.
- (b) Size of the file.
- (c) ACL flag.
- (d) File's access permission.
- (e) Owner of the file.
- (f) Group the file is associated with.

8. The following figure shows a control flow of a simple script, one that prints the sum of it's arguments. Match the commands below to appropriate places:



- (a) `let res=0`
- (b) `while [ $# -gt 0 ]`
- (c) `echo $res`
- (d) `shift`
- (e) `res = $res + $1`
- (f) `let res=$res+$1 ; shift`

9. File days looks as follows:

```
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Sunday
```

Match the following results:

1. Monday  
    Tuesday  
    Wednesday
2. Friday  
    Saturday  
    Sunday
3. Sunday  
    Thursday
4. Saturday  
    Sunday

with possible commands:

- (a) `grep -vi "s" days | tail -2`
- (b) `head -3 days`
- (c) `sort days | head -5 | tail -2`
- (d) `cat days | tail -c23`
- (e) `grep "u.*d" days | grep -v "s"`
- (f) `sort days | tail -3`

10. Below are four lines taken from the configuration file of `sshd` server:

- (1) `ListenAddress 1.2.3.4:4444`
- (2) `UsePrivilegeSeparation yes`
- (3) `PermitRootLogin no`
- (4) `X11Forwarding yes`

Match those lines with their explanations:

- (a) Makes `sshd` spawn another process, after successful authentication, to be running as the authenticated user, instead of running as root.
- (b) Enables the possibility of forwarding requests when server is temporarily disabled.
- (c) Causes `sshd` to listen on the remote system and transfer GUI commands back to the local machine.
- (d) Disables the possibility of using `ssh` to log in as root.
- (e) Specifies that `sshd` should listen on IP address `1.2.3.4` and port `4444`
- (f) Requires users to provide valid password before being able to log in.

## Part 3

1. Find problems in the following script. For every one you find, explain *why* is it a problem *and* how can it be fixed. Observe that there are both problems that clearly errors (i.e. things that will cause the script to not work as intended), as well as smaller “imperfections”. Try to find as many as possible of both kinds.

```
secretNumber=$(( ((`date +%N` / 1000) % 100) +1 ))
read $time
for [ "$time" != "$secretNumber" ] do
echo -n "I am thinking of a number between 1 and 200. "
echo -n "Enter your guess:"
if [ "$time" = "" ]; then
echo "Please enter a number."
elif [ "$time" != "$secretNumber" ]; then
echo "Yes! $time is the correct answer!"
elif [ "$secretNumber" -gt "$time" ]; then
echo "The secret number is larger than your guess. Try again."
elif
echo "The secret number is smaller than your guess. You lose!"
done
```

2. Explain the recursive and iterative DNS queries. Pay special attention to differences and similarities between them. Give an example of situation where recursive DNS server is better than the iterative one, and an examples of an opposite situation. Justify both examples.
3. Explain the concepts of relative and absolute pathnames. Provide examples. Justify why both are needed for efficient working environment. Give examples of problems/situations that would be unsolvable without one or the other.

4. Suppose you have two files, `colour1` and `colour2`. You use the `diff` utility and obtain the following output:

```
$ diff -u colour1 colour2
--- colour1  2012-01-04 14:21:16.998242100 +0100
+++ colour2  2012-01-04 14:21:14.649107800 +0100
@@ -1,7 +1,7 @@
   red
   blue
+yellow
  orange
-green
  violet
  black
  white
```

Describe what does this output mean. Reconstruct the contents of `colour1` and `colour2` files. Is this the only possibility? Explain your answer.

5. Suppose you being hired by a small company as an “IT administrator”. The company has no network infrastructure whatsoever, but they want you to change that. Assuming you have decided to use GNU/Linux, describe which services would you install, how would you configure them, and in what order would you work on that (i.e. which ones do you consider most important). You can decide upon the details of the company. It is also up to you what their needs are, as long as you motivate how those needs influence your decisions. Feel free to also describe why have you decided that some services are *not* going to be useful for your company. Maximum 1 page.